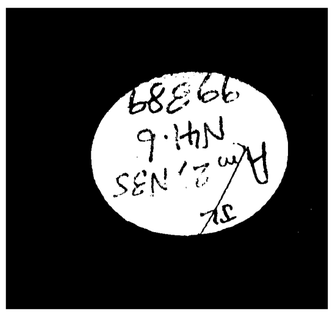

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SCIENCE AND CULTURE

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Agricultural Research in India

THE Imperial Council of Agricultural Research concluded its ninth working year on 31st March, 1939. The annual report for the period 1st April, 1938 to 31st March, 1939, which we received a few months back, gives as usual an account of the large amount of useful researches and other activities conducted under its aegis. The Council financed 122 schemes employing about 350 scientific workers and spent more than 16 lakhs of rupees. We are glad to note that a cess on agricultural exports has been imposed ; this will improve the financial position of the Council. The annual report serves as a handy reference to the various activities of the Council. There are also three journals, mainly for the scientific investigators, published by the Council and recently a popular monthly journal *"Indian Farming"* dealing with the subjects in a more elementary way has been added to the list. It is not, however, easy to form an idea of the actual progress of the schemes from the annual report and the journals. The report in itself does not seem sufficient for the purpose. When we consider the vast areas and the wide divergences in climatic and soil conditions with their special problems, the colossal losses caused by erosion, by leaching by water, by extractive farming, by the soil-depleting crops, and the backwardness of our agricultural practices, one cannot but feel that the time has come for the Council to review the whole position and evolve more definitely a policy of its own and advise the Government accordingly.

Steps should be taken to ensure a more energetic and better co-ordinated drive all along the front, with a view to the elimination of the weak spots in the present organisations in the Centre and in the provinces for research, education, advisory work, and propaganda, and remodelling all these activities in the light of experience. Through the efforts of the Council, a framework of agricultural research has been built up and the experience gained should now enable it, with the help of its own resources, of the provinces and of distinguished non-official scientists, to draw up a comprehensive programme. The public as well should be kept better informed of the present position, the problems and the possibilities of their solution. Every year useful information and data are collected and it seems to us that separate periodical reviews of this stock of information and the progress made in the separate schemes will be very helpful. These reviews need not be published annually, but every three or five years, and should contain a clear statement of the problems and the progress and achievements made so far. We are sure such reviews will be much appreciated by the general public. They need not be merely popular expositions but should be accompanied by a summary in non-technical language. The inclusion of accounts of the work related to the major schemes which have been done elsewhere will materially enable technical and non-technical men to appraise our efforts and achievements as far as their essential value is concerned and will also stimulate the research workers themselves. This will involve merely an elaboration

of the present method ; but will offer an opportunity of assessing the progress of the schemes far more adequately to decide on their continuation and improvement. We are quite aware that this procedure may mean an increase of staff in the publication section and will also require men properly qualified to sift the results and to collect information contained in relevant publications. But this sort of survey is expected to be of such material help to the Advisory Board, the standing committees and the research workers that we have no hesitation in recommending the suggestion for the serious consideration of the authorities. It is not intended that the work of the Imperial Bureaus should be duplicated. The reviews should deal with the major subjects for investigation, *e.g.*, rice, jute, cotton, sugar, irrigated lands, reclamation of lands, soil research, manurial trials etc. with special reference to Indian conditions and should make a comparative study with what has been done elsewhere.

From several points of view, it is desirable that research workers working under the schemes scattered all over the country studying isolated problems should meet periodically and exchange notes. The meetings of the Advisory Board, of the Board of Agriculture as also of the Indian Science Congress and the Indian Society of Soil Science offer some opportunities in this direction. But the time which can be spared for a fruitful discussion is insufficient and the atmosphere on these occasions breeds a sense of haste which does not conduce to thoughtful scientific work. Besides, agriculture is a field science and a detailed experience of field conditions obtaining in different parts of the country is essential. Most of our scientific workers have little chance of keeping themselves in touch with the progress of the work done outside their own province or laboratory. Newer techniques and methods of theoretical approach are being continuously developed and it is necessary that our workers should have an opportunity to discuss these and to see such work as is going on in the university and other laboratories. University men interested in agricultural problems should also have opportunities of gaining field experience. A periodical conference of research workers in different parts of the country with a well-defined purpose will be helpful in this direction and non-official representatives of pure science, who are engaged in allied problems, should be invited to participate in the discussions.

At the meetings of the Council, of the Advisory Body and the special *ad hoc* committees, held for the purpose of supervision and guidance of the workers no serious thought can be given in the short space of time allotted for the purpose to the very lengthy agenda. Excepting the ordinary administrative details, the members do not find sufficient leisure, nor are they in a position to marshal sufficient materials to enable them to make substantial contributions to the discussions. The work of the Council has expanded enormously and a thorough scrutiny and co-ordination of all activities is not possible at the periodical meetings of the Advisory Board. It is essential from the point of view of the utility of the work that there should be a harmonious co-ordination of the different aspects of related studies. It seems to us that the present technical expert staff is having a tiring time in carefully analysing the increasing number of schemes. They would be gradually so preoccupied with their specific branches that for the profitable co-ordination of the schemes they should soon be provided with additional expert help and, if necessary, from outside. We suggest that the close co-operation between the university staff and the technical staff under the employment of the Government of India which is already bearing fruitful results may be immediately extended for this purpose. In addition, a small advisory committee consisting of the experts of the Board and of non-official scientists should be constituted to help in this co-ordination. The Advisory Board itself is too unwieldy to effect this and a standing advisory committee for purposes of co-ordination would best meet the situation. This committee should meet continuously for a number of days before the meetings of the Board and prepare a memorandum on the schemes, their progress, etc., for the consideration of the standing and the *ad hoc* committees. This committee will again meet immediately after the standing and *ad hoc* committees have finished their deliberations to prepare a digest for the Advisory Board. The function of this committee will be advisory and it will naturally relieve the Advisory Board of a great amount of strain. This committee should have the power to suggest to the Advisory Board new and alternative schemes and to advise it on questions of policy. It is expected that this committee will be able to give a greater impetus to fundamental research and will always keep definite objectives in front of the Board. The Council through this committee may be in a position to arrange for detailed discussion with workers in different localities.

Sometimes the programmes in the different government institutes and research laboratories show a tendency to be stereotyped. Standing committees with advisory functions, as suggested above, having non-official experts may be similarly in touch with the work of the sugar, cotton and jute committees. There is unfortunately very little co-ordination and co-operation between the research laboratories of these committees and those of the universities. The standing committees for these will be able to give valuable advice and guidance and the Advisory Board is sure to find their work most helpful. We do not think it will cause friction and undue interference. The suggestions made above that the committees will have advisory functions will protect the institutes concerned from such difficulties in their work. The method of securing non-official experts on these committees should be such as not to lead to wire-pulling of any sort and the best men should be nominated by the Advisory Board itself. We are sorry to note here that there is at present no close contact between the research laboratories of the Central Jute Committee at Calcutta and the universities at Dacca and Calcutta. We are afraid some of the resources of these Universities are not being utilised to the best advantage for the furtherance of the objectives which led to the foundation of the Central Jute Committee and its research laboratories. An advisory committee in this case may consider the existing facilities in the different laboratories and suggest which work may be offered to each of them, by providing extra facilities, if necessary.

The proposed technical advisory committee under the Board in co-operation with other standing advisory committees will be competent to assist in co-ordinating under a sound comprehensive policy not only the different schemes and the activities of the research institutes but will also be in a position to give advice to the provincial departments of agriculture wherever necessary. The best scientific methods must be applied to the problems and in carrying out the work it is always necessary to see that resources in men and laboratory facilities are utilised to the best advantage. We are afraid that at present there is too much of work in isolated compartments and this seems to be very common in institutions financed by the Government. The administrators at the top too often find it rather perplexing to come to a definite decision on technical matters and on the merits of proposals. The proposed advisory committee, if well constituted, should be of a great help to them, and if the present staff and the financial resources of all these laboratories are brought in line to fit with the major development schemes, the chances for a quick solution of the different problems that are facing us will materially increase.

Crop production and financial prosperity of the cultivators should constitute the objectives of the research activities financed by the Council. For this purpose, the conservation of the soil and its fertility should be optimum and balanced. One of the functions of the proposed technical committee of the Advisory Board should be to classify the existing schemes and point out their relationship to definite objectives whenever necessary. For purposes of classification of research schemes it will be worth while to follow the system given in the *Report of Agricultural Research in Great Britain* by the P.E.P. which we reviewed in this journal in the issue of May, 1939. It is given below and we make no apology to quote in length the references to activities which must supplement research.

(1) "Background research into fundamental scientific laws underlying all agricultural and industrial enterprises which should be carried out under the auspices of the universities.

(2) "Basic research into broad subjects with a pronounced practical bearing to be done by research institutions.

(3) "*Ad hoc* research into special problems to be mainly done by research institutes, though a considerable amount may be done privately.

(4) "Pilot or development research to bridge the gap between laboratory experiments and commercial practice which can be undertaken by research institutes, colleges, farm institutes and private farms.

"To supplement these activities there should be

(*a*) information service with provision for a continuous pooling of data between research workers, and the dissemination of research results among agricultural advisers and instructors,

(*b*) extension work comprising spreading of scientific knowledge amongst farmers and reporting the farmer's problems back to the scientists,

(*c*) Public relations work to interest the public and the farmer in the research activities by means of films, broadcasting and other methods of mass publicity, and

(*d*) training facilities for equipping the personnel both for future research work and for key posts in all the agricultural services."

Much spadework is yet to be done in

(1) Better control of water supply for crops ;

(2) Prevention of partial stratal loss of silt by erosion, by leaching by water, by bad methods of management, by faulty irrigation, etc. ;

(3) Provision of better implements ;

(4) Better system of crop-planning, in particular, of better rotation ;

(5) Evolution of varieties suited to different climatic and soil conditions ; and

(6) Improvements in the methods of soil management and manurial treatments. In this connection, a more detailed and up to date knowledge of our soil is of prime necessity. The manurial trials and the improved varieties have to be correlated to the types of the soil where the crops are to be grown for better returns.

At the invitation of the Government of India Sir John Russell, whose vast and authoritative experience is widely known, made a study of the position of agriculture in this country, and submitted his report a couple of years ago which *inter alia* suggested certain measures. These measures concerned mostly the developmental side of the work of the Council. The public are not aware what steps have been taken by the Council and by Governments in respect of his recommendations. His recommendations should not be allowed to be forgotten and pigeon-holed in the Secretariat. The scope of the Council's work now requires more broadening on the developmental side. The stage is ripe when reorientation of Council's activities should be made and the idea that agriculture is purely a branch of technology, where new knowledge is not necessary, should be modified. It is also high time that along with the improvement of our primitive agricultural practices the recommendations of Dr Wright in connection with the dairy improvements should be given earnest consideration.

VEHICLE FOR SWAMPS

MANY of the oil and geophysical companies operating in the Gulf Coast areas, where swamps abound presenting transportation difficulties, have not been satisfied with being baulked by nature. This has led to the development of the "marsh buggy", a truck or conveyance which can carry a heavy load over hard or soft ground or through water. After examining the methods used by other seismograph parties, the Stanolind Oil Co. has developed a marsh buggy which will travel with equal ease in water or on land. After it has finished work in a particular area, it can be disassembled into three parts and carried to the scene of its next operation on a truck. This buggy has four wheels but they are also pontoons, being made from sheet steel and hollow on the inside except for bearings and braces. Each wheel has a drain plug and a plug for greasing the bearing. All of the wheels are 4 ft. wide at the axle although the back ones are tapered to 3 ft. in diameter at their circumstance. The wheels are 9 ft. in diameter, the front ones being equipped with lugs made from 4 in. angle irons for driving and the back ones having an arched surface with a steering rim on them. The Stanolind marsh buggy is 21 ft. overall in length and 15 ft. in width ; the wheels, frame, motor and transmission weigh approximately 9,000 lb. It will carry a useful load of 6,000 lb. when it is put in service. Despite its weight it will climb hills, travel at 15 m.p.h. on land and approximately the same speed through water, regardless of depth. Steering on land and shallow water is through the back wheels. In the water the front wheels are used to steer. It is extremely manoeuvreable in both.

—Journal of the Franklin Institute.

Problems of Irrigation*

N. K. BOSE

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TO talk about irrigation in this country one is led to the province of the Punjab, the land of five rivers. The peculiar geographical position of the Punjab makes it the premier irrigation province of India. On the north it is bounded by the snowcapped mountains of the Himalayas from whose glaciers all the five rivers of the Punjab derive their supply. During monsoon the rivers are mostly in flow which passes off rather quickly and by the middle of September the rivers are low. There are heavy rainfalls in the mountains and the foothills, which fall off rapidly as one goes south into the plains and by the time one reaches the tracts round Lyallpur the rain is not more than 10 or 12 inches per year. Even this scanty rainfall is not properly distributed all throughout the year. When valuable crops such as cotton or wheat are to be matured, there is seldom any rain so that these crops can hardly be raised on rainfall alone. Hence during pre-irrigation days most of the country looked like deserts, only riverine tracts were cultivated.

Before the British came to the Punjab there were a few canals which were mostly of inundation types. Feroze Shah Tuglak dug a canal from the Jumna to feed Hissar and the districts round Delhi. This was in the 14th century. In the 17th century Ali Mardan Khan, the great engineer-general of Akbar and of Shah Jahan, dug Hasli canal from the Ravi to feed the Shalamar Bagh of Lahore. Later Ranjit Singh dug another canal from it to supply water to Amritsar. Besides these there were a number of smaller inundation canals taking off from the Jhelum. They supplied water to tracts near Shahpore. There was also well-irrigation, but this could only be practised near the rivers as the subsoil water in the Punjab is mostly saline and not fit for irrigation. This was the state of affairs when the British conquered the Punjab in 1849. It is well known that in the early days of occupation of the Punjab by the British, the Sikhs were always giving them trouble. In order to pacify the Sikhs, attempts were made to make them settle down on lands for cultivation. Hence canals were dug and irrigation started. The old existing canals were first renovated and one of them was the Western Jumna Canal taking off from the foothills where the Jumna emerges from the Himalayas, and another was the Upper Bari Doab Canal taking off from the Ravi at Madhopur. In 1890 proposals were first made to build a new system of canals.

Cultivation by artificial irrigation has been practised in India for many centuries before the advent of the British in India. Eminent engineers like Wilcocks and others are of opinion that the systems of waterways in the deltaic region of Bengal and in the Tanjore District of Madras were originally artificial channels taking off from the Ganges and the Cavery. These systems of irrigation were not however perennial. Another system of irrigation built dams in hilly tracts and created vast reservoirs of water during rainy season from which supply for irrigation could be had when monsoon was over or rains had failed. Examples of such reservoirs are now found very frequently in the hills such as the Dal Lake in Srinagar. In a third system of irrigation water was drawn from wells. It was generally practised in riverine tracts and is still being done in the Ganges and the Indus Valleys.

IRRIGATION BY WEIRS

It had been said earlier that some of the pre-British period canal system had been renovated and made fit for perennial irrigation. Previously they used to be mostly inundation canals, these canals used to run full supply when the river level was above a certain point and water could be thus forced into the canal due to some natural obstructions such as boulder or shingle bar on the bed of the river.

* Adapted from the first of a series of lectures delivered before Calcutta University in August, 1939.

At other period when the river supply used to be low these canals did not carry any water. But with the present type of weirs or barrages it is possible to feed the canal system even in winter when the river supply is very low—sometimes it so happens that all the water available in the river is taken into the canal and the river bed below the weir runs dry. The advantage of such a system of control is obvious, and such structures known as "Indian type" of weirs are now being built in America and other countries also.

The first weir on the new lines was built in 1890 on the Chenab at Khanki. Before any irrigation was opened in this *doab* between the rivers Chenab and Ravi, there used to be very little cultivation done in this tract—lands looked mostly like deserts and the population then was only seven per square mile. The present population in this canal colony known as Lyallpur Colony is 350 to the square mile. This area is now one of the most prosperous colony in the Punjab, yielding a land revenue well over 2 crores of rupees. It is fed by a system of canal known as the Lower Chenab Canal. This system of canal has presented to the engineers almost all the problems that can conceivably arise in dealing with irrigation.

If we look at a map of the Punjab, we will find the river Chenab on which there is Wazerabad, an important railway centre. A weir or masonry bund had been put up ten miles downstream of the river

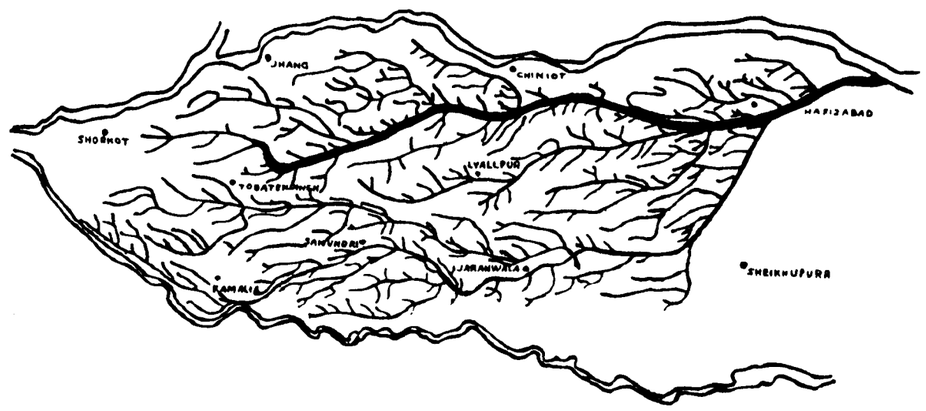
number of spurs in the river called as A, B, C, D, E, F, G, H, I and J on the plan. These were constructed after the weir was built. The original

PLAN SHOWING
HEADWORKS AND TRAININGWORKS
LOWER CHENAB CANAL
AT
KHANKI



course of the river was between the spurs I and J. According to the practice in the Punjab, the weir was built in the dry in its present position and

LOWER CHENAB CANAL



to head up the water supply in the river upstream of the weir site. It will be seen that there are a

subsequently the river was diverted over the weir by closing its original course. This practice has its

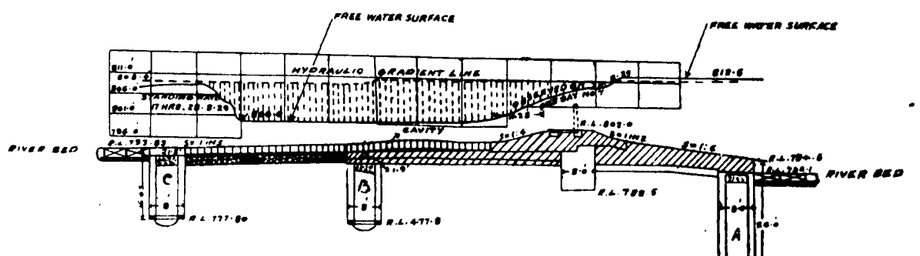
advantages and disadvantages. The main disadvantage is that after the construction of the weir the problem of river control becomes very important and lakhs and lakhs of rupees are spent in keeping the unwilling river to its new course. At Khanki one can see an array of spurs, some of them are due to the fact that the Upper Jhelum Canal drops a considerable supply of water from the Jhelum to the Chenab at this point, while others were built to train the river on to the weir. In spite of such heavy battery of spurs, the river at Khanki is still a source of anxiety and expense. In 1932 a heavy flood visited Khanki and due to unusual concentration of discharge in bays 4 and 8, heavy damage occurred necessitating extensive repairs costing about 25 lakhs of rupees, and loss of revenue due to closure of this canal on account of the failure. The weir was reconstructed during 1933-34 according to the latest engineering practice; for greater flexibility of control, bays Nos. 4 and 8 were fitted with gates and the crests of the weir in the bays were lowered by 12 ft. By this means it was thought that the river could be diverted to the left, right or centre of the weir as desired. In practice this has not been possible. It will be seen that the river approaches the weir along two channels, the right channel and the left channel. During 1936 the right channel was so much developed that in the following winter great difficulty was experienced in feeding the canal from the left channel and the level of the crest of the weir had to be raised by temporary bunds to bring water to the canal from the right hand channel.

CONTROL OF SILT

The problem of river control is intimately connected with the question of silt entry into the canal. Coarse silt is harmful to a canal system in more than one ways. If it goes to the water-courses it is harmful to the fields, and if it settles in the canals it requires frequent clearance, otherwise bed levels of the canals will go up and banks will fall down necessitating heavy repairs. So that harmful silt has to be excluded from the canal before it can enter it, or ejected after it has entered. Exclusion at the point of the river where the canal takes off is generally effected by controlling the river, or by constructing some types of silt excluders. These excluders are built on the principle that heavy silts are generally found on the bottom layer of a volume of flowing water. When a weir is built across a river, the portion of the river that is nearest to the canal is separated from the main river by a long divide-wall sometimes extending 700 or 800 ft. upstream of the weir. The area enclosed between the divide-wall and the bank of the river where the canal takes off (which is known as the Canal Regulator) is called the pocket, and the portion of the weir that is thus cut off is called the Undersluice. The Undersluices are generally provided with gates so that supply into the pocket in excess of the requirement of the canal can be regulated. When the river water enters the pocket, its velocity is gradually reduced and heavier silt deposits on the bed of the pocket, and comparatively silt-free water enters the canal. By this means silt goes on accumulating in the floor of the pocket and sometime so much is heaped up that it gets drawn into the canal. At this stage the Undersluice gates are opened and the canal regulator gates closed and the pocket is flushed. These are known as sluicing closures. They are rather inconvenient during period of keen demand and cause some loss of revenue. In order to avoid these closures various types of silt-excluding devices have been tried in models and in the river. There is another method in which silt is allowed to enter the canal at the river head but after it has proceeded 2,000 to 3,000 ft. down the main line it is extracted along with the bottom water and sent back to the river.

Thus river training is not only useful in controlling the river and preventing it from attacking the weir, but it can also be useful in regulating silt entry into the canal. Such experiments on models of the Khanki Weir are being carried on now, and already a sum of Rs. 12,000 has been spent on these experiments. But considering the importance and magnitude of the problems the Punjab Government is prepared to spend much more. The very existence of a colony which brings in a revenue of over 2 crores depends on this headworks. It has been mentioned before that this headworks was repaired after 1932 flood at an expense of 25 lakhs of rupees. Due to the flood of 1932, serious damage to this headworks was discovered in bays 3 and 4. A boatman stumbled into a hole on the downstream side of the weir and this gave a clue to the damage. The soil below the floor of the weir was all washed away leaving a hollow of about 900 cubic feet capacity. One of the characteristics of these weirs is that they are built on sand so that where the masonry structure ends water comes into contact with the sands of

the river bed and can percolate through them. Water enters the sand medium at the U/S end and percolates through the sand. As it advances, it looses pressure so that at any point P below the D/S floor a certain fraction of the total pressure is still left trying to lift the floor. This pressure is known as uplift pressure. At the D/S end Q where the masonry structure ends, water comes out into the free water. If it comes out with great velocity it carries along with it lot of sand particles leaving a hollow beneath the structure at P. Now above the structure the river is flowing and creating a



LONGITUDINAL SECTION OF A WEIR

turbulence known as "Standing Wave". The floor below having no soil support cannot stand this "Standing Wave" and hence gives way creating a hole through the weir through which the boatman slipped. This is almost in all cases the principal reason of weir failure. Engineers like Bligh, Lane and others had been busy in devising means for counteracting this. It will be seen that the main causes for such failures are due to (*i*) the exit velocity of water at Q being very high ; and (*ii*) the uplift pressure at P being not balanced by the downward weight of water on the floor. After an extensive series of experiments carried out in the fields and in the laboratory directed by theoretical investigations, extended over a period of 4 years or more, it has been possible for the workers in the Punjab Irrigation Research Branch to completely solve this aspect of the problem. It must be remembered that these weir failures are very costly—sometimes the cost of repairs may well run into half a crore if not more, besides the loss in revenue of few crores of rupees. All the new weirs are being built on these new principles which have been published in the "*Design of Weirs on Sand Foundation*" by the Government of India.

SURFACE FLOW

Mention has previously been made about "Standing Wave". The violent impact created by the fast moving water flowing over the weir meeting the slow moving water on the downstream river bed creates what is technically known as the "Standing Wave". There is considerable action on the floor below the "Standing Wave", and unless the floor is made strong enough to withstand this, a deep scour hole will be formed endangering the safety of the whole structure. Hence it is very important to know where the standing wave will occur. This can easily be done by calculations and experiments.

It is found that even if the standing wave forms on the pucca floor, its action extends considerably downstream of the point where the floor ends and the sandy bed starts. Deep scour holes are produced necessitating extensive repairs every year, and if they cannot be detected and repaired before a heavy flood comes up, the whole weir may be blown off. Such a case happened on the Anderson Weir which was repaired at a heavy cost of about 10 lakhs after the experiments at the Lahore Laboratory had suggested the changes required. These were : (*i*) Downstream and upstream sheet pipes to cut off the pressure and to reduce the exit velocity ; and (*ii*) Blocks and arrows on the floor to reduce the action of the standing wave.

Position and magnitude of these blocks and arrows are fixed after model experiments which in the case of the Anderson Weir cost about Rs. 350/- in actual material used. If we consider the overhead charge of the laboratory staff it will come up to Rs. 5,000/-. If these experiments were carried out before the construction of the Damodar Weir, the

Bengal Government would have been saved the expense of Rs. 10 lakhs in repair.

The above gives an idea of the problems that engineers are likely to come across while building and operating weirs on sandy river bed. These are : (*i*) River Training, (*ii*) Exclusion of silt, (*iii*) Protection against uplift pressure, and (*iv*) Protection against downstream scour.

All the problems refer to the headworks, that is, the position of the river where the weir is built and the canal takes off. It is the most important unit of a canal system and is most carefully and zealously looked after. We know something about problems (*iii*) and (*iv*) but very little about (*i*) and (*ii*). Extensive experiments are being carried out in India and outside to solve these problems.

IRRIGATION BY DAM

Irrigation is also carried out by drawing water from reservoir dams. Dams are generally masonry structures constructed in a gorge as a river flows through it in a hilly country and the river water is



BOULDER DAM

collected in a reservoir from which supply for canals may be taken off. The Boulder Dam of America, is the biggest dam so far built. It has got an overall height of 527 ft. The capacity is such that if all the water that it contains be spread over, it will cover 30,500,000 acres of land to a depth of one foot. Part of the storage facilities of the reservoir are intended to assure a dependable supply of water for irrigation purposes to the Palo Verde Valley near Blyche, California, to the Yuma (Federal) Project near Yuma Arizona, and to the Imperial Valley in California. The remainder of the storage may be used to furnish an assured source of water supply for the cities and towns in Southern California to help by irrigation the development of lands in Arjona, California and Nevada.

The upper 9,500,000 acre feet of the reservoir volume will allow control of floods of the magnitude of 200,000 cusecs above the dam to 48,000 cusecs below ; and a flood of 300,000 cusecs (probably the largest flood in recent times) to 75,000 cusecs. Apart from the question of water supply for irrigation purposes and also of flood control in the Colorado river, the dam had been equipped with power plant designed to furnish 1,600,000 to 1,800,000 horse power of installed capacity. This will make available four and a third billion kilowatt horse power annually upon completion of the dam.

In India there are at present very few dams of good magnitude. Muthra Dam, Krisnaraj Sagar Dam are worth mentioning. In these types of dams generally known as Gravity Dams, the theory of elastic stress and strain had been extensively applied. In complicated structures mathematics had failed, and recourse had to be taken to model experiments depending on stress function and photo-elastic properties of models. It has been possible to analyse many intricate cases with the help of such models at comparatively small cost. Considering that failure of such a dam may entail the expenditure of a few crores of rupees, and risk of life and property over an extensive stretch of country, such model experiments are nowadays essential features of dam construction.

IRRIGATION FROM WELLS

Another method of irrigation is by taking water from wells. This is the most primitive method of irrigation. Recently scientific methods have also been applied here. In U. P. the Ganges Valley Tube Well Scheme is a well-thought-out and extensive scheme that is revolutionising the old method of tube well irrigation. The Ganges Canal in the first hundred

miles of its length passes through a rapidly-falling steep landscape. The canal is brought down to the general level of the Ganges Valley by a number of falls. These falls have been utilised by the present scheme and electric current generated. These currents are distributed in small units to villagers, who use them for pumping water from tube wells for irrigation purposes. The Scheme is still in its infancy and nothing definite about its prospect can be said at this stage.

To carry water from the river or the tube well to the fields, canals form the connecting link between them. In almost all cases canals are dug, or constructed in earth and generally follow the slope of the country. Canals are so designed and aligned that they run along the ridge of a countryside so that supply to the fields is simply by gravity flow. If the canals strictly followed the slope of the country the water-level in the canal would not be much higher than the level of the fields that are to be irrigated. Hence the slope of the canals is maintained slightly flatter than that of the country, and after 10 or 15 miles, depending on the difference between these slopes a sudden drop is given in the bed of the canal and the water is carried from the upper part to the lower portion over a masonry structure known as Falls. The drop in the bed level which is the same as the drop in the water-level varies from 2 to 3 ft. and 12 to 15 ft. In going down this fall water attains very high velocity and a standing wave is formed at the downstream end of the fall, so that all the difficulties of a standing wave are encountered here also. Remedies are more or less the same as in the case of the river, but in this case there is this complication that as the sides of a canal are generally artificially formed they cannot stand the side action of the standing wave, and just below a fall the side-scours are very troublesome and increase the maintenance cost of a canal. Extensive experiments in models are being carried out to prevent these side-scours.

Silt Problem

It has been mentioned before that elaborate precautions are taken at the headworks to stop the entry of coarse silt into the canal. By this means very coarse silt can be excluded but some coarse silt does get in and the canal has to be designed in such a way that this silt will be carried by water in the main line and branch into the water-course. Attempts have been made by empirical methods to arrive at a satisfactory solution of the problem. It has been long recognised that silt plays an important part in the economy of a canal system. In spite of very rigid regulations at the headworks the canal engineer finds that the canals are silting up badly and thereby losing command, or the berms are falling in rapidly widening the channel and thereby threatening breaches along the line. The amount of money spent on silt clearance and repairs due to silt troubles is considerable on a canal system whose success depends on the degree in which the ill-effects of the silt can be overcome or obviated.

Regular observations of hydraulic data are being carried out in the Punjab in channels that are known to be in regime. These consist of discharges, velocity, cross-section, slope, bed silt sample and water temperature. These data have been statistically analysed and various relationships have been obtained which are being tested in other channels in the Punjab.

Another line of attack has also been started in the Irrigation Research Institute. It is well known that the flow in a pipe or a canal depends on the characteristic of the boundary and the velocity distribution depends on the nature of the boundary. Prandtl and Nikuradse have shown this to be the case for both smooth and rough pipes. It has been possible to show in the Lahore Institute that the same law holds for flow in canals. It is proposed to correlate the characteristics of the bed material with the velocity distribution in the canal and thereby to arrive at a solution of the problem of flow in alluvial channels.

Waterlogging and Salt Efflorescence

Though the problems that I have dealt with up till now are of great importance for an irrigation engineer and may cost the Government lakhs and lakhs of rupees yet they pale into insignificance when one considers the question of seepage water from canals and consequent waterlogging and salt efflorescence of the countryside. Wherever in arid or semi-arid countries perennial irrigation has been practised, this menace of waterlogging and salt efflorescence has threatened the very existence of the whole system of irrigation and thereby the very prosperity which irrigation had called forth. America and Egypt are going through this stage and the Punjab had been no exception to this. As water flows through channels dug into the earth, considerable amount of it seeps through the bed and the sides and goes to the water-table to raise it. If the addition goes on, the water-table rises continuously and comes up to the natural surface and forms ponds and marshy lands breeding malaria carrying mosquitoes. It sometimes happens that as the water-table rises it passes through soil strata that may contain harmful soluble salt. As the water-table approaches the natural surface evaporation draws up salty water from the water-table and leaves the salt on the ground surface. It frequently happens specially in the Punjab that as the water-table rises it touches a layer of hard clay which in certain cases may extend to 20 to 25 ft. from the natural surface. If this soil crust contains harmful salt then capillary action which is very strong in such soils starts the movements of moisture from the spring level and brings the salt up on the surface.

Various methods are being tried in the Punjab and elsewhere to combat these evil effects of the rise in the water-table. One of the methods is to line the canals so as to make them impervious. This is an expensive method but the saving of water that it will bring and the partial relief from the evils of waterlogging that will result has made the method financially possible and the Punjab is going to try it on extensive scales. Various other methods are being tried and efforts to reclaim the lands that had already gone bad are ceaselessly going on. The Punjab Government is not sparing any efforts for this as the prosperity of the province depends on the solution of this problem of waterlogging and salt efflorescence.

EARNINGS ON COLLEGE EDUCATION

RANDOM reading among recent statistics yields the information that in 1936 the average earnings of an American employee amounted to $1,244. In that same year college graduates (male) only a year in possession of their diplomas had averaged $1,300, and the analysis by the United States Office of Education —which had disclosed this fact—also pointed out that girl graduates a year out of college had averaged about $1,100. Men who had been out of college eight years in 1936, however, were getting $2,400 apiece, while their women colleagues could average only $1,600.

For those college alumni who had spent eight years struggling for a living and whose status was known to the Office of Education, it appears that engineering and research paid about as well as general business—that is about $2,500 a year—but not so well by a matter of $500 as medicine or the law. A previous and unusually comprehensive survey confined only to engineers and made by the Bureau of Labour Statistics showed that in 1929—a year when 6·4 per cent of all incomes in the country exceeded $4,000—graduate engineers with ten years' experience obtained from $3,600 to $4,600 in the various branches of their profession, and that the median income for all engineers was $3,400. By 1934, however, this median income had shrunk to $2,300.

—The Technology Review

Vitamin K*

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WHILE working on fat metabolism in chicks, Dam (1929) observed that the diets deficient in certain respects gave rise to a disease resembling scurvy. This was not due to the absence of vitamin C in the diet as vitamin C could not cure this haemorrhagic disease. Dam later observed that newly hatched chicks, fed on a diet containing all the essential foodstuffs but deficient in certain fat-soluble materials, suffered from a fatal haemorrhagic diathesis characterised by bleeding from the pinfeathers, haemorrhages into the subcutaneous tissues and muscles and gizzard erosions. This condition could be cured or prevented by administration of the non-saponifiable, non-sterol fraction of hog liver fat or by feeding alfalfa. This anti-haemorrhagic principle in different food substances was termed by Dam vitamin K or Koagulationsvitamin. Almquist and Stokstad (1935) working independently of Dam simultaneously described the same haemorrhagic disease in the chick, which was cured by feeding alfalfa, a very rich source of the vitamin. Schonheyder (1935) observed that the haemorrhagic tendency was due to a prolonged clotting time associated with a deficiency of prothrombin content of the blood. Other constituents of blood taking part in blood coagulation, namely fibrinogen and calcium, were not altered.

Source of the Vitamin

Green leaves are very rich in vitamin K. Alfalfa, cabbage, spinach are very good sources of vitamin K ; cereals and carrots are poor sources, while potatoes, lemon juice and cod liver oil are practically devoid of this vitamin. The vitamin may also be prepared from fish meal, rice bran or casein after the extracted material has been allowed to putrefy, bacteria apparently effecting the synthesis of the vitamin under such conditions. Almquist *et al* (1938) have isolated a fish meal organism closely resembling bacillus cereus, which contains and is capable of producing in fish meal considerable amounts of vitamin K. Vitamin K is also present in bacillus subtilis, staphylococcus aureus, bacillus coli etc. Vitamin K may also be produced by bacterial activity in the intestinal tract.

Isolation and Chemical Nature

Mekee, Binkley, MacCorquodale Thayer and Doisy (1030) have isolated two pure compounds with vitamin K activity. Vitamin K_1 obtained from alfalfa is a pale yellow oil which crystallises on cooling and has characteristic absorption bands. The empirical formula is $C_{32}H_{48}O_2$ or $C_{32}H_{50}O_2$. Vitamin K_2 isolated from putrefied fish meal is a pale yellow crystalline compound melting at 50°5 to 52°C. Empirical formula is $C_{40}H_{54}O_2$ or $C_{40}H_{56}O_2$. From chemical studies of the properties of this vitamin so isolated, it is concluded that the vitamin is a 2-methyl-3 phytyl-1 : 4-naphthoquinone. The preparation of a pure, stable crystalline derivative, the diacetate of di-hydro-vitamin K, having one half the activity of the vitamin, offiers conclusive proof of isolation of vitamin K from alfalfa and putrefied fish meal. 2-methyl-1 :4-naphthoquinone though not identical with the naturally occurring vitamin has anti-haemorrhagic properties (Almquist *et al.* 1939). This has been confirmed by Macfie *et al* (1939), on human patients.

Estimation of the Vitamin

Estimation of the vitamin deficiency is based on the determination of the prothrombin contents of the blood. There is no direct method of estimation of prothrombin. An indirect idea of the prothrombin content of blood plasma is obtained by the following methods. Almquist *et al* (1937) follow Quick's (1935) method of determining the prothrombin time. According to the generally accepted theory of blood coagulation, prothrombin of blood plasma is activated by an enzyme, thrombokinase, obtained from tissue extract, in the presence of calcium to form thrombin ; thrombin then converts the soluble fibrinogen, a blood protein, to insoluble fibrin or clot. In Quick's method, oxalated blood is taken and centrifuged. To the oxalated plasma in a tube, known amounts of calcium chloride and thrombokinase prepared from human brain are added. The tube is immersed in a water bath at 37°C and shaken vigorously for a few moments until the mixture coagulates. The time in seconds from the moment of adding the calcium to the moment of coagulation constitutes the prothrombin time. By comparing this with the clotting time of a normal plasma, the prothrombin index is obtained. In normal humans prothrombin time varies between 25 and 35 seconds. In vitamin K deficiency the time usually exceeds 75 or even 100 seconds.

Macfie *et al* (1939) have determined the crude clotting time and have compared this with the prothrombin time determined by Quick's method. According to their view crude clotting time determination is as significant as the prothrombin time. Glass capillaries of diameter 2 to 3 mm. are filled with blood and placed over a dish which is kept at 37-39°C. Portions of capillaries are broken off from time to time and examined. As soon as a clot is formed, easily observed by breaking the capillary and pulling the two pieces apart, the time is noted as the crude clotting time of the sample. By comparing this with the crude clotting time of a normal individual, prothrombin deficiency may be ascertained.

Dam *et al* (1038) follow a different technique in the determination of K-avitaminosis. This method is a modification of that developed by Fischer in 1930. 2 c.c. of venous blood are taken through a cannula and placed in a centrifuge tube containing 0·1 ml. of 0.15% solution of heparin. After mixing and centrifuging, the clotting power is determined by using an extract of human brain. The concentration K of the brain extract which just coagulates the plasma in three minutes, when one drop of the extract is added to four drops of plasma, is determined. A corresponding determination is made on normal plasma (K_n). The quotient R (K/K_n) is a measure of the alteration of the coagulation, while the reciprocal value $1/R$ is a measure of the ability to coagulate with tissue extract. In normal plasma $R=1$. In some new born children R values come to about 300, *i.e.*, the prothrombin content is only 0·3 per cent of the normal.

Vitamin K in food-stuffs is usually assayed on chicks because they become K-avitaminous earlier than other animals, *e.g.*, rabbit, rat, etc. This is supposed to be due to the fact that the large intestine, where putrefaction usually takes place, is comparatively smaller in chicks than in the mammals. It has been observed by Almquist *et al* that vitamin K is present in faecal matter of chicks receiving none of the vitamin in the diet. Possibly the vitamin is synthesised in the lower intestine by putrefactive bacteria present. Newly hatched chicks are given a synthetic vitamin K-free diet for a period of 15 days. Substances to be tested are mixed with the diet. Prothrombin time or R values are determined as usual and by comparison with normal values, simultaneously obtained from normal animals, vitamin K content is ascertained.

A chemical method of estimation of vitamin K in concentrates has been described by Almquist *et al* (1939). The test substance is dissolved in methanol and sodium methylate is added. The mixture is shaken with light petroleum. Interfering carotenoid pigments remain in the petroleum and the colour due to the reaction of the vitamin and the sodium methylate remains in the methanol. A good agreement exists between chemical and biological assay.

Vitamin K and Disease

Sir James Mackenzie in his treatise *"The Beloved Physician"* has said—"There are three stages in the history of every medical discovery. When it is first announced people say that it is not true. Then a little later when its truth has been borne in on them so that it can be no longer denied, they say it is not important. After that if its importance becomes sufficiently obvious they say any how it is not new."

Conservative surgeons may say that the vitamin K is not important. With modern surgeons, however, this vitamin has been proved to be a very valuable weapon in combating pre- and post-operative haemorrhages in patients suffering from obstructive jaundice.

In all forms of obstructive jaundice due to lack of bile in the small intestine fat absorption is impaired and the fat-soluble vitamin K is not absorbed properly. This leads to diminished prothrombin content of the blood and a consequent haemorrhagic tendency is observed in obstructive jaundice. If

* Read before the Calcutta University Chemical Club.

vitamin K concentrates are administered per mouth with bile salts or desoxycholic acid or the vitamin is injected, normal prothrombin time and R values are obtained within a very short time (Illingworth, 1939). Macfie *et al* (*loc. cit.*) have successfully treated several cases of obstructive jaundice with a vitamin K analogue, 2—methyl-1 :4 naphthoquinone previously mentioned. This compound has recently been put into the market by Messrs. Glaxo Laboratories as Kapilon. After injections of 15 mg. of the substance remarkable results are obtained.

In new-born, slight haemorrhagic diathesis is usually seen. Blood examination reveals hypoprothrombinaemia. This lack of vitamin K usually disappears within a week. This is due to insufficient supply of vitamin K from intestine. Sick infants are improved by vitamin K administration. (Dam *et al* (1939).

Cases of anaemia neonatorum, icterus gravis neonatorum and hydrops congenitus have got one common symptom in lowered prothrombin in the blood. Most of these cases are improved by vitamin K. Non-tropical sprue is associated with prolonged clotting time. The case is improved after vitamin K administration. Kirk *et al* (1939) have observed that a dietary deficiency of vitamin K exists in men who are not jaundiced but have prolonged bleeding time. Vitamin K increases the prothrombin content of the blood of these individuals. Vitamin K therefore sems to be very valuable agent in combating haemorrhagic diseases due to lack of prothrombin in plasma, for which there was so long no other remedy.

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PLANT ROOTS CONSERVE SOIL

IN order to determine the relative efficiency of various cultivated crops in prevention of soil erosion, Dr Howard J. Dittmer, of Chicago, has investigated the root systems of several plants. The results will be surprising to these who are not familiar with the aggressive fight plants make for life.

It was found that the average number of roots in each cubic inch of soil in the top six inches ranged from 80 for soybeans to 2,000 for Kentucky blue grass. The total length of the root hairs of soybeans in a cubic inch averaged 40 feet, and in the case of blue grass more than 4,000 feet. The total surface area of the root hairs in cubic inch averaged only 3·5 square inches, while in the case of blue grass it averaged over 200 square inches. These figures are a measure of the contact of these plants with the sub-surface world as well as of their power of preventing soil erosion.

—F. R. M. in *Scientific Monthly*

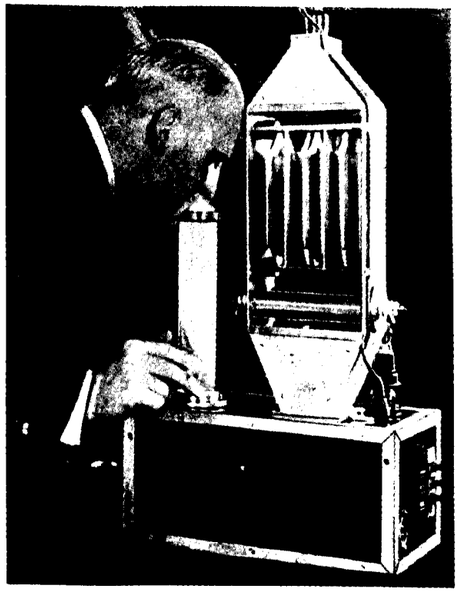
Dust Magnet and Bactericidal Gun

ANDRE' LION

AIR-BORNE dust and bacteria are present everywhere, but more disastrously so in the air above cities. Investigation has shown that the average resident of an industrial city inhales at least a teaspoonful of dirt each day. Ninety per cent of all impurities in the air we breathe are smaller than one micron, that is smaller than 1/25,000th of an inch, much below visibility of the naked eye. Over a smoky industrial city, a cubic foot of air contains up to from 200,000 to over 4,000,000 dust particles and microbes. We see the tiny motes dancing in a ray of sunshine but our eye cannot detect the vast majority of the impurities in the air: pollens which cause hay fever and asthma, from 15 to 25 microns in size; bacteria, averaging 1 to 2 microns in diameter; smoke particles of 0.3 or tobacco smoke corpuscles of 0.1 microns. Are these particles harmful? Of course, they are. Bacteria spread typhoid, pneumonia, influenza, colds, tetanus, tuberculosis, etc.; mould spores grow on bread, meat, and milk; smoke and dust collect on our walls and furniture; grime ruins merchandise on display; and all that is but a small excerpt of an extensive record.

To purify the air by passing it through screens and filters, which today is accomplished in many thousands of air-conditioning units in homes and offices or exhaust systems in dust-producing plants, is a rather inadequate job. Even the finest screens remove only a small portion of the finer air impurities. Their tiny mesh leaves the door wide open to bacilli which never measure more than 1/100th of the diameter of a human hair and mostly much less. There is another rather ingenious way of removing diminutive impurities from the air, and that is the electrostatic precipitation. The particles are not filtered out but electrically charged and pulled out of the air by an electrical force, just as a magnet attracts iron filings. The possibility of cleansing gases by an electrical discharge was discovered 115 years ago, but only by the Precipitron, invented in the Westinghouse research laboratories, has this ideal method of air cleaning been so simplified, compacted and practically developed that it now can be used economically for air purifying in homes, stores, offices, restaurants, hotels, and industrial plants. Now tobacco smoke particles measuring about 1/2,000th of the diameter of a human hair may as readily be removed from air as larger impurities such as soot or pollens.

The Precipitron, this novel dust magnet, consists of a number of units, individually installed and assembled, depending on the special job, the volume of air to be handled, and the space available. There are two standard sizes of units, shaped like flat boxes, the smaller cell being rated at 300 to 375 cubic feet of air to be cleaned per minute, the larger one at



MODEL OF A PRECIPITRON UNIT IN WHICH, BY ELECTROSTATIC PRECIPITATION, EVEN THE FINEST DUST PARTICLES MAY BE REMOVED FROM THE AIR. IN THIS PICTURE, TOBACCO SMOKE, THE PARTICLES OF WHICH MEASURE ABOUT 1/2,000TH OF THE DIAMETER OF A HUMAN HAIR, IS BLOWN INTO THE CYLINDER AT LEFT. WHEN PASSING THROUGH THE PRECIPITRON CELL AT RIGHT, THE AIR INSTANTLY BECOMES PURIFIED AND CLEAR.

600 to 750 cubic feet, resulting in an air purification of 85 to 90 per cent.

In order to remove a dirt particle from the air electrostatically, it must be given an electrical charge and then placed in an electrostatic field with a voltage gradient high enough to attract it out of the air on to a plate where it will stick by its own adhesion. Thus each Precipitron cell consists of two parts, the ionizing and the precipitating units.

In the ionizing chambers the air passes small wires placed between grounded cylinders. The wires are supplied with high voltage electricity, thus ionizing the air between the wires and the neighbouring cylinders and creating a kind of electrostatic screen passing through which all dust particles are electrically charged. Next, in the precipitating chambers, the air passes a number of closely-spaced parallel plates. Alternate plates are grounded and electrically charged, thus setting up another electrostatic screen between the plate systems. As the air passes through the parallel plates, this screen exerts a force on its charged dust particles, pulling them to the grounded plates where they are deposited, allowing almost completely purified air to be discharged through the outlets. A small power unit supplies direct current of 12,000 volts for the ionizing and of 5,500 volts for the plate section of the Precipitron cell from any electric supply line.

There are many spheres of application of the Precipitron. Industrial dusts which constitute a hazard to the health of employees or interfere with production processes may be removed. Frequently, this dust is valuable and justifies collection. For example, a West Virginia pottery has installed ten Precipitrons on its automatic glaze-spraying machines to recover excess glaze in suspension from the exhaust air. Each of these precipitators in a 40-hour week collects 800 lbs. of glaze, valued at from $48 to 1600. Air may be cleaned to protect delicate apparatus such as automatic telephone switching equipment to which considerable trouble may be caused by dust so fine that it cannot be removed by other than electrostatic means. In a private telephone exchange the average monthly number of service interruptions due to dirt thus has been reduced from 22 to only 9. The air may be cleaned in stores to reduce damage to merchandise or in homes and offices to diminish cleaning costs of walls, draperies, furniture, and files. By this modern means, the first four floors and lower arcade of the new Field Building, tallest in Chicago, are supplied with over 16,000,000 cubic feet of dust and germ-free air every hour. Finally, electrostatic air cleaning may result in a real relief to hay fever and asthma sufferers and may, moreover, reduce the bacteria content of the atmosphere in operating rooms and hospital wards, thus lowering the rate of deaths and contagion following operations. The American Society of Heating and Ventilating Engineers, in co-operation with the Department of Industrial Hygiene of the University of Pittsburgh has just begun a programme of investigation on how the bacteria content of the air, especially in operating rooms may be affected by precipitation and ultra-violet sterilization of dust. The classing together of dust precipitation and ultra-violet sterilization in prominent research plans leads to the other modern means of air purifying. Of course, ultra-violet radiation does not free the air of its mineral or smoke constituents, like silica dust or tobacco smoke. It only attacks and kills living matter, such as bacteria, germs, spores, and mould.

Ordinary sunlight has sterilizing power but its action on bacteria is relatively feeble after penetration of the atmosphere. Even the employment of only the ultra-violet spectrum without its neighbouring visible wavelengths is a senseless and costly means of killing micro-organisms, no better than killing rabbits with an elephant gun. For only a very limited range of the ultra-violet spectrum, that is the radiation of exactly 2,537 Angstrom of about 1/100,000th of an inch wavelength, is an effective microbe death-ray, though harmless to humans. In the same Westinghouse research laboratories in which the Precipitron has been achieved, the Sterilamp has been developed, a rod shaped gas-discharge lamp containing mercury vapour and other emitting gases. The discharge of electricity passing through this tube brings about an almost heatless emission of selected ultra-violet radiation which contains about 80 per cent. of 2,537 Angstrom emission. Thus the elephant gun has become a very efficient bactericidal gun, and a very cheap one at that, requiring no more electrical energy than a 10-watt lamp and possessing a useful life of approximately 4,000 hours.

No wonder that this gun, shooting all around, is most effective against post-operation infections in operating rooms. The aseptic technique used by modern surgeons has provided no defence against contamination from the air. Tests in a North Carolina hospital have shown that colonies of the dangerous staphylococcus bacillus were rendered

sterile after only one minute's exposure to the radiation of a Sterilamp at a distance of five feet. Operations on patients have been performed under the lamp, and from the first the results were striking. Virtually all the bacteria in the air about the operative wound, the supply and instrument tables were killed and even in the extreme corners of the room the radiation eliminated eighty to ninety per cent of the germs. Without exception, where Sterilamps have been installed in operating rooms—and this has been done in numerous United States hospitals—infections, formerly a constant hazard, have practically disappeared.

The great advantage of this bacteria gun is that it may attack and annihilate any germ not shaded from its invisible rays, whether still floating in the air or already deposited on their prospective prey. That is why this lamp is ideal for use in electric refrigerators in which a steady flow of air takes place on account of the cooling process. A recently developed small Sterilamp is now available as a plug-in accessory to refrigerators. Not only any kind of mould on bread or milk is killed but also any bacteria floating in the circulating air before settling on meat or fruits.

Wherever sterile air and surfaces are requisite to the preservation of health, these special ultra-violet lamps are expedient and now used in a thousand places. Grocery, meat, dairy, and bakery stores have tried these lamps out and obtained substantial savings in terms of less spoilage, longer life, and higher quality of their merchandise. Two large firms of the baking industry have been using the lamps to retard mould growth on fruit cakes, and consequently, spoilage fell from fifteen per cent to a trifling one or two per cent. In many other instances the lamps prevent mould contamination of baked goods in cooling rooms and during the wrapping process. On farms, barns and bows may be scrubbed, milking pails and operators' hands may be washed, but heretofore no satisfactory method has been known of preventing air-borne germs of falling into the pail before raw milk is bottled. Today, Sterilamps are being used regularly in a number of farms, not only in connection with the milking operation, but in hen-houses, brooder-houses, and hog-pens. One of the largest poultry farms in the United States has these lamps installed to combat chicken infection. In restaurants and soda fountains, where common methods of cleaning drinking glasses, dishes, and silverware are ineffective in destroying all bacteria and often constitute a menace to public health, Sterilamps have proved to be complete sterilizers of these easily contaminated utensils and to keep them sterile up to the moment of use. They are the ideal solution for this problem, since they can be installed in series along the inside shelves of bars and soda fountains, in wire glass-holders, etc. They accomplish a sterilization of 99·99 per cent in a few seconds' time, thus effectively controlling the spread of air-borne diseases, such as colds, grip, pneumonia, and many others.

For the same reason a New York bank has a Sterilamp installed over each teller's window, to reduce the hazard of communicating cold germs and other disease-breeders. One of the best known cosmetic factories in the United States is using these lamps to irradiate toothpaste and cleansing creams. Several manufacturers of food products even installed Sterilamps in the air ducts of their ventilating and conditioning systems, and tests indicated that an exposure of a little more than one second killed ninety per cent of the bacteria floating in the air.

Thus today, two modern means, electrostatic precipitation and ultra-violet radiation of a selected wavelength, are used to make the air which we breathe and which comes in contact with the necessities of life as pure as that of the highest mountain peaks where the sun itself does that work without need of human help.

Wheat and Couch Grass Hybrids

N. V. TSITSIN

[We publish below an account of hybridisation of wheat and couch grass done at U.S.S.R. The species of couch grass of the genus *Agropyron* are found mostly in the temperate region. In India *Agropyron* is met with only in the Himalayas and at a fairly high altitude (5000—14000 ft. usually). *A. repens*, which is one of the 5 species used for the above experiment, is found in the Himalayas at elevations of 8000—14000 ft. The paper has therefore not much bearing on the improvement of wheat or other crops in India. But whether the hybrids obtained from *A. repens* or from other species will be suitable for the plains of India may be a subject for investigation of Indian workers on this line. The problem tackled in this paper may therefore attract attention of Indian plant geneticists towards undertaking experiments on hybridising wheat with the Himalayan species *A. repens* or other allied species of Indian grasses.

—*Editor.*]

AS a result of extensive research the following species of couch grass: *A. glaucum*, *A. elongatum*, *A. irichoporum*, *A. junceum* and one variety of creeping couch grass, *A. repens* have been crossed with wheat. Experiments have shown that different varieties of the above species of couch grass can be crossed with all species and varieties of wheat. This enabled us, research workers, to formulate a number of definite tasks in this work. We undertook to develop hybrids with the following properties: (*i*) A highly productive variety of cereal with a large yield of grain of high nutritive value, (*ii*) Frost-resisting varieties capable of withstanding severe winters with but little protection from snow, and (*iii*) Drought-resisting varieties suitable for cultivation in the drought-subject areas of the Soviet Union. In 1930 after successfully evolving wheat and couch grass hybrids, a hypothesis was advanced on the feasibility of developing a new variety of plant unknown in nature, namely, perennial wheat and in 1934 this hypothesis was proved in practice.

It will be interesting to draw here a comparison between wheat and couch grass. Wheat is a plant cultivated by man, and consequently the various qualities and properties, it possesses, were gradually forced by man who adjusted this plant to his requirements. But couch grass, on the contrary, had to fight for its existence, accumulating all its properties and qualities, adjusting its organism to all sorts of exigencies and unfavourable conditions of growth. Thus, historically the development of wheat and couch grass was totally different.

Wheat as compared with couch grass is a much more tender and capricious plant which man protects by various cultivation methods from dry winds, cold, frosts and so on. On the other hand, man is trying to exterminate couch grass by such methods as drying and freezing its rhizome, though these efforts are not always successful. Wheat requires good soil and grows poorly on inferior land. Couch grass, however, is so unpretentious that some of its varieties can even grow in salt marshes and soil containing salt. Most of the wheat varieties are subject to fungal diseases, such as rust on stalks and leaves, smut, bunt and mildew, while many varieties of couch grass, as a rule, are not affected by these diseases. Couch grass, however, grows on marshy lands next to sedge, on salty lands and salty marshes, in sands and rocky mountain slopes, in arid plains and under the shade of trees and shrubs, and it can be found everywhere. In the process of struggle for existence couch grass has become very hardy. It can resist both high and low temperatures. The tremendous capacity for self-propagation which is accomplished both by vegetative propagation and true reproduction renders the struggle with this plant extremely difficult. A powerful rhizome which accumulates a great reserve of nutritive matter makes couch grass one of the most unpretentious plants.

Our experiments have disproved the conception current formerly that couch grass, in view of its adaptability to reproduction by vegetative propagation, is a plant of little fruitfulness. The great fruitfulness of certain varieties of couch grass (5,000 seeds and more in one plant as compared with 100 and 150 in wheat under the same conditions of growth) makes it extremely valuable for hybridisation. Taking account of all these valuable properties experiments were undertaken to transmit them by heritage to cultivated plants and we began experimenting

on the crossing of wheat with couch grass. The first generation born of a crossing of the seeds of wheat and couch grass resembles couch grass in outward appearance. Its shoots just like the shoots of couch grass are of violet, reddish or orange colour. The plant has many stalks. Outwardly the ears resemble those of couch grass and only a close examination would reveal a number of properties inherent in wheat.

All plants of the first generation are perennial. It should be noted that the hybrids react sharply to an improvement in conditions of growth. Proper cultivation and mineral fertilizers raise the yield from one and a half to two times. The plants have powerful roots which at times extend for two metres, a fact of tremendous importance in developing drought and frost-resisting varieties. In their resistance to drought and cold hybrids of the first generation considerably exceed even couch grass. In the main, plants of the first generation are totally immune to rust and smut, the usual diseases of wheat. The hybrids could be divided into two groups—the spring and winter varieties; it is highly significant that hybrids obtained by crossing couch grass with spring wheat produce grain at the first year while hybrids obtained from crossing winter wheat bear grain only at the second year. As an exception there are some plants which behave differently from other plants in the group.

Hybrids of the second and third generation received by continuous crossing with wheat pollen bear mostly the properties of an intermediary variety: the original properties of the hybrid undergo a change; the property of a perennial plant grows weaker with each succeeding generation; on the other hand, the fruitfulness rises and most plants retain the resistance to diseases possessed by couch grass. At present we have a number of varieties of annual and perennial wheat which possess valuable properties. Of great interest among the perennial wheats are two varieties known as 34085 and 23086. A specific quality which distinguishes the perennial varieties from the usual annual wheat is their ability to grow again after harvesting and to come to life after wintering. The perennial hybrids of wheat, variety 34085, represent powerful plants with many stalks and strong leaves. The roots are fibrous in the main. In the presence of moisture they are capable of forming creeping roots. The stalks are straight. The plants have an average height of 65 to 70 centimetres. The straw is rather strong and does not tend to lodge.

A number of plants of this variety has the property of producing in field conditions roots above the surface, the formation of the latter usually takes place at height of 2 to 3 centimetres from the ground. The number of stalks that head into grain from these roots reaches 6 to 7. The ear when the grain ripens is of white colour with a yellow tinge; it is hard to thresh and is bearded. The ears grow to an average length of 6 to 10 centimetres. An ear has 16 to 18 spikelets, the spikelet has from 6 to 7 flowers, while the number of kernels varies from 3 to 4 and sometimes 5 and 6. The number of grains in one plant reaches on the average 300 to 350. The seeds are red and large and weigh 25 to 33 grams per thousand.

The above variety of wheat possesses great vitality. Research has shown that in three years under experimental conditions it is capable of yielding 7 to 8 crops without replanting. Experiments in field conditions are now in progress. Even under the unfavourable conditions of last year, perennial wheat 34085 yielded 25 metric centals per hectare exceeding the yield by 7 metric centals of the best varieties of wheat. The particular resistance of variety 34085 to drought and salt makes feasible its tests on salty soils and in districts of a sharply continental climate.

The other variety 23086 also possesses very valuable properties. As distinct from 34085, it is beardless and possesses great resistance to cold. At present we also have developed a number of other varieties of perennial wheat which are of considerable interest. Our experiments offer grounds for the assumption that perennial wheat when planted in the northern and central regions of the Soviet Union would yield one harvest of grain and would also be mowed once a year for fodder. In the southern regions it would be feasible to raise two harvests of grain and one fodder crop a year.

The hybridisation of wheat is remarkable for the fact that it solves in principle the problem of the possibility of developing perennial wheat, which until very recently was a debatable question in agricultural science. Alongside with the numerous varieties of perennial wheat we have also developed annual plants. The annual hybrids of wheat and couch grass in the main are not inferior in their yields to wheat. A number of varieties produces a yield considerably higher than wheat as well as a superior grain.

There are hybrids producing yields 50 per cent higher than the best varieties of wheat such as Lyutestsens O 62 and Tsezium O 111. Some varieties of hybrids though infected with spores of smut for a number of years have proved immune to these. Similarly there are varieties absolutely immune to rust on staiks and leaves. The variety 22850 in natural conditions even with the excess of moisture does not lodge. This variety is not affected by smut, bunt or rust and neither does it shell out. Its baking qualities are even superior to those of the best standard wheat Tsezium O 111. In 1938 it yielded 34.5 metric centals per hectare as compared with 13.2 metric centals of Tsezium O 111.

Experiments are at hand on crossing other cultivated plants with the wild growing flora. For example, the rye-couch grass hybrids we have developed, enabled us to solve the problem of evolving a new variety of rye with changes in the biochemical properties of the grain. The hypothesis advanced by us several years ago that for every cultivated plant it is possible to find a wild growing one for crossing has now become the guiding principle in the work of many Soviet scientists and experimenters.

BACTERICIDES FROM SOIL

DR RENE' J. DUBOS working at the Rockefeller Institute for Medical Research in New York has discovered a new method of producing bactericidal agents. Dr Dubos began his line of research nearly a decade ago. He mixed a large number of soil samples gathered from different localities, baked the mixture at moderate temperature to decompose most of the dead organic material, and then injected a sample of the specific bacteria for which he sought a killer. One of his early trails was with the Type III pneumococcus, cause of one of the most baffling and destructive types of pneumonia. After an appropriate waiting period, he analyzed the soil to find a bacillus whose enzyme dissolved the shell of the pneumococcus. Later instead of a single bacterium, he inserted in his soil sample a potpourri, including pneumococci, streptococci, staphylococci—all representatives of the Gram-positive group of bacteria, named after the Danish scientist Hans Christian Joachim Gram, who indicated a significant division among bacteria on the basis of their ability, or lack of ability, to retain a certain violet dye. Analyzing his soil sample at the end of two years—during which time he had added more Gram-positive bacteria periodically—Dr Dubos found a bacterium that was less selective in its bactericidal tendencies. He described it as a "Gram-positive, spore-bearing, aerobic bacillus, capable of lysing the living cells of many Gram-positive microbial species". In fact all Gram-positive species thus far tested are killed, many of them dissolved, by the exudates of this one bacillus.

The *Technology Review* reports that further study revealed that a fractionation of the agent released by the bacillus and soluble in alcohol, acetone, and dioxane, but not in water, was the true bactericidal agent, and that it was fifty to one hundred times as active as the original extract. When tried on mice, a single milligram was sufficient to ward off as many pneumococci as would normally kill ten thousand of those animals. On the basis of such tests, it appears that a bacterium lacking the type of food to which the strain has been accustomed, may adapt itself, developing an enzyme that will digest whatever organic material happens to be present. Once the bacillus was isolated, it was cultured in peptone until large amounts of its bactericidal enzyme could be extracted with the centrifuge. The agent is yet to be tried on man.

Dr Dubos hopes to find in nature microbial species with catalysts for any type of biochemical reaction. He further hopes that some day soil organisms opposite in character to the present ones will be discovered, such as Gram-negative bacilli and the acid-fast bacteria, causing tuberculosis and leprosy.

Food and Nutrition*

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INTRODUCTION

MAN must have food in order to provide for materials for the growth and development of the physique as also to have adequate supply of energy for his bodily requirements. The amount and the quality of food vary according to various factors such as age, sex, occupation, etc. As a result of physical exercise and the various vital processes within the body including thinking there is wear and tear of the body tissues which require to be constantly replaced. Even when a man is normally asleep, the vital parts of his organism are working continuously and food has to be provided for such processes to continue their function in a healthy manner.

For the purposes mentioned above the various kinds of tissues forming the human body, that is, nerves, muscles, bones, glands and other cellular organs have to be provided with suitable special types of food elements. For muscles and bones, protein and certain minerals like phosphorus, calcium, etc., are essential. Similarly, for the nervous tissues, protein, phosphorus, carbohydrates are essential. To keep the metabolism in the human body in proper order, one must have adequate supply of different types of vitamins. Vitamin A is necessary for giving man the power of resistance to infectious diseases. It assists growth and prevents night-blindness. It is found in butter, eggs, ghee, oil, meat, milk, liver—particularly of fish—and green leafy vegetables. Vitamins B_1 and B_2 are found in the pericarp of cereals like rice, wheat, maize, etc. Vitamin C is found in all citrous fruits like lemons, oranges and limes and in fresh vegetables and meat, which, however is largely lost in cooking. Vitamin D is found in eggs, milk, fat, liver—particularly of fish. The human skin also produces this vitamin when exposed to sun's rays. Vitamin E is found in the germinated portion of all cereals, seeds, eggs, etc. These vitamins should be present in adequate quantities. This is essential because not only do they have specific actions themselves on the body but many of them have also marked influence over the action of the other. In other words, they assist mutually to a great extent. For production of energy, fats like ghee, butter, oil and carbohydrates like wheat, rice, sugar and vegetables are essential. For the total requirement of the body, there should be proper supply in different forms of the following essential principles of food: proteins, fats, carbohydrates, salts, vitamins and water. These are found in different quantities in different articles of food. Protein is found in meat, fish, lentils, milk, eggs, etc. Carbohydrate is found in rice, wheat, milk, certain tubers, vegetables like marrow, fruits, etc. Fat is found in milk, butter, ghee, mustard and other edible oils like *til* and cocoanut.

In the problem of supplying wholesome food and the necessary nutrition the following factors are involved: (*i*) production and supply, (*ii*) preparation, (*iii*) cooking, (*iv*) distribution and sale, (*v*) quantity and quality, (*vi*) ingestion, (*vii*) utensils, (*viii*) assimilation and excretion, (*ix*) age and sex, (*x*) occupation, (*xi*) climate, (*xii*) cost, and (*xiii*) adulteration of food.

PRODUCTION AND SUPPLY OF FOOD MATERIAL

As food is essential for life, it is desirable that the country should produce its own required food supply. When a country cannot produce the required amount, the deficiency can be met by supplies from other countries. This is possible now due to easy communications all over the world. In order to do so, the country must have the wherewithal to pay for the commodity imported. Usually those countries which do not produce sufficient food, pay for the imported food material by exporting industrial or other products. For example, England exports large quantities of industrial products in order to pay for

* Based on a lecture delivered at the Calcutta Corporation Commercial Museum on the occasion of the Food and Nutrition Exposition.

her food material. It is needless to point out that our countrymen are undernourished. Food is not in abundance and added to this, the poor cultivators are compelled to sell off a part of their own food-crops to meet other demands. On the other hand, industries are yet to grow to supply to our needs, not to speak of exporting their products. There should therefore be a concerted drive to produce our own food materials in sufficient quantity at present. Efforts may be made for more intensive production by adopting suitable methods, and if necessary, with the help of State protection. Only a decade or so ago India used to import a huge quantity of sugar, but now mainly by a revision of the trade policy, particularly with regard to this commodity, sugar industry has become self-sufficient. India still imports large quantities of rice. One of the main reasons for this deficiency is the low yield per acre on account of poor quality of the soil. Japan produces nearly 15 to 16 maunds of rice per bigha whereas we produce on an average only 7 maunds. Although mustard oil and ghee are consumed to a great extent in Bengal, the province barely produces half of her requirements.

PREPARATION OF FOOD

After the food supply is obtained, it has to be properly prepared. For example, paddy has to be husked and the rice from it has to be cleaned and washed. Home-pounded rice is far superior in food value to milled rice. Yet it is a matter of great regret that sufficient quantities of home-pounded rice are not available for even the Government or Government-aided institutions. Similarly, vegetables have to be cleaned and the meat dressed. Such preparation should be done in a clean place and in a scientific manner. Rice should be cleaned but not rubbed hard during the process of washing, as by doing so a lot of salts and vitamins are lost. Similarly some vegetables and fruits should be eaten with their skin on, for example, tomato, apple, etc., while others like mango should be peeled. Those food articles which are eaten raw should be particularly and carefully cleaned and washed with clean water, otherwise there is chance of bowel diseases.

COOKING

From time immemorial cooking has been a great art. King's connoisseurs, as well as the poor, have enjoyed and eulogised a properly cooked meal. In the European countries in the modern hotels, 'chefs', usually men, are highly-paid persons. In this country, women as a rule have excelled in this art, in any case, in private homes. Cooking is really a scientific art but a great deal remains to be done on a scientific basis. The material should neither be overcooked nor underdone. Only when the food is properly cooked, does proper assimilation take place and one gets the greatest benefit. Certain articles require to be cooked at a low temperature but for a long time, while others require to be cooked at a high temperature but rising gradually. Overcooking makes the food insipid, while food which is underdone may give rise to griping. Overboiled milk loses most of its vitamins, while underdone vegetables are not good for digestion. Cooking of rice in a proper way is essential to get the best benefit out of it. Rice should be cooked in such a way that no water has to be thrown away after it is cooked, as otherwise one loses a great deal of vitamins and valuable salts. Cooking under steam pressure probably gives the best results. Fried food is usually not very beneficial although it may appeal to the taste.

DISTRIBUTION AND SALE

In our social dinners large numbers of people are invited. But do we take the utmost care for the proper cooking and distribution of the food to our guests? Do we ensure that the banana or other leaves or earthen platters on which food is served are scrupulously washed and carefully cleaned first? Very often we do not and that is why we so often notice dirty finger marks on them or sometimes actually find dirt attached to them. Do we ensure that no food which is distributed to the guests is touched by hand? We do not. And that is why it is a common sight to see pilau, fish, curry, dal, sweets being distributed by hand without a spoon or ladle being used. Nor do we ever bother even to make enquiries about the people, cooks, servants, etc., whom we engage for such occasions as to whether they have suffered from any communicable diseases such as dysentery, typhoid, cholera, tuberculosis and syphilis. It is because of this utter carelessness and indifference to rules of health that we find tragedies happening in homes after a person or persons have been to a social dinner. Typhoid and para-typhoid, cholera, acute diarrhoea, indigestion, etc., are some of the penalties we have to pay if we accept a large-scale social dinner. Meat and fish are very often sold under very unsatisfactory conditions. Cooked food is often sold under very unhygienic conditions. The conditions prevailing in a very large number of tea-shops and lower-grade restaurants are simply abominable. There is no proper arrangement for washing the used plates, cups and saucers. These should be effectively controlled by the local authorities who are primarily responsible for issuing licenses to these places. The terms under which the licenses can be granted should be carefully framed and clearly stated at the back of the license. The remedy requires a little planning and the will to do the best for the community.

QUANTITY AND QUALITY OF FOOD

In order to get full nourishment one has to eat a sufficient quantity of food. Not only quantity is necessary but the quality is also essential. There is a good deal of difference between fresh food and food which is either stale, contaminated or of poor quality. Rice is usually decried as an article of diet because of its alleged poorer nourishing value than wheat. But the defect lies in the faulty method of preparation and cooking, when rice loses most of its vitamins, nitrogen and salts.

INGESTION OF FOOD

This is an important process. One must not consider that one can gulp down food and derive the best benefit out of it. That is not so. The food should be properly masticated so that the saliva gets an opportunity to mix with the material. It is only then that proper digestion and assimilation could occur lower down in the stomach and in the intestine. Further, food should be taken in a clean place kept apart for the purpose and, wherever possible, in good company. A cheerful mental condition at the time of ingestion has an important effect on the digestion and assimilation of food.

UTENSILS

It is needless to assert that utensils from which food is taken should be scrupulously clean and should be of such material as is not affected by the food itself either during its cooking or when it is being eaten. For example, badly tinned utensils when utilised for cooking may give rise to copper poisoning, while acid material put on brass plates may give rise to metallic poisoning. Similarly dirty plates, cups and glasses may give rise to communicable diseases, such as typhoid and cholera.

ASSIMILATION AND EXCRETION

No matter how food is prepared, no matter how much it may be of good quality, if one is not able to assimilate it and derive the best benefit out of it, ingestion of food only leads to excretion of large amount of faeces. In order that assimilation may take place to the highest extent, one must be physically fit ; bowels must move properly and he must take sufficient exercise. Physical exercise is particularly important for rice eaters, that is the only way in which real benefit can be derived from rice. This is clearly shown by the Nepalese and the Japanese who do not shun manual labour. On the other hand, the Bengalees and the Madrasees suffer from a shyness of physical labour—particularly the Bengalees, with the result that they suffer very greatly from diabetes and bowel diseases. Bulky vegetable diet increases the amount of faeces, whereas a diet rich in protein does not do so.

AGE AND SEX

Growing children require proportionately much more nourishing food than people advanced in age. After the age of 40, one should cut down the quantity of food that one takes daily and occasionally fast, say, once a month or so. Carried out in a reasonable manner, fasting is beneficial for health, particularly when the life's sun is on the decline. Women, when they are pregnant, require much more nourishing food as they have to supply all the building material not only for their own bodies but for the infant which is growing inside the womb. Serious deficiencies in the elements of food during the period of the gestation may have a very regrettable influence over the growth of the child. The bones may be soft and the child may be deformed. Similarly people doing hard manual labour require a different type of food from those doing brain work. The former require proportionately more carbohydrates such as are contained in rice, wheat, etc., and in fats and oils, while the latter require comparatively more of proteins such as are obtainable from meat, fish, *chhana*, cheese, dal, etc. Therefore we must exercise intelligent discretion regarding the articles of food and drink that we require in accordance with the factors mentioned above.

OCCUPATION

A man doing hard physical labour, such as a blacksmith, requires a comparatively large quantity of food and can digest properly a greater proportion

of carbohydrates, such as rice and wheat, while a brain worker or a man with a sedentary habit requires more of protein and less of carbohydrates. If a maximum amount of energy is required to be produced in a minimum space of time, a greater proportion of protein is required, while the man with the predominantly carbohydrate diet can suffer privation longer.

CLIMATE

Our food must be suitable to the time of the year, that is, to a certain extent there should be a variation during the winter and summer. The essential element must remain the same but more fat may be consumed in order to help the body in the production of more heat during winter. Conversely, during summer, there may be a certain reduction in the consumption of fat and meat.

COST OF FOOD

In a comparatively poor country like India, the cost of diet is a very important item in the family budget. As the wage earning capacity of an individual is practically the poorest in the whole world, he cannot have very much to spend on his family budget as a whole. In European countries, cost of food generally forms 25 to 33 per cent of the income of the average middle class and in the poorer classes about 40 per cent. But, in India, food practically forms nearly 60 per cent and at times even more than that for the poorer classes. This means ultimately that in India there is very little reserve left to fall back upon when the earning capacity is reduced or when the wage earner is unemployed. However, one has to make the best out of the present circumstances and one must cut down the superfluous food material from which one cannot derive the fullest possible benefit. Even with the limited resources available at our disposal it is possible to do so. Many articles which we consume in large bulk can be safely reduced in quantity and replaced by more nutritious material required in much lesser quantity, which would not entail any extra expenditure. The Public Health Department of Bengal has worked out a number of cheap menus varying in cost, the minimum of which is Rs. 3/- per head per month and some of these have been mentioned in the booklet written by the present writer *"Problem of Rural Reconstruction."* But we must not run away with the idea that the minimum is the optimum. For an average middle class Indian family, Rs. 12/- per head per month may be sufficient. We should spend a sufficient amount on food commensurate with our income, but at the same time we must get the fullest benefit from the diet for the nutrition of our body, as it is only by doing so that we can maintain our health and physical fitness to produce the maximum amount of wealth which the community demands of every citizen living within its ambit.

ADULTERATION OF FOOD

It is a matter of regret that when money is found, proper nutrition cannot be ensured due to adulteration of foodstuffs by unscrupulous persons. Unless articles are purchased from reliable vendors, we are likely to be cheated by dishonest dealers. Adulterated mustard oil gives rise to epidemic dropsy and adulterated flour may give rise to severe choleraic symptoms. One of the best methods to tackle this, from the point of view of the community, is not only the enforcement of the Food Act dealing with adulteration or safeguarding the standard of purity of food, but organised boycott of those unscrupulous grocers and shopkeepers who deal in them. The enforcement of such Acts largely depends upon the local authorities and for this purpose they must maintain an adequate staff of properly qualified men. There must be laboratory facilities for the examination of the sample of food. Development of local facilities should be encouraged where desirable but the question of undue parochial influence has to be borne in mind. The alarming state of affairs regarding adulteration is shown below.

PERCENTAGE OF ADULTERATION.

Food articles	*District Boards.* Percentage found adulterated.		*Municipalities.* Percentage found adulterated.	
	1937.	1933.	1937.	1933.
Mustard oil	21·0	32·0	21·3	28·1
Ghee ...	41·7	23·1	31·9	27·7
Milk ...	68·4	77·1	72·7	71·6
Atta and Wheat flour	8·7	nil	3·7	1·9
Tea ...	5·7	nil	10·5	nil
Channa ...	23·3	15·7	nil	nil
Dahi ...	95·4	85·7	59·0	77·7
Butter ...	...	...	27·2	83·3

NUTRITIONAL FACTOR OF FOOD

Not only should one have sufficient food but one must have a balanced diet. Unless this is achieved, any one or more of the diseases mentioned below may arise:

Diarrhoea, Dyspepsia, Constipation, Diabetes, Beri-Beri, Sterility, Amblyopia, Rickets, Osteomalacia, Scurvy, Pellagra, Lathyrism and Carious teeth. Food which is very rich and contains a lot of acid element, contaminated food, food which is not properly cooked and unripe and rotten fruit cause diarrhoea and dyspepsia, while inadequate roughage leaves little residue and leads to constipation. Overconsumption of sweet and starchy food particularly, when combined with lack of sufficient exercise, leads to diabetes. Continued eating of polished rice cause beri-beri. Lack of consumption of eggs, seed grains which are devoid of the germinal parts may lead to sterility. Insufficient consumption of food like butter, leafy green vegetables which contain vitamin A may cause amblyopia. Lack of consumption of sufficient quantity of milk, eggs and other foodstuffs which provide the calcium of the body as well as lack of vitamin D leads to rickets and osteomalacia. Long continued consumption of tinned and dried food, absence of citrous fruits, fresh vegetables, fish, meat, milk in the diet causes scurvy. Similarly long continued deprivation of vitamin B_2 may give rise to pellagra, while continued consumption of *Khesari dal* causes lathyriasis.

From the analysis of figures of examination of school children in the province, it seems that defective diet is common both in the rural and urban areas. This rather supports the view that the food in this province is deficient in nourishment and is ill-balanced.

Apart from the diseases mentioned above, ill-balanced and insufficient diet has a definite bearing on the incidence of such diseases as tuberculosis and leprosy which get a much easier hold on people who are ill-fed, especially when the diet is ill-balanced. As a matter of fact, good nutritional level increases the powers of general resistance, particularly to infectious diseases.

CONCLUSION

What is essential with regard to food is that we must have a balanced diet. A balanced diet should contain protein, carbohydrate, fat, vitamins, salts and water in proper quantities. It should not only be qualitatively correct but the quantity should also be sufficient. It is not essential to have meat always. A good deal depends on the availability, climate and habit with regard to vegetarian and non-vegetarian diets. But it has been well established by Sir Robert McCarrison that Sikh diet is practically the best diet in the world. It consists of wheat, vegetables, milk and milk products. Meat is only occasionally taken. At least one third of the total amount of protein required for the body should be of animal origin, which need not necessarily mean meat but may be fish, eggs, or milk products. For a normal person, the food should contain a certain amount of roughage. This helps to keep the bowels open and prevent the serious obnoxious effects of constipation.

PHILANTHROPIC CONTRIBUTIONS IN U.S.A

THE record for the year 1939 throws no new light on the question as to whether the total annual amount of philanthropic contributions is likely to rise or fall. On the other hand, it does confirm the impression that the base of supply is steadily widening. It is significant that a Masonic body in Ohio is contributing $50,000 a year for research in mental hygiene. It is significant also that the human as well as the economic problems of modern housing are being attacked by Federal, State and municipal authorities, by two younger foundations, the Ford and the John B. Pierce, as well as by certain of the older ones, and finally by real estate and insurance interests, notably by the Metropolitan Life Insurance Company, which is investing some $65,000,000 in a housing development in New York City.

—*Report of the President of the Carnegie Corporation of New York.*

The Royal Botanic Garden, Calcutta

K. BISWAS

Superintendent, Royal Botanic Garden, Calcutta.

HISTORY OF THE GARDEN

THE Royal Botanic Garden, Calcutta is situated on the west bank of the river Hooghly and is only a few miles from Calcutta. The Botanic Garden at Sibpur, near Calcutta, thus offers remarkable parallel to the Royal Botanic Garden, Kew, which is situated on the bank of the river Thames and is only a few miles from London. Both the gardens are of high scientific interest as well as of great aesthetic beauty. Both of them serve as source of inspiration, education and research for their many visitors. To quote Sir Arthur Hill's words, "May they find in them both spiritual rest and refreshment and also that tree whose leaves were for the healing of nations".

But the Royal Botanic Garden, Calcutta, has a different origin from its sister garden, the Royal Botanic Garden, Kew. The Kew Garden, which is younger than the Calcutta Garden by about fifty years, owes its origin to the interest in Botany of Royalty. But the Royal Botanic Garden, Calcutta, like many other overseas botanic gardens founded in later years of the 18th century, was founded with economic and scientific aims. Although the Royal Botanic Garden, Kew, with an area of 288 acres can at present claim to be the largest botanic garden possessing the largest herbarium in the world, it was started with only 15 acres of land in 1841. The Royal Botanic Garden, Calcutta, started with a little over 300 acres of land and at present occupies an area of 273 acres.

Col. Robert Kyd of the Bengal Infantry, the then Superintendent of the Hon'ble Company's dockyard and Secretary to the Military Board of Fort William, a keen horticulturist, suggested on the 1st January, 1786 to the Governor-General, Sir John Macpherson, then officiating in the absence of Warren Hastings, to form a botanic garden in Calcutta. Without further delay effect was given to Kyd's proposal and with the subsequent approval of the Court of Directors in England, the present site then measuring about 310 acres immediately below Kyd's private gardens was acquired. Col. Kyd very appropriately was also appointed as the Honorary Superintendent and the work of developing this area into a botanic garden commenced with Kyd's valuable collection of exotic plants. The Garden henceforth became the property of the East India Company under the control of the Governor-General-in-Council. This is the reason why the garden is still known among local people as the 'Company Bagan'. The epithet 'Royal' came to be applied to it after the Queen's Proclamation of 1857. The control of the Garden apparently passed on to the local Government on the constitution of the Province of Bengal in 1834. Kyd continued to perform the duties as Superintendent until his death in 1793. A marble monument was erected in memory of Col. Kyd at the centre of the Garden.

Dr William Roxburgh, the Company's Botanist in Madras was appointed as the first official Superintendent in 1704. Roxburgh built the Superintendent's house in 1795. This house is now 145 years old. Roxburgh was the first to draw up a catalogue of 3500 plants then growing in the garden. This catalogue, *'Hortus Bengalensis'*, in two parts was published after Roxburgh's departure from India in 1813 by his friend Dr Carey, the celebrated missionary. Roxburgh's *'Flora Indica'*, his *'Plantae Coromandelianae'* composed in three volumes and his magnificent large portfolio coloured illustrations numbering 2382 embodied in 35 volumes prepared during the years 1794-1814 with the help of Bengali artists form the basis of Hooker's *Flora of British India* and many subsequent works on Indian plants. Roxburgh thus fully merited the title of "The Father of Indian Botany". The famous scientific society under the title of 'United Brotherhood' was established at this time by Roxburgh's preceptor John Gerard Koenig, a pupil of Carl Linnaeus, who was the guiding spirit of Roxburgh's botanical studies in India. Sir William Jones who founded the Asiatic Society of Bengal in 1784 was one of the members of this brotherhood. Roxburgh died in 1815. A monument was erected in the Garden near the Great Banyan to perpetuate his memory.

Dr Francis Buchanan, (afterwards Sir Buchanan Hamilton F.R.S.) succeeded Roxburgh along with others. Sir Buchanan, an accomplished botanist and geologist was on special duty in connection with the development of agriculture in India and in the collection of materials for a gazetteer.

In 1817, Dr N. Wallich, an able and energetic botanist, was appointed and he held office until 1846. At this time the eastern portion of the garden measuring 40 acres including the teak plantation was given up by Government to the Lord Bishop of Calcutta (Dr Middleton) as the site for a Christian College known as the Bishop's College. This college since 1880 is the Bengal Engineering College, Sibpur. In 1836 about 2 acres of land were allotted to the Agricultural and Horticultural Society of India, which was founded in 1820 by William Carey, its first President. This area expanded to about 25 acres where the Society in co-operation with the garden officers conducted greater part of its agricultural and horticultural operations for about 40 years until 1872, when the Society's garden was transferred to its present site in Alipur.

Dr Nathaniel Wallich, F.R.S., undertook an extensive survey of a large part of the Indian Empire, particularly in the little known region of Kumaon, Nepal, Sylhet, Tenasserim, Penang and Singapore. His enormous collections were catalogued and named in Europe by himself and with the help of other botanists. They were then distributed to all the leading botanical institutions in Europe. A more or less complete set of this valuable collection however is still in the Calcutta Herbarium together with Wallich's voluminous irreplaceable catalogue and his correspondence from 1794 to 1829 which were transferred to the Calcutta Herbarium from the India House, London. Through the munificence of East India Company, Dr Wallich published his *'Plantae Asiaticae Rariores'*, consisting of three superb volumes of illustrated coloured figures. Dr Wallich was not only Superintendent of East India Company's Garden but also Professor of Botany at the Medical College, Calcutta, and Superintendent-General of Teak Plantation in Bengal. Dr Wallich retired in 1846 after thirty year's service and died in 1854. His friends and admirers raised a beautiful monument in respect to his memory.

Dr William Griffith officiated during Wallich's absence on leave and while on botanical expedition in Malaya died in 1845. Griffith's premature death deprived botanical science of one of its ablest and most meritorious votaries. Griffith's extensive notes and drawings were, after his death, published by Government in nine volumes. A marble monument in Griffith's memory was raised in the Garden.

Dr Wallich was followed by Hugh Falconer M.D., F.R.S., a palaeontologist, who held office till 1855. Early in 1858 during G. McClalloud's officiating period Sir Joseph Hooker visited the Garden on his famous journey to Sikkim and again on his return to Calcutta in 1860. Falconer was succeeded by Dr Thomas Thomson, M.D., F.R.S., a traveller and a botanist of much ability. Dr Thomas was the President of the Agri-Horticultural Society (1859-1860), the coadjutor of Sir Joseph Hooker in the collection and distribution of an extensive and well-known herbarium of East Indian plants and the joint author of the first volume of the *Flora Indica*. Thomas retired in 1861 and was succeeded by Dr Thomas Anderson, M.D., whose untimely death in 1870 was caused by a disease contracted during his effort for the introduction of the quinine yielding cinchonas into the Sikkim Himalayas. Dr Anderson was not only Superintendent of Royal Botanic Garden, Calcutta, and Professor of Botany but also the first Conservator of Forests for Bengal and in charge of the introduction and cultivation of Cinchona in India. For two years (1869-1871) subsequent to Anderson's departure from India, Mr C. B. Clarke, F.R.S., an officer of the educational establishments of Government of Bengal, the well-known systematic botanist and President of the Linnean Society, London, acted as Superintendent and during his incumbency he began a series of botanical publications on his vast collections of plants. He collaborated with Sir J. D. Hooker in writing *Flora of British India*.

In 1864 occurred the great cyclone of Calcutta. It was accompanied by a storm wave from the river Hooghly that laid the greater part of the Garden under water, in some places to a depth of six or seven feet, and carried two ships into the Garden with great violence. Over a thousand trees—at least one half of the total number in the Garden—and innumerable shrubs were prostrated. The survivors

were much shattered, and scarcely a vestige of leaf, flower or fruit remained. Three years later a less severe but still very destructive cyclone, in which over 750 of the surviving trees were blown down, completed the ruin.

In 1871 Dr George King, took charge of the Garden which was in a most unpromising state. The devastation wrought by the two cyclones had deprived it of all shade. A large extent was under coarse grass, and large parts were still, as they always had been, little better than swamps. Most of the roads were narrow, subject to flooding and unfit for vehicular traffic, while the present ornamental lakes were represented mostly by unsightly channel and 'tanks'.

Sir George after taking over charge set to re-making of the garden. The whole extent of the grounds has been raised in level, the necessary soil having been obtained from large sheets of ornamental water which have been cut out. These artificial lakes have been connected with each other by underground pipes, and a steam pump (and now an electric pump) has been supplied, by which the water in the whole system can be kept at a high level by means of water pumped up from the river. Many wide roads have been made all through the garden—so that carriages may be driven through every part of it.

The valuable collections of dried plants has been suitably housed in a handsome building designated by Mr E. J. Martin, the Government Architect, the internal arrangements of which are to a considerable extent adapted from those of the then new Herbarium building at Kew. New propagating houses, tool and potting-sheds have been erected, and good dwelling-houses have been built for the members of the garden establishment. A boundary wall and ditch have been partly built round the garden ; and finally, attempts at landscape effects have been made in the gardens, and the collections have been increased by considerable accession of plants, both indigenous and exotic.

King made enormous and remarkable contributions towards Indian botany and initiated the publication of the world-famous *Annals of the Royal Botanic Garden, Calcutta*, in 1887. The second part of Vol. XIV of the *Annals* appeared this year. Sir George also moved the Government of India at this time for the establishment of the Botanical Survey of India which originated in 1890. The first *Record of the Botanical Survey of India* appeared in 1893.

The work of the Botanical Survey of India and the Garden with its Herbarium is so much interdependent that since the inception of the Survey in 1890 the Superintendent, Royal Botanic Garden, has been the ex-officio Director of the Botanical Survey of India. Botanical exploration is essential for utilising the vegetable resources of the country and maintaining the vitality of the Herbarium and the Garden. A glance at the map of India of the explored, unexplored and insufficiently explored regions will show what an enormous amount of work in this direction remains yet to be done.

In 1878, in succession to the late Mr Kurz, the reputed author of the *"Forest Flora of Burma"*, Mr John Scott was appointed Curator of the Herbarium. On the 9th January of 1879, Mr Adolph Biermann, the Curator of the Garden met with a fatal attack by a tigress which, unnoticed by him or Mr Scott his companion, was crouching under shrubbery on the opposite side of the road. The tigress escaped from the menagerie of the ex-king of Oudh, swam across the river and landed in the Garden. Six weeks later a black panther also escaped from the same menagerie. This animal spent a night in the Garden and was shot by Dr G. King next morning before it had time to do any mischief. No such danger exists now.

Lt.-Col. (afterwards Sir) David Prain, who was first appointed as Curator of the Herbarium, succeeded Sir George King, Kt., F.R.S., K.C.I.E., who after 26 years of meritorious service retired in 1897 and became the Director of the Royal Botanic Garden, Kew. Before Sir David left India in 1904, he sketched out a geographical plan of garden divisions in accordance with which future plantings were to be regulated. Sir David Prain's plan, with slight modifications, continued to be carried on by his successors as opportunity allowed up to the present day. Sir David Prain's valuable voluminous publications are known all over the world. His botanical investigations proved to be of considerable importance to the State. He is now about 85 years old and has just finished his monumental works on *Dioscoriaceae* in collaboration with Mr I. H. Burkill, an officer of the Botanical Survey of India. Sir David Prain, M.A., D.Sc., Sc.D., LL.D., F.R.S., retired in 1906 and was appointed Director, Royal Botanic Garden, Kew. Lt.-Col. A. T. Gage who was first appointed as Curator of the Herbarium succeeded Sir David in 1906. A catalogue of non-herbaceous phanerogams cultivated in the Royal Botanic Garden, Calcutta, prepared by Lt.-Col. A. T. Gage, I.M.S., C.I.E., was published with the object of facilitating

the exchange with other botanical institutions of plants, seeds, or materials for systematic, anatomical, physiological or chemical investigation. Gage was also Professor of Botany, Medical College, Calcutta. He retired in 1923. During his absence on leave in 1908, Mr W. W. Smith (now Sir William Wright Smith, Regius Keeper, Royal Botanic Garden, Edinburgh, and Professor of Botany, University of Edinburgh) who was then the Curator of the Herbarium officiated as the Superintendent, Royal Botanic Garden. Subsequently Mr C. C. Calder, B.Sc., was appointed as Curator of the Herbarium after Smith. Mr Calder succeeded Lt-Col. A. T. Gage in 1923 and retired in December last year when the writer succeeded Mr Calder.

THE REGIONAL ARRANGEMENT OF THE GARDEN

In the open Garden there are about 15,000 trees and shrubs. In addition to these there are several thousands herbaceous species in the Palm-houses, Orchid-houses and Ferneries. The Garden, however, is by no means so rich in species as it might be, the total number of species in the open probably not exceeding 2,500. For some time the Garden fulfilled to a certain extent also the purposes of a Zoological Garden by having in it birds, deer, swans, monkeys and other animals. Still there is a colony of hill Moina living in the garden.

A scheme adopted 34 years ago was to treat the Garden as a map of the world on Mercator's projection representing the tropical floras. The plants of India and Burma are to occupy the central triangular area of the large western part of the Garden, this area being sub-divided in accordance with the geographical subdivisions of the Indian Empire. To the west and south-west of the large central Indian area are the divisions for North-west Asia, Europe, the America, Africa, and Madagascar, and to the east of it the divisions for north-east Asia, China, Japan, the Philippines, Siam and Annam, the Malayan Peninsula and Archipelago, and Australasia, the last five being separated from the large central Indian divisions by the special collections of palms, screw-pines, and bamboos. Scattered throughout the Garden are twenty-six irregular lakes, some of which are of large extent with islands. Altogether the lakes comprise about one-ninth of the total area of the Garden. Most of them were designed by King with such skilful diversity of outline and surroundings as very greatly to enhance the beauty of the Garden. The Garden contains more than 10 miles of roads which have been recently macadamised.

The Garden which is open from sunrise to sunset daily is now accessible both by roads and by the river. Communications have been made much easier than what they were about 50 years ago. Passing through the Oreodoxa Avenue, from the river gate one reaches the Orchid House, the Large and the Small Palm Houses where in artistic beds selected ornamental and delicate herbaceous species and rare



OREODOXA AVENUE IN FRONT OF THE RIVER GATE.

palms are on view. The Asiatic palms have all been monographed by Dr Becarri and O. Martelli in the *Annals of the Royal Botanic Garden*, volumes XI, XII and XIII.

Coming out of the northern gate of the Orchid House a visitor will find himself among conifer group, adjacent to the flower garden.

Turning towards the Palm Avenue one reaches the Palmatum. Within the close range of the Palmatum two other avenues are seen—(*i*) Mahogony Avenue and the (*ii*) Albizzia Avenue. To the right of the Mahogany Avenue lies the Bambusetum. The bamboos of India have been monographed by the late Mr J. S. Gamble of the Forest Service in the *Annals of the Royal Botanic Garden, Calcutta*, Vol. VII, 1896. Many rare species of bamboos of great economic value are still under cultivation in the Garden. Here in the Bambusetum are seen clumps of *Melocanna bambusoides* with the large apple like germinating seed. This bamboo known as *Muli Bans* is much used for building purposes,

basket work and various other domestic needs. This species is distributed in the eastern part of India from East Bengal to Tenasserim in South Burma.

Within the close range of this area are visible some of the rare plants, which flower once in their lifetime and then gradually die like many of the bamboos. Agave (Century Plant, American Aloe *A. fourcroydes*) in which 2-3 leaves are formed in a year during 5 to 100 years, finally a gigantic terminal inflorescence comes out of the centre. There is so great a rush of sap on the inflorescence that the Mexicans cut off the flower heads and collect as much as 1000 litres of sap which is fermented and is used as a national drink. Many yield useful fibres. The species (*A. sisalana*) Sesal hemp is cultivated in Bhamas and India for fibres. *Corypha umbraculifera* L. (talipot palm) of South India grows to a height of 80-100 ft. The gigantic terminal inflorescence bursts out of its massive spathe with a loud explosion and the prolific panicle gradually unfolds. The leaves are used as umbrellas, for thatching and as writing material.

From the river gate to the left of the Oreodoxa Avenue runs straight the Banyan Avenue and the visitor can reach the Great Banyan after 5 minutes' walk from the river gate. The Great Banyan in the days of its full juvenile glory looked more like a forest in miniature than a single tree. The Great



THE GREAT BANYAN TREE—GENERAL VIEW WITH THE AERIAL ROOTS.

Banyan is now 171 years old. The crown is 1100 ft. in circumference and there are about 666 aerial roots actually rooted in the ground. In 1895, the girth of the main trunk was 51 ft. The tree suffered to a certain extent during the cyclones of 1864 and 1867 and some of its main branches were broken and thus exposed the tree to the attack of a hard fungus which was subsequently identified as *Fomes pachyphlaeus* Pat. by Dr S. R. Bose and was for the first time reported by him from Bengal. This attack finally led to the deterioration of the trunk where the fruit body as large as 60-90 c.m. long and 30 c.m. broad and 8 c.m. thick developed at different heights of the trunk. During the rains when the rays of the sun happened to reach the body of this perennial fungus, masses of spores were seen discharged from it. Sometimes so dense was this smoke of spores that it was visible from a distance as a cloud overhanging the tree. Slides exposed over the tree revealed that the colour was mainly composed of spores of the fungus. The trunk thus decayed was subsequently attacked by insects too. Therefore there was no other alternative but to remove the main trunk some time after 1920 in order to save the major branches. Series of operations were performed and by grafting a daughter-tree fresh energy has been infused. The tree has thus been saved from total destruction. Attempts are being made now to fill up the central gap and to extend the branches across the road round the Banyan circle like a canopy overhead. The tree is flourishing quite well.

There are many plants which behave curiously and sometimes create much interest both for the botanists and for the laymen. These are (*i*) Ficus and date-palm ; (*ii*) breathing roots of *Taxodium distachyum* and *Heritiera* minor ; (*iii*) plank buttresses of *Sterculia alata* along the Scott Avenue. To the northern end of the Avenue under *Kigelia pinnata* Mr Biermann was mauled by a tigeress in 1878 ; (*iv*) the bud mutation of Ficus Krishnae. This tree is named after Lord Krishna who is supposed to have twisted the leaf into an ascidiform structure. The tree reverted to the character of its parent—*Ficus bengalensis* after about 30 years. It cannot therefore claim a specific rank. The tree (*F. Krishnii*) had its origin from a graft made out of a branch bearing the abnormal leaves. When propagated from the graft this tree has always the character of its scion. But when raised from the seeds it is only about 10% that develop the funnel shaped leaves.

In some lakes of the Garden are grown aquatic plants of much interest. Recently limnological investigation particularly of the fresh static waters in Bengal is engaging my attention. Researches in

this direction are of far-reaching importance in tackling many an intricate problem of sanitation, water purification, filter works, irrigation and of public health. In Bengal most of our jhills, swamps, lakes, tanks are choked up with aquatic vegetation. If the water plants are properly controlled, a considerable headway can be made towards ample



VICTORIA REGIA AS GROWN IN THE EDEN GARDENS.

supply of pure wholesome water in the villages. In the lakes of the Garden many aquatic plants of horticultural, economic and medicinal importance are cultivated. Of special interest are *Victoria regia* and *Victoria Curziana*—the Giant Amazon lilies tion as a whole (see next page).

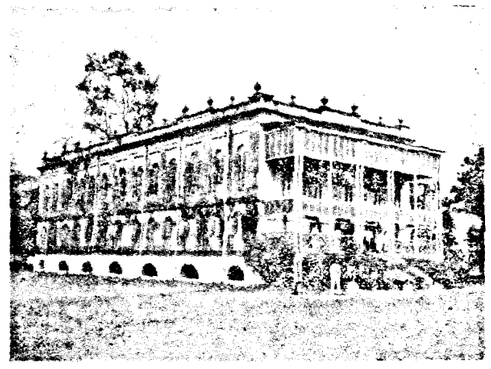
Different sections under the administrative charge of the Superintendent, Royal Botanic Garden, Calcutta, as sketched in the accompanying table (facing next page) will give an idea of the various activities of this institution as a whole.

THE LLOYD BOTANIC GARDEN, DARJEELING

In 1878 a botanic garden was laid out at Darjeeling by the efforts of Sir Ashby Eden, the then Lieutenant Governor of Bengal. It is named after Mr William Lloyd, who made over to Government 40 acres of land within the Darjeeling station. The garden developed under the guidance of Sir George King. In this garden in an area of 40 acres are represented in miniature the temperate flora of the world with special reference to submontane, montane and Alpine flora of the Himalayas. This is the well-known centre for the distribution of Himalayan seeds and plants in India, and with its Herbarium serves the purpose of studying the East Himalayan plants on the spot. The Lloyd Botanic Garden has been largely instrumental in acclimatisation and investigation of Himalayan plants and particularly in improving the town of Darjeeling by way of introduction of many economic plants and foreign species of great horticultural interest.

HERBARIUM

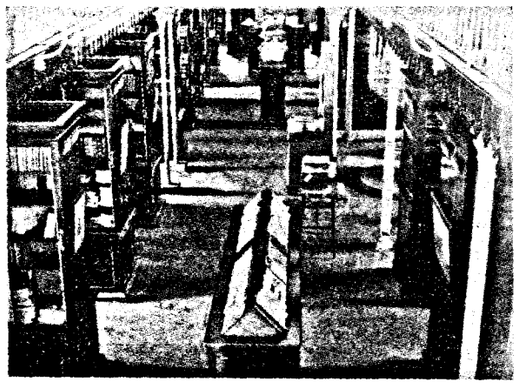
The Herbarium and the Library have gradually developed since the foundation of the Garden in 1786. The present damp-proof and fire-proof building especially designed to house nearly two and a half million authentic sheets of Herbarium specimens which form the basis of all botanical and allied investigations was erected in 1883. In this Herbarium all these precious sheets consisting of irreplaceable types, cotypes, lectotypes, ecotypes, etc., are arranged in proper scienfic order. The Herbarium is thus the depository of a very complete collection of the dried materials of plants of the whole of the Indian Empire as also fair collections of those of Asia outside India, of Europe and Australia. Plants of Africa and America are partly represented. For the systematic botanists, forest officers, herbalists,



EXTERIOR VIEW OF THE HERBARIUM.

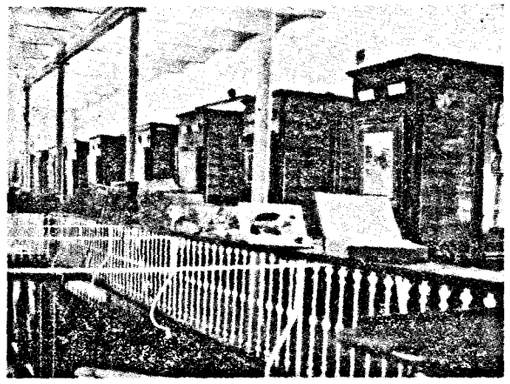
druggists, pharmacologists, industrialists and others interested in plants, the Herbarium is the most interesting and valuable spot in Asia. This is the only place for botanical investigation of its kind in India and is recognised as the best Herbarium not only in India but also in the East by the international

botanical organisation of the world. This Herbarium is, as Sir Arthur Hill, Director, Royal Botanic Garden, Kew, puts it, "the Mecca for the study of Indian Systematic Botany by botanists not only in India but from overseas". It will be interesting to note here what Sir Richard Temple, a Lieutenant Governor of Bengal said on the utility of a herbarium as early as 1876, "The collection is and will always be most useful in dealing with questions regarding the naturalisation of plants, the introduction of new vegetable products into the country, the adaptation of raw produce to the growing requirements of manufacturing industry, the management of the forests and the scientific improvement of Agriculture." Introduction of quinine, rubber, Ipecacuanha, various timber trees, fibre and oil yielding plants and other plants of great economic value is mainly due to exploration by the scientific officers of this Garden. The task of plant-hunting is by no means an easy job. In the inaccessible places it is hazardous and sometimes costs the life of the explorer. Dr T. Anderson lost his life in introducing cinchona into this Province. The cinchona cultivation in Bengal was first started by him in Sinchal. Then it shifted to Rungbee and finally the plantation was located in Mungpoo where the conditions proved favourable for wider cultivation and further extension.



INTERIOR VIEW OF THE HERBARIUM (GROUND FLOOR).

Besides quinine, various other useful plants like jute, tea, potatoes, coffee, spices, sugarcane, flax, hemp, rhea, sisal hemp, tobacco, cocoa, rubber, indigo, fodder grasses and numerous other economic plants were introduced through this Garden. Almost all the road-side trees and ornamental garden plants now found widely grown all over India and Burma were first acclimatised in this Garden. These were then distributed all over India and abroad. Of recent introduction is the Tung oil tree which is a source of considerable revenue in China. Experiments at this Garden indicate possibilities of cultivation of Tung oil in suitable areas of Bengal and



INTERIOR VIEW OF THE HERBARIUM (UPPER FLOOR)—IN THE RIGHT-HAND SIDE ARE SEEN WALLICH'S CATALOGUE AND A SKETCH OF ROXBURGH'S ICONES.

Assam in the drier lower ranges of the Himalayas between 2000-5000 feet. Reports of successful cultivation from Assam, North Burma and some parts of Bihar are promising. There is no reason why India should not be made self-supporting with regard to the supply of this oil so useful for various industrial purposes. The Garden distributed half a ton of seeds received from Kew to various parts of India with view to acclimatising Tung oil yielding trees. Some ornamental plants of recent introduction are *Victoria Curziana, Erythroxylon coca,* (cocaine plant), yellow lotus (North American *Nalumbium luteum* Willd.), *Musa rosacea, Cympogon Martinii* (Citronella oil yielding grass), Durio (Duriozebithenus) the Burmese fruit tree.

On the 6th January, 1938, the 150th foundation anniversary of this Garden was held, which happily coincided with the Silver Jubilee Session of the Indian Science Congress held in Calcutta. Many distinguished botanists took part in the celebration of the sesquicentenary of the Garden. Encouraging messages and greetings wishing prosperity to the Garden were received from far and wide.

Late reputed Prof. Hans Molisch, while working at the Bose Institute during 1928-29 as a guest of our

ROYAL BOTANIC GARDEN, CALCUTTA.

Royal Botanic Garden, Sibpur.

(273 acres)

1 Garden proper	2 Library	3 Botanical Laboratory	4 Botanical Explorations	5 Herbarium
Arranged regionally in different geographical divisions. Approx. 15,000 plants represent 2,500 species. Arboriculture, acclimatisation of tropical indigenous and foreign plants of botanical, economic and medicinal importance. Distribution of seeds, seedlings and plants, 10,000 to 20,000 per year.	Containing about 25,000 volumes, one of the best libraries in India, if not in the East, for the study of systematic botany.	For anatomical, ecological work and investigation of lower Cryptogams.	Throughout India for collecting materials for the Herbarium and the Garden.	Different sections of the herbarium, containing about 2½ million sheets.

1 General herbarium.	2 Local herbarium.	3 Garden herbarium.	4 Cryptogamic herbarium.	5 Artists & Photographers.
(1) Identification of specimens. (3) Preparation of specimens for herbarium. (5) Cataloguing and preparation of plant and seed sheets.	(2) Classification and systematic study of plants collected. (4) Guidance and expert advice to the workers in the herbarium.			

(1) Indian flora representing the various provinces occupying the central triangular area. (9) Lake flora. (12) 2 Orchid Houses. (13) 4 Ferneries. (16) Flower garden for growing annuals.	(2) Some plants representing the tropical flora of the whole world. (7) Economic, medicinal and student gardens. (10) Cactus garden and Succulent houses. (14) 2 Palm houses.	(3) Palmetum. (4) Pandanetum. (5) Bambusetum. (6) Arboreta. (8) Shade-Rockery. (11) 2 Nurseries. (15) Seed house (tropical) for seed storage, fumigation and distribution.

Calcutta Gardens.

(68 acres)

Eden Gardens | Dalhousie Sq. Gardens | Curzon Gardens

Educative and Recreational value.

Lloyd Botanic Garden, Darjeeling.

(40 acres)

1 Garden proper	2 Herbarium & Library	3 Seed house
(1) Regional and temperate flora with special reference to the Himalayan species. (6) Arboreta. (2) Rockery. (3) Nurseries. (4) Hot houses. (5) Medicinal and student gardens. (7) Seed house for distribution of Himalayan seeds to India and other temperate gardens of the world.	Containing valuable East Himalayan dried plants and some literature for studying local flora on the spot.	

great scientist, the late Sir Jagadish Chunder Bose, D.Sc., F.R.S., used to spend long hours in the garden pondering over many of his intricate botanical problems whose solutions he believed to have found under the sylvan surroundings of this Garden. The Garden to him, as he expressed it, was "a paradise, a wonderfield for botanists where life of every species grown under a tropical climate offers problems of careful investigations".

Prof. E. J. Salisbury in the concluding remarks of his presidential address in 1937 at Nottingham before the British Association for the Advancement of Science rightly observed, "A sympathetic understanding of botanical thought and progress is essential to a community which is to deal adequately with such national problems as agricultural policy, land utilisation, afforestation, drainage and water supply, the preservation of rural areas or the provision of national parks". The long records of the achievements of this Garden clearly show how far this Garden has contributed towards these items of nation-building works. But considering the vast needs of the country much remains yet to be done.

It is gratifying that a young and enthusiastic body of brilliant Indian botanists is being turned out through the gradually enlarging scope of specialisation of the Indian educational system. It is also encouraging that some of the work done by those men is now of a standard that is gaining recognition in the world of botanical science and there is no doubt, it is always gaining in importance. But this is the better reason, why the historical living and herbarium collections of the Botanic Garden that come down to the new schools should have the same care, attention and study that was formerly given to them. In the eyes of the scientific world of tomorrow it will take much more than a plea of financial stringency to justify the neglect today of priceless irreplaceable objects of art and science that have come down as treasure to us. I hope, as my predecessor hoped, for a brighter prospect to dawn in the future and enlightened recognition by both the public and those in authority of the great possibilities of this unique botanical institution in India, if not in the East.*

* Published with the kind permission of the Trustees of the Indian Museum, Calcutta, where the lecture on the Royal Botanic Garden, Calcutta, was delivered under the auspices of the Trustees on the 15th March, 1940.

INSPIRATION FOR RESEARCH

GREATER even than the greatest discovery is it to keep open the way to future discovery. This can only be done when the investigator freely dares, moved by an inner propulsion, to attack problems not because they give promise of immediate value to the human race, but because they make an irresistible appeal by reason of an inner beauty . . . . In short, there should be in research work a cultural character, an artistic quality, elements that give to painting, music, and poetry their high place in the life of man.

—John Jacob Abel.

Notes and News

House-heating by Solar Energy

THE problem of utilisation of radiant solar energy has been in the mind of scientists for a long time. Now and then construction of solar engines has been suggested and even made practicable, though none has been utilised so far. Some real progress is expected to be achieved in this direction in the near future as the Massachusetts Institute of Technology has taken up the problem of house-heating by solar energy with the aid of a gift of 650,000 dollars from Dr Godfrey L. Cabot. The energy received by the earth from the sun amounts to about ¼ of a horse-power per square yard, the amount somewhat varying with the latitude. The amount of solar energy received anywhere on the surface of the earth (except at the poles) varies from zero to a certain maximum during the course of the day and in order to have an unfailing and uniform supply some feasible storage system is necessary. If efficiently stored and used the solar energy received by a house in mid-latitudes is sufficient for house-heating. Theoretically there are many ways of storing the solar energy—as heat, as chemical energy, as electric energy or as potential mechanical energy. For various reasons the storage of energy in the form of heat appears to be most promising. Something will absorb the solar energy as heat when the sun shines, store it safely and economically and deliver it whenever required. The scientists at Massachusetts Institute of Technology has chosen water as the storage material. The problem of getting solar energy into water and preventing its escape until it is required is really a difficult one but the workers engaged on the problem are quite optimistic about arriving at a solution. Just at present there is no prospect of solar energy competing with coal or petroleum for our everyday purposes. But eventually coal and petroleum will be exhausted and scientists will have to find out substitute sources of energy of which the sun appears to be the most promising. An account of the earlier pioneer work on the utilisation of solar energy is published in the Science in Industry section of this issue.

Million Volt X-Ray Tube

IN the treatment of cancer and other diseases where gamma-rays or 'hard' X-rays have to be used, the use of gamma-rays has now been almost confined to treatment where the source of the rays can be introduced into or placed in intimate contact with the diseased tissue. This is because of the low gamma-ray intensity even when a large dose of radium is used. On the other hand, the penetrating power as well as absolute intensity of the beam can be suitably increased in the case of X-rays by raising the voltage applied to the X-ray tube and this permits the patient to be located at a greater distance from the tube. These considerations have led to the development of an one million volt X-ray tube in the Mozelle Sassoon X-ray therapy department of St. Bartholomew's Hospital, the output from which is approximately equivalent to that obtainable from £8,000,000 worth of radium. In order to afford protection from unwanted X-rays the apparatus-rooms and treatment-room are enclosed in walls of barium sulphate concrete, whilst the control room is separated by an eighteen-inch thick wall of barium-sulphate concrete. Patients are observed from the control room by means of a periscope system of mirrors. In the treatment-room all that can be seen of the equipment is the large horizontal steel tube, spanning the full width of the room and provided with a central aperture through which the X-ray beam emerges. This steel tube is a protective shield in the form of a double walled cylinder surrounding the X-ray tube proper and filled with lead shot six inch thick to cut off all X-rays except those directed on to the patient. The X-ray tube itself consists of a fourteen-inch diameter steel tube, seventeen feet in length, on the horizontal axis of which are located the cathode and anode, mounted on steel support-tubes and operating in a high vacuum. The cathode head is provided with six interchangeable filaments, any one of which may be brought into operation immediately in the event of a failure, without evacuating the tube freshly which would require about two hours. From the filament, streams of electrons shoot out and are accelerated through a potential difference of 300,000 to 1,000,000 volts to bombard a gold and copper target on the anode from which the X-rays are projected. A closed water-cooling system, comprising a radiator and fan dissipating ten kilowatts is employed to produce artificial cooling of the anode. In order to maintain high vacuum in the tube, continuous evacuation is employed by means of high speed Apiezon oil-diffusion pumps backed by mechanical pumps. During the two years that the tube has been in operation it has been energised nearly for 2,800 hours.

More about Magnetic Mines

ALMOST everybody is familiar with the word "Magnetic Mine" but to many its working principles have not been made absolutely clear. As in the *Arabian Nights*, where it is described in a story that the nails and other iron parts of the ship of Sinbad, the sailor, were pulled out from their places by the force of attraction of a magnetic hill in the sea, the general belief is that due to the attraction of the ship's iron the magnetic mine rises from the bottom of the sea, and the explosion takes place on impact with the ship's bottom. But the working principle and the mode of explosion of the magnetic mines are quite different.* These mystery mines are of two types: first the inert shallow-water type; and second the mobile deep-water type. They are very light and can easily be dropped into the sea from a height of 100 to 200 ft. from the water level by aircrafts, without damaging its mechanism or without detonation. Both the types have three distinct compartments. The upper one or the head contains a battery, a magnetic grid or device, and several other delicate electrical circuits and pressure valves. The middle compartment contains the explosive with the detonator caps. In the mobile type in the hind portion there is a bottle of compressed air, the mouth of which is connected by complex electrical circuits to the magnetic grid. The inert type has no compressed air bottle. The extra space in the hind compartment is filled up with water when the mine is dropped into the sea, in consequence of which it sinks.

When a ship comes within a certain range, the ship's iron bottom actuates the magnetic grid, which closes the electrical circuit, thus releasing the compressed air. This air forces out the water from the hind portion, and the mine, being now lighter than water, begins to rise. When at a distance of about 50 ft. from the sea level the detonator circuit is closed by a pressure release valve and the mine explodes, the effect being that of a depth charge. It does not really strike the bottom of the ship. The mobile types are suitable for deep seas from 200 to 400 ft. depth. The inert type does not rise from its place at the sea bottom. When the ship comes just above it, the magnetic grid closes the detonation circuit and the explosion takes place at the bottom of the sea. This type is suitable for shallow waters up to 50 ft. depth.

The difficulty against these mines is that the existing mine detectors or sweepers are quite ineffective against them. Though precise details, for obvious reasons, are not disclosed, it is now known that the British Admiralty has been able to develop a device, which, it is believed, will constitute efficient protection for steel ships against the form of magnetic mines at present being used by the Germans. The device is known as the "De-gaussing girdle" and consists of insulated electric cables, energised in an undisclosed manner by electric current. The de-gaussing girdle neutralises the natural magnetic field of a steel ship and renders her as safe from the magnetic mines as is a wooden ship. It is applicable to ships of all sizes, though the details of the treatment vary from ship to ship. When the *Queen Elizabeth* arrived at New York a conspicuous girdle around her hull attracted notice, and it has since been known that all British ships are to be so fitted as quickly as possible. Some time ago it was announced in the press that arrangements had been made at the Calcutta docks to fit the ships with the de-gaussing girdles.

N. K. S. G.

* An earlier account of these magnetic mines was published on p. 622 of the April '40 issue of this journal in this section.

World Catalogue of Meteorites

A WORLD catalogue of meteorites, the largest and most comprehensive of its kind yet published in any country, which should prove of use to those interested in these extra-terrestrial arrivals, has just been brought out as a *Memoir* by the Geological Survey of India. A special reference is made in the publication to the Indian falls and finds and to specimens exhibited in the Indian Museum, Calcutta.

Three hundred and ninety one of the 1,258 meteorites listed in the Catalogue are recorded from the United States of America. This is by far the greatest number for any country. India ranks second with 116 meteorites and it is followed in order by the U. S. S. R. 98, Australia 95, France 57, Mexico 53, Chile 40, with South Africa, Germany and other countries less than 36 each. The *Memoir* deals with questions of "craters" caused by meteorites and "showers" of meteorites, and also with the origin of meteorites.

Portions of extra-terrestrial bodies, meteorites, are the only tangible source of our knowledge of the universe around us. There are two chief kinds, *irons*, composed mainly of nickel-iron, and *stones*, composed mainly of silicates; but there is every gradation between them. They contain mainly elements of low atomic weight—which means they do not contain heavy metals like gold and platinum. Their average composition indicates matter which would have a density near that of the earth as a whole, *i.e.*, about 5 where water is taken as *1*. The largest meteorites are all *irons*, the largest known mass at Hoba in South-West Africa weighing 54 tons. The largest known *stone* meteorite fell at Long Island, Kansas and weighed 1,275 lbs. The immense masses of the large meteorites, the impact of which on the earth has been responsible for the formation of remarkable craters, can only be conjectured. Most of iron meteorites which have been found were not observed to fall. On the other hand, most stony meteorites have been seen to fall. No human being is definitely known to have been killed through the fall of meteorites.

It is estimated on the measurement of helium content that the oldest known iron meteorite solidified 2,900 million years ago. It has also been estimated that if meteorites are scattered portions of our solar system, their age should not be greater than 3,000 million years; but if they come from other stars, their period of solidification might date back some 10,000,000 million years. The determined date of solidification of iron meteorites thus accords with the assumption that they belong to our solar system.

Temperature Forecasts in India

TEMPERATURE forecasts are now being included in the daily weather reports of the India Meteorological Department. Forecasts are prepared by the Meteorological Officers at Poona, Calcutta, Karachi, and Delhi. Temperature and humidity affect the well-being of men, animals and plants. Forecasts of abnormal temperatures are of use to the general public as well as to the agriculturist, the engineer, the medical man and probably also a progressive industrialist.

Timely warnings of cold waves to agriculturists can lessen the losses arising from frost. A small expenditure on preventive measures, *e.g.*, by providing wind-breaks and burning heaters in orchards may enable a farmer to save his crops. Usual heat waves sometimes scorch up crops. It is possible that the bad effects of these may in some regions be minimised by timely irrigation.

Forecasts of incidence of low and high temperatures were previously given in the daily weather reports between 1890 and 1905. In 1905 there grew up a tendency to shorten all reports and accordingly to drop out forecasts of temperature which disappeared from the reports between 1906 and 1928.

In the winter of 1928-29 the occurrence of an unusually intense cold wave induced the Meteorological Department to revive the old practice of including the temperature forecasts in the reports whenever large changes of temperature were expected. In the winter of 1936-37 warnings for low temperature began to be sent to a large number of officers, mainly agricultural, in those provinces and States where crops are liable to be affected by frosts.

Kodaikanal Observatory Report

A FURTHER fall in solar activity is reported in the annual report for 1939 of the Kodaikanal Observatory, which specialises in the study of the sun. Observing conditions were slightly more favourable for solar observation than in 1938. The daily mean number of sun spots remained the same as in 1938. There was a decrease of 39 per cent in the mean daily areas of calcium prominences and a decrease of nine per cent in their mean daily numbers. A study of prominence areas was made to determine the possible influence of the earth on solar prominences.

Photographs of the sun on a scale of eight inches to the sun's diameter were obtained on 330 days and photographs in the lights emitted by calcium and hydrogen on the sun on 317 and 284 days respectively. Photographs showing solar prominences were taken on 305 days. Some of these photographs were supplied to Observatories at Greenwich, Cambridge and Meudon. The bright eruption on the sun on March 3 could be photographed in its successive stages. During the months of August and September, the sun showed unusual activity. These, as well as selected Fraunhofer lines, formed subjects of special study. A theoretical investigation on the mechanism of solar dark markings was also undertaken.

An amplifier to the photo-electric microphotometer at the Observatory was constructed and fitted up. The Observatory carried out the programme of the International Astronomical Union. The Milne-Shaw seismograph recorded 193 earthquakes during 1939.

New Water Level Recorders

Two automatic recorders, one for use in seepage drains and another for recording fluctuations of supply channels, have been designed by a Punjab engineer. The seepage drain recorder which is known as 'Cam' Recorder is entirely self-contained. The drum on which the chart is placed is driven by clockwork filled with jewelled escapement and will run for one month for each full winding and the recording pencil will last for the same period. The chart moves forward at one-tenth of an inch per hour and three days recording will be seen at a glance.

The other instrument which is called 'Zem' Recorder can be set to operate either at the head or tail of a supply channel. The pencil operating on the chart of the instrument can be set to the correct indent and fluctuations in the supply are recorded either above or below the line in the centre. The range can either be six inches up and six inches down or three inches up and three inches down. The chart moves at the rate of one-tenth of an inch per hour and one roll will last twelve months. The drum on which the chart is placed is driven by a one-second electric pendulum clock actuated by a battery of five dry cells and will run for at least six months without attention. The recorder can be allowed to read up to 14 feet range by fitting in differently pitched screws. The float arrangements for both gauges consist of an eight-inch copper float fitted in a twelve-inch light steel tube and cannot be tampered with. This tube requires a twelve-inch square well or can be placed in an open channel.

Report of the Imperial Agricultural Research Institute

SCIENTIFIC REPORTS of the Imperial Agricultural Research Institute for the year 1939 have been just published. The research for types of wheat is being carried on at the Institute and in one of the preliminary tests an increase in yield by about 200 lb. per acre in bulk plots has been recorded. Work on the breeding of wheats resistant to rust and loose smut was continued at Simla and preliminary trials showed a number of successful hybrids. Studies in other crops, particularly on tobacco, potato, oats, rice, etc., were continued. Experiments are in progress, both in Delhi and Simla, in the breeding of disease-resistant varieties of potato. This crop is subject to numerous diseases both while in the field and in storage. Among a large collection of Indian varieties, over 300 samples were studied and classified into groups after elimination of synonym stocks. Experiments in shortening the rest periods of potato are also being continued.

Work on the flue-curing of tobacco and experiments to determine the effect of chemical fertilisers and the rotation of crops on the quality of cured leaf are in progress at Guntur. In order to produce strains combining a good yielding capacity with high nicotine content, crosses between suitable types have been made and the results so far obtained are encouraging.

The Coimbatore Sugarcane Research Station has evolved a sugarcane-bamboo cross, which is of great importance both from the scientific and economic points of view and the trials, though still in the initial stage, are yielding encouraging results. Varieties of cane suitable for different cane-growing tracts of India have been evolved at the Coimbatore Station and some of the new productions obtained by careful combinations of thick and medium varieties bid fair to excel the earlier types both in adaptability and performance.

A finding of outstanding importance, both from the point of view of production and human nutrition, was that manures and fertilisers, when properly applied, were capable of influencing the quality and composition of the crop to such an extent as to affect appreciably its value both as seed and food. The importance of the discovery, particularly in India, where a major part of the soil is poor in organic matter and where in many cases one variety of grain forms the staple food of the bulk of the population, cannot be overestimated.

Experiments with different types of fertilisers and manures were continued. Correlated with these investigations were the studies undertaken on plant nutrition in general and, in particular, on the effect of soil conditions and fertilisers on plant metabolism.

The Institute has devised a combined furnace (New type 938) for gur and carbon manufacture at a construction cost of only Rs. 100. It will accommodate both the processes of carbon manufacturers and open pan-boiling within a compact space of 30 by 20 feet and will provide for the better utilisation of the heat of the flue gases. It has considerably helped to make further reduction in the cost of carbon, which can now be produced at less than a pice per pound.

Ten students completed the post-graduate course during the year and were granted the diploma of the Institute. The one-year course in farm organisation and general farm engineering was completed by five students. Nine students and a few officers deputed by provinces and universities were given short training in special subjects. Besides, 11 honorary workers were admitted for research on definite problems.

African Race and Culture in Photographs

MR A. M. DUGGAN-CRONIN, an employee of the De Beers Company in Kimberley, came in contact with the different types of African people who came to work in the mines. His interest was

aroused by their difference in culture and features and he made up his mind to make a photographic record of these people. From 1904 he began to collect photographs of the different South African racial types. Later on he added photographs of cultural traits too. With the help of the Union Research Grant Board and the Carnegie Institute he visited systematically different parts of South Africa year after year since 1925, and collected interesting objects of native use. The number of these photographic records has come up to 2600 at present, a part of which he has already published in the form of books with short notes.

In 1938 he made over his collection of photographs and ethnographic objects to the town of Kimberley and the Duggan-Cronin Bantu Gallery was opened in a building of the De Beers Company. At the joint meeting of the Rhodesia Scientific Association and the Rhodesia Photographic Society, held recently at Salisbury, this collection was very highly appreciated. A similar collection is not impossible in India, and if effected, would help to a very great extent in giving us a correct view of the life and culture of our primitive tribes (about 25 millions) about whom utterly conflicting ideas are held even by our educated public.

T. C. D.

Announcements

THE Government of India have revised their rules for the award of a State scholarship, ordinarily tenable for three years in Great Britain, which is awarded every year. Qualified students, without restriction of sex, race or creed, not ordinarily more than 30 years old on January 1 of the year in which the award is made, who are by birth or domicile natives of a territory under the administrative control of the Government of India or any administered area in an Indian State, are eligible for the scholarship. The scholarship will be awarded only for special purposes, *viz.*,

(*a*) training for particular posts such as those in special institutions like schools for defectives ;

(*b*) preparation for some particular work, *e.g.*, inspection of girls' schools, examination of educational systems or types of training etc., and

(*c*) study in any branch of knowledge for which suitable facilities do not exist in India.

The value of scholarship awarded will be as follows :—

At Oxford or Cambridge (Collegiate)	£335 per annum.
At Oxford or Cambridge (Non-collegiate)	£300 per annum.
At universities or colleges other than Oxford or Cambridge ...	£216 per annum exclusive of fees and sanctioned travelling expenses which will be payable in addition.

The selected scholar will be provided with fare from his or her home to the place of study. Similar facilities will also be allowed for return home provided the scholar has complied with the rules. The selected scholar will be required to execute a bond undertaking to pay a sum of £1,000 (or, in India, its equivalent in rupees) if he or she fails to return to India when directed or if he or she settles in some other country within five years of the termination of the scholarship.

THE University of Bombay have conferred the degree of Doctor of Science on Prof. Maneck B. Pithawalla for his Geographical Studies of the Lower Indus Basin (Sind). This is probably the first instance when a person has been admitted to the doctorate degree in recognition of his researches in geography with reference to India. Dr Pithawalla has a number of publications to his credit, mainly with reference to the geography of his own province, Sind. He worked for sometime under Professor E. G. R. Taylor in London.

THE Governing Council of the Indian Institute of Science have approved of an industrial research scheme involving Rs. 1¼ lakhs as additional expenditure for two years as an emergency war measure. The proposed researches relate to manufacture of fertilizers, synthetic drugs and artificial plastics.

PROFESSOR B. N. SINGH, Head of the Institute of Agricultural Research and Professor P. S. Varma, Department of Organic Chemistry, Benares Hindu University, have been appointed Local Secretaries of the next session of the Indian Science Congress Association to be held at Benares in January next. Professor M. R. Siddiqi of Osmania University and Mr C. C. Inglis, Director, Central Irrigation and Hydrodynamic Research Station, Poona, have been elected presidents of the mathematics and statistics and the engineering sections respectively of the Benares session in place of Professor K. Anand Rao and Sir M. Visvesvaraya who have expressed their inability. In the geography and geodesy section Dr S. M. Tahir Rizvi of Aligarh University will preside.

SCIENCE IN INDUSTRY

Glass Fabrics in Electrical Industries

THE use of glass textiles as insulators in motors and generators is increasing very rapidly. Glass fabrics have been proven stronger not only at normal temperatures but also at elevated temperatures. At temperatures around 200°C all organic materials deteriorate very rapidly and soon lose practically all mechanical strength, even the asbestos fabrics which usually includes some organic ingredients slowly lose their strength, but glass fabrics do not. Glass fabrics do not become brittle until they are heated to about 700°C and do not soften below 800°C. The above temperatures are far above the operating conditions of motors and generators.

The glass fabrics are non-hygroscopic and consequently have higher insulation resistance than other materials when exposed to highly humid air. One of the causes of the deterioration of silk etc., is this absorption of moisture. The resistance of glass fabrics to attack by acids, oils, corrosive vapours and vermins are of obvious advantage where these hazards exist. Of course with respect to dielectric strength and other properties glass insulators in its present form is not comparable to mica.

Glass fabrics have greater thermal conductivity, this means that for a given flow of heat the temperature difference between the inside and the outside of the insulation is less, with consequent lower internal temperatures.

The finish taken by glass insulated machines are excellent and the machines look very decent in appearance. But glass has its disadvantages too. Its resistance to shearing against sharp edges is low. Although most of the characteristics associated with glass have been modified, it is still fundamentally glass and its inherent brittleness is evidenced in this manner. So in order to use it sharp edges must be avoided.

N. K. S. G.

Spraying Surfaces with Shellac

A NEW process for coating surfaces with shellac, by spraying it from a heated "pistol", has been evolved in the Chemical Engineering Department at the University College in London by Mr K. B. Lalkaka, on behalf of the Indian Lac Cess Committee with the co-operation of two British research workers.

The process is applicable to many commercial purposes, such as the spraying of wood, paper, tin, aluminium and copper sheet, concrete, glass, asbestos board, plaster castings, and porous stoneware ; for anti-fouling compositions, laminated insulation and coatings for storage tanks containing edible fats or corrosive mineral oils. The spraying of lacquers, and even of metals, has been employed for some years, but this is the first process which has enabled the application of a resin direct, without using solvents, thereby saving time, labour and expense.

The film is hard as soon as it is cold, and thus the usual drying time is eliminated. This property will be of great value in many industries. Among other advantages are the saving of time and labour, owing to the speed with which a coat of shellac can be applied ; and the saving of expense, owing to the fact that solvents are no longer required.

More Salt from Sambhar Lake Area

ROUND the Sambhar Lake a vast area has been discovered from which the salt is now being scraped out. It was so long dumped with the refuse liquor of the surrounding *kyars*, or collection of manufacturing pans.

It is anticipated that on the edge of the area where crystal salt has been discovered, there is about 10,00,000 maunds of powdered salt. The existence of a thick deposit of *reshta* or powdered salt along the edge is, it is explained, due to action of westerly winds and the consequent rapid precipitation of fine salt as is met with on a smaller scale in the *kyars*. Till now a quantity of 4,50,000 maunds of *reshta* has been collected, which is being despatched to the stores after washing. About 5,00,000 maunds of salt of this kind is still lying there in admixture with some grained salt.

Ordinarily, after the rains, this bitterns area remains covered with brine practically throughout the year, but this year, owing to deficiency in rainfall, the whole of the deposit lay exposed and its explora-

tion led to the discovery by Mr Rahim Baksh, a Superintendent in the Northern India Excise and Salt Department at Sambhar, of a regular layer of crystal salt of good quality about three inches in thickness, beneath one inch to two inches thick crust of impure salt, which was easily removable from the top. On excavation by normal methods the layer breaks up easily into separate and well matured crystals, medium and large in size, and absolutely white in colour. Washed with condensed brine, the salt attains a purity which physically and chemically compares very favourably with the ordinary salt manufactured or mined in India, or imported from abroad, the percentage of sodium chloride varying between 95 and 99. The collected salt after being washed with canal brine is carried to the Central Stores of the Sambhar Lake by meter-gauge trucks hauled by a railway loco.

Solar Rays as Source of Power

OF solar radiation which we receive, 15 per cent has the possibility of being converted into mechanical work. Similar to hydroelectric power which we generate from natural water sources, solar power demands no continuous expense except care and interest on the initial investment. The only drawback is that solar power ceases during night hours and on cloudy days. For irrigation purposes however this intermittence is not a serious objection as during day time solar heat may be converted into mechanical energy and water may be pumped by means of this. For utilization of solar heat thin and flexible aluminium sheets known as 'Alcoa' are now used instead of glass. These metal sheets reflect only 80 per cent of solar radiation and can be used for years without dimming. The accumulated heat is protected by glass jackets enclosing high vacua like thermos bottles. By driving mechanically the heat collector in the direction of the sun's movement, the sun is followed in its daily march through the sky as also in the annual march from month to month. In clear sky condition one may expect to get from 1·2 to 1·4 calories per square centimetre per minute from the solar beam. But losses due to reflection and transmission from vacuum jacket leave 0·79 to 0·87 calories for use. Dr C. G. Abbot who is primarily responsible for sustained work in the mechanics of utilizing heat from the sun has published an exhaustive revised account of the various devices to which solar heat has been put in the *Smithsonian Miscellaneous Collections*, Vol. 98, No. 5 (reproduced in the *Publications of Astronomical Society of the Pacific)*.

For domestic water heating, a shallow depression on the roof is lined with blackened sheet metal which supports a blackened grid of pipes like steam radiator. The depression is generally covered with glass windows which focus the solar beam. Water circulates through the pipes and collects at a reservoir. Dr Abbot has been able to get 5 gallons of 'very hot water' in half an hour on sunny days.

He has developed cooking devices also. Engine cylinder oil within a blackened metal tube at the focus of the ray-collecting mirror was utilised as a heat conveyor to get temperatures which were obtained above the boiling point of water. About 60 gallons of this oil were employed for having a large capacity of heat. Two days of 7 hours' sunshine were required to initially heat the system. The heated oil is circulated by tubes to a sheath on the oven and the quantity of oil in the oven sheath guards against loss of temperature due to the temporary cloudiness and the night hours.

Solar heat has also been used to distil water. The entering water in the arrangement condenses steam and the temperature of the circulating water is gradually raised almost to boiling point, and only the latent heat of steam is supplied in the distilling device by solar radiation.

To overcome the interference by the clouds, Dr Abbot has made a 'solar flash boiler' which raises full steam pressure with 5 minutes of solar exposures. It is automatic so that water supply is stopped as soon as the sun is hidden by clouds, and more water is pumped when steam pressure rises above the desired maximum. By multiplying tubes connecting to the inlet and the outlet tubes leading to the boiler maximum amount of heat is obtained and the superheated steam is protected as well against cooling by the entering water. With the help of differential expansion between the boiler tube and an invar tape attached to the lower end of the boiler tube the temperature of the boiler gives an index to the prevailing steam pressure and controls the position of the carriage of the device. With the help of this difference of temperature, on the other hand, a uniformly rotating eccentric pin controls the pump of water. The efficiency factor of the flash boiler is 34·5 per cent ; mechanical efficiency 75 per cent and efficiency of conversion of solar to mechanical energy 15·5 per cent. Dr Abbot suggests that with high efficiency and great simplicity of the present flash boiler scheme, power from the sun at not exceeding 0·5 per cent horse power/hour will be available, which is estimated to give a good return on the capital investment for building the device. Unless this heat energy from the sun is conserved there may not be any possibilities for its use in industrial organizations. Unfortunately, there is no thermal insulator as the electric insulators. It has however been suggested

that a silo-shapped cement-lined pit containing dry coarse sand, which is a very bad conductor, with a layer of glass wool on the top to protect against conduction and upward convection may serve as a storage agency. An appropriate network of pipes at the bottom and at the top of the sand pit (but not through the sand) will be connected to the solar heater. An automatic pump controlled by the heat of the focus tube will draw hot air into the top of the sand. The heat on the sand pile will gradually work down, the whole attaining the temperature of the focus tube on prolonged working. By reversing the circulation of the air, the heat of the sand would give the outgoing air from the top a very high temperature out of the heat of the sand pile.

Dr Abbot thinks that the best heat storage would be within a pressure tank filled with water with a thick coating of glass wool. The water, heated far above the boiling point, would supply steam for hours during cloudiness and night. He is of opinion that these solar devices being of extremely simple mechanism can be produced in mass scale at attractive prices, particularly for heating, cooking and distilling. He has estimated that New Mexico can supply ten trillion horse power-hours per year of mechanical power.

Beryllium and its Uses

BERYLLIUM is a metal which is hardly known to the public. There is no use of the metal separately in the pure state. Its property of increasing the hardness and resistivity of metals like copper, nickel, etc., even when present in a very small percentage, has made it commercially very important nowadays. The metal was identified in the year 1797. It was in the post-War period that the extraordinary heat-treatable characteristics of copper-beryllium alloys were discovered in Germany, which at once found a very high commercial application. It is lighter than aluminium, has a strong durability and fatigue resistance, and has strong affinity for oxygen.

Cooper is a soft metal, but when 1·5 to 2·75 per cent of beryllium is added to it, after proper heat treatment, it acquires hardness comparable to that of steel. Usually 2 per cent is mixed, and the resultant alloy has a tensile strength of 70,000 pounds per sq. in. in an annealed soft state, whereas cold-rolled and heat treated strip will give a tensile strength of 190,000 lb. per sq. in. By way of contrast, structural steel has a tensile strength of 60,000 pounds. The peculiarity of this alloy is that it can be formed in relatively soft temper, and in the ductile state can be rolled, forged, and drawn. After heat treatment it acquires its extreme strength and hardness. Beryllium-copper is non-magnetic and gives no spark when struck. It is very hard and wear-resistant, and is used for bearings and bushings and certain types of gears. Its non-sparking quality, coupled with hardness, makes it suitable for special tools to be used in plants where there are explosives or inflammable substances.

Beryllium-copper has a very wide use as a spring material. A more uniform product can be made, than is possible with spring steel or phosphor-bronze, and the alloy is virtually untiring. A beryllium-copper spring for example can be flexed 15 billion times as contrasted to 400,000 for phosphor-bronze.

Recently, cast moulds in plastics industry are being made of beryllium-copper alloy. It is particularly suitable for these moulds because it has a low melting point and good flowing qualities, which give excellent reproduction of intricate designs, and has a thermal conductivity twice that of steel, which permits a quicker moulding cycle.

When 2 per cent beryllium is added to nickel, the resultant alloy, after proper heat treatment, acquires a tensile strength of 260,000 lb. per sq. in. as contrasted to 60,000 lb. for structural steel and 90,000 lb. for stainless steel. Beryllium-nickel valve springs work in aircraft engines without showing the slightest fatigue and that bushings of this alloy has not yet failed for a single time.

Continuous attempts are being made to produce alloys of beryllium with aluminium and magnesium, but so far it has not yet been successful. If beryllium-aluminium alloys can be produced with the expected properties, then the aircraft industry will have a new material for engine pistons, and consequently the aircrafts will be much lighter.

Some of the interesting successes in beryllium research are nickel-chrome-iron-beryllium and beryllium gold. The former alloy has an elastic limit of 200,000 lb. per sq. in., is highly corrosion-resistant and non-magnetic. Its commercial use is now limited to replacing watch spring steel in high grade watches. Beryllium-gold formed with 1 per-cent of beryllium is extremely hard and can be used as a dental inlay and for low-melting gold solders.

Beryllium has a very high affinity for oxygen and sulphur. The metal reacts with all oxides at high temperatures and combines very readily with sulphur. These deoxidising and desulphurising properties are now being used for the production of high conductivity copper castings and to remove the sulphur in the steel melts. Even when a high

sulphur content remains in steel, it is still possible to roll it, if beryllium is present in small amounts.

Side by side with the increasing use of beryllium its extraction processes has improved with consequent decrease in price. As recently as 1922 the cost was rupees 15,000 per pound. The present price is roughly Rs. 40/- to Rs. 45/- per pound.

N. K. S. G.

Industrial Research in the U. S. A.

FROM an analysis of the National Research council surveys it is found that the number of organisations in the U. S. A. maintaining research laboratories has grown from 900 in 1927 to more than 1700 in 1938. These afford employment to nearly 50,000 workers. The chemicals and allied products industries are engaging the largest number which was over 9,500 in 1938. Like the large factories of mass production where the progressing divisions of labour in manufacturing processes have made significant changes in the quality and quantity of production, the present-day research laboratories are systematically dividing complex problems among the specialists in the several sciences or their branches. Each works on a separate phase of the investigation and with the help of team work, the laboratories are achieving solution of various complicated industrial problems.

Manufacture of Liquid Gold in India

LIQUID gold is a dark, viscous oily substance containing organic compounds of gold and certain other suitable metals dissolved in essential oils. It is applied to the glass and ceramic articles to be decorated by means of a feather or a fine brush, either as such but usually after dilution with essential oils. After drying, which usually takes about an hour, the articles are carefully fired in a muffle furnace in such a manner that the temperature rises gradually and uniformly. For this purpose, the use of a channel type of furnace in conjunction with a conveyer in which the suitable temperature gradients can easily be maintained is desirable. During firing, the organic portion of the liquid gold is lost, and a lustrous film of metallic gold which adheres firmly and cannot be easily removed is deposited on each article.

In liquid gold, the gold and the other necessary metals are present in the form of resinates, which can be prepared either by interaction between the metal chloride and the sulphur-turpentine compound or by heating together the oxide of the metal with Venetian turpentine at the boiling point of the latter. The sulphur-turpentine compound is an oily dark brown liquid, prepared by heating flowers of sulphur with a mixture of Venetian turpentine and oil of turpentine.

That there should be no difficulty in manufacturing liquid gold in India, even during war time, and that the manufacture would be profitable, is suggested by the Industrial Research Bureau in their Bulletin No. 16 "*Manufacture and Application of Liquid Gold*" issued recently.

Used extensively by the Indian glass bangle industry and manufacturers of ceramic articles for decoration purposes, liquid gold has hitherto been exclusively imported from abroad. Since the outbreak of war, its supply has become greatly restricted and its price higher. The Industrial Research Bureau has estimated that to produce an ounce of liquid gold under war-time conditions would cost Rs. 16-7 instead of its peace-time cost of Rs. 13-3-10, or 24 per cent more.

Can Tidal Energy be Used in India for Production of Power?

S. K. BANERJI

IN the rise and fall of the tide, we have an inexhaustible source of energy. In a very small way the energy of the tide has been utilised at various places. A tide mill in the river Tamar in England, which was installed in 1790, is reported to be still in operation. It is only recently that large-scale projects for harnessing the tides have been seriously proposed. The French Government have provided funds for the construction of a tidal power station of an experimental type near Brest. In England consideration has been given to a tidal power scheme in the estuary of the Severn.

While the practicability of power production from tides is beyond question, the desirability and expediency of such a project will depend on the cost

at which power can be produced in any tidal power scheme. Norman Davey in his book entitled *Studies in Tidal Power* has classified the various schemes that have been suggested for the utilization of the tidal energy into four systems, (*a*) the float system, (*b*) the tidal stream system, (*c*) the compressed-air system, and (*d*) the basin system.

The Float System: The device is a very simple one. A floating body having considerable weight is lifted by the rising tide and during the fall of the tide this body is made to do work by means of a system of levers and gears. If an old ship, weighing 20,000 tons is made to work in this way over a tidal range of 20 feet and in a tidal cycle of 12½ hours, its horse power is

$$\frac{2240 \times 20{,}000 \times 20}{12{\cdot}5 \times 60 \times 33{,}000} = 36{\cdot}2$$

Apart from the practical difficulties of working such a scheme, the relatively small power that can be obtained in this way makes it of little practical importance.

The Tidal Stream System: The tidal stream system makes use of paddle wheels, which are usually fixed on a raft anchored in a tidal river. The moving water, due to the tidal current, causes the paddle wheels to rotate. This system is more efficient than the float system, but, nevertheless, can be used only as small power units.

The Compressed-Air System: The compressed-air system makes use of the energy of the tides for the direct compression of air in closed chambers of suitable design. This system is more efficient than the two previous ones, but the cost involved in the design is so great that it is of very little practical value.

The Tidal Basin System: Of the various suggested schemes, the tidal basin system seems to offer the most practical method. There

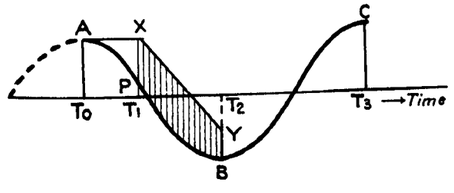


FIG. 1.

may be a single tidal basin cut off from the sea by a dam, in which are installed turbines, with intermittent periods of working and idleness, and equipped with suitable storage plant, or a system of duplicate tidal basins capable of working at all stages of the tide and therefore without storage plant. If a single tidal basin is used, water may be allowed to enter the basin through sluices during the rising tide, and after the sea-level has fallen through a portion of its range, water is allowed to operate the turbines at a nearly constant head until low water.

If ABC (Fig. 1) represents the sea surface during a tidal cycle T_0T_3, and if it is desired to work the turbines under the head PX, then the period of their working will be T_1T_2 and the period of idleness $T_0T_3 - T_1T_2$. It will be clear from the diagram that if it is proposed to increase the working head, the period of operation will be shortened. It can be easily shown that the maximum output will be obtained when the head is approximately half the tidal range.

We can get an increase in the output by utilising both the rising and the falling tides. If we wish to do this, the arrangement of the water passages should be such as to permit the use of the turbines with a flow from either side of the wall in which they are set. Otherwise duplicate inflow turbines should be provided. With such an arrangement the work done in a tidal cycle would be about 50 per cent greater and the idle period of the turbines would be correspondingly shorter. The dimensions of the storage plant would also be reduced.

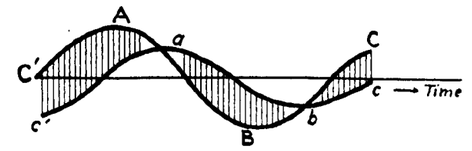


FIG. 2.

We can also arrange the system in such a way that the water during both the rising and falling tides flows through the turbines and adjusts its own level.

The working condition is illustrated in Fig. 2. Both the sea-level C'ABC and the level of water in the tidal basin, c'abc, undergo cyclical variation. The working head is shown by the shaded portion of the diagram. The head is variable and at the points, a, b, where the two curves intersect, it is zero. Therefore for an interval before and after these points, the turbines will stop working for want of sufficient working head. The working period and the possible output are greater with such an arrangement, but the variation of working head is a great disturbing factor.

If there are two tidal basins, namely "the upper basin" and "the lower basin", we can develop power almost continuously.

The working arrangement is illustrated diagrammatically in Fig. 3. Flow from the sea into the lower basin through the turbines occurs during the upper portion, C'AB', of the tidal rise. At the same time the upper basin is being filled through the sluices. During the lower portion of the tidal fall, B'BD, flow through the turbines into the sea is allowed to take place from the upper basin. During this period the lower basin goes on emptying itself through its sluices. In this way the power is developed continuously; the output, however, is not appreciably greater than in the best of the single basin systems. The cost of providing two tidal basins and the duplicate sets of turbines makes the system lose much of its advantages.

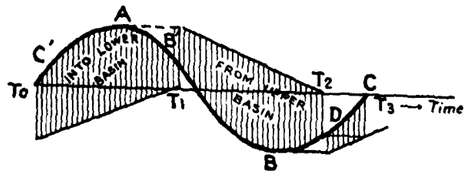


FIG. 3.

POWER AVAILABLE IN BASIN SYSTEMS

Let us suppose that at low water the sluices in a tidal basin having the area of A square miles, or 27,878,400 A square feet, are closed and remain closed during the entire period of the following rising tide. At the time of high water outside, there is a difference in head between the level of the water in the basin and the water outside equal to H feet. If the sluices be now opened, and if they be supposed to be large enough to permit the basin to be filled in a few minutes, a mass of water equal to 27,878,400 AH cubic feet will have entered the basin. Since the average distance of fall of the water is ½H feet and since the weight of a cubic feet of sea water is approximately 64 pounds, the amount of work which this mass of water is theoretically capable of doing is 892,108,800 AH^2 foot pounds. But this represents the work for the total tidal rise, or in a period of 6¼ hours. Hence the horse power theoretically available is

$$\frac{892,108,800AH^2}{6{\cdot}25 \times 60 \times 33,000} = 72AH^2.$$

The tidal power available therefore depends on two factors, namely, the area of the basin and the range of the tide; it varies directly as the area of the basin but as the square of the tidal range. Therefore to get the best advantage we must construct the tidal basins at places where the tidal range is high.

SUITABLE PLACES IN INDIA FOR TIDAL BASINS

Because of the above consideration much attention has been given to the estuary of the Severn, the mean range of spring tides at Chepstow having the high value of 42 feet and of neap tides of 21 feet, as compared with the average value around the coast of Great Britain of 16.4 and 8.6 feet respectively.

For some of the Indian and Burma stations we get the following values from the tide-tables:—

Port.	Mean High Water Springs ft.	Mean High Water Neaps ft.
Akyab	7·85	5·58
Amherst	19·09	13·67
Bassein	8·62	7·22
Beypore	4·16	3·49
Bhavnagar	34·30	27·27
Bombay (Apollo Bundar) ...	13·82	10·66
Chandbali	8·58	6·82
Chittagong	12·89	9·74
Coconada	4·99	3·71
Cochin	2·90	2·38
Colombo	2·21	1·43
Diamond Harbour (Hooghly River) ...	16·34	11·87
Dublat (Hooghly River) ...	16·28	12·06
Elephant Point (Rangoon River) ...	19·93	15·17
Karachi	8·74	6·82
Karwar	6·07	4·82
Kidderpore (Hooghly River)	15·80	12·84
Madras	3·49	2·57
Mergui	17·58	11·73
Marmagao	5·97	4·69

A tidal range of less than 10 feet is not of much practical value. The most suitable place for experimental tidal basins is Bhavnagar. If experiment is desired to be performed near a populous centre, then obviously the best place is the Hooghly River. If an area of 20 square miles could be utilised at the spring tidal range of Bhavnagar, the average output, working without storage plant, would approximate to a million horse power.

EFFECT OF FLUCTUATIONS IN HEAD

The principal difficulty in connection with any tidal power scheme lies in the relatively great fluctuations in head. The great relative differences between spring and neap tides present some difficulty. It can be met by designing for the minimum head and thus utilising only a small proportion of the available energy, with a consequent increase of the power unit cost, or by adopting some equally costly form of storage reservoir, which could be used for the production of additional power in a secondary power plant during periods of neap tides.

This short note is intended to suggest the problem which offers a good deal of scope for inventive genius. Owing to the vast possibilities which await the development of tidal power it is most important that investigations at those places where conditions are most favourable should be pursued seriously.

Mineral Resources of Central Provinces and Berar

THE most important geological formations in the Central Provinces from the mineral point of view are the Dharwars, with their deposits of manganese ore, iron ore, steatite, red ochre and dolomite; the Gondwanas, with their stores of coal, fireclays and pottery-clays; the laterite, with its bauxite and building stone; and the alluvium with its supplies of brick-clays and kankar; while excellent building stones may be obtained from all the formations as well as materials for the manufacture of cement, particularly in the Lower Vindhyas and Cuddapahs and there is the possibility of many minor mineral products being developed. This information is given in a paper on the Mineral Resources of the Central Provinces and Berar, published in the *Geological Survey of India Records*, Volume 74, part 3. The relative importance of the various mineral industries hitherto established in the province can be judged from the production figures for 1938:—

	Tons
Coal	1,658,626
Manganese Ore	646,465
Limestone and Kankar ...	551,978
Clay	60,252
Bauxite	4,634
Ochre	2,924
Steatite	2,189
Iron ore	611

COAL OUTPUT

The total coal available in the province is computed at 17,000 million tons of which the reserves of workable coal amount to 5,150 million tons. Of this nearly 4,000 million tons occur in the Wardha Valley, 1,000 million tons in Chhattisgarh Mahanadi and 150 million tons in Satpura region. A part of this reserve lies in Indian States. In spite, however, of the existence of a large number of coal fields, the majority have not been worked partly because of their situation as regards communications and partly because of the rather inferior quality of coal. Coal worked in the Pench Valley fields which are the best producers in the province, is of average second grade and is now finding a good market in the Central Provinces, Gujerat and Bombay.

Judged from the standpoint either of quantity or of value, the manganese ore industry is the most important mineral industry of the province, which contains some of the finest manganese ore deposits in the world. Nearly 600,000 tons of the mineral are extracted every year. The rocks of the gondite series with which the manganese ores are associated are developed typically in the Chhindwara, Nagpur, Bhandara and Balaghat districts and to a small extent in Seoni.

VARIETY IN BUILDING MATERIAL

Materials suitable for building purposes occur in great variety and abundance. The alluvial tracts, not only of the Narbada, Purna, Wainganga, Kanhan and other big rivers, but also of many of the smaller streams, yield excellent brick-clays, whilst kankar is abundant in the tracts of older alluvium. Laterite is abundant in some parts while the Deccan trap provides an excellent building stone, and is also one of the best stones for macadam roads and for concrete-aggregate. The lameta or limestone occurring in the Satpuras and in Nagpur and Chanda (Karamgaon) constitutes an excellent ragstone.

There are several formations of excellent ornamental stones. For marble, the best known locality is the Marble Rocks in the Jubbulpore district, but numerous excellent marbles occur also in the Betul, Chhindwara, Nagpur, Seoni and Narsingpur district. Beautifully marked serpentine marbles can be had in Chhindwaras. Sandstones suitable for ashlar work and fine carving may be obtained from Bhutara hill

and Isapur in the Chanda district, Silewada near Kumptee, Akhund in Nimar and Ellichpur in Amraoti. Fine white sandstones are quarried at Sirgora and Pathe in Betul. The Panchmarhi sandstone is also a good building stone.

SANDSTONES

Red, yellow and buff sandstones used in so many of the famous buildings of Northern India have been taken from various divisions of the Upper Vindhyas. The Rewah group near Hoshangabad has yielded thin red sandstone flags for use as roofing tiles. Limestone suitable for lime-burning and building purposes is found at Katni. Mixed with Lower Vindhyan shales it is also used for the manufacture of cement, while the Raipur and Penganga limestones are now being extensively used for building purposes. A pure quartzite suitable for crushing for glass sand occurs in large masses near Kishanpur, ten miles from Narsinghpur railway station.

White clays are often seen in the Jabalpur beds of Jubbulpore and Chhindwara district. The Jubbulpore potteries obtain their supplies from near the town. In Chhindwara the clay beds are 2 to 3 ft. thick and sometimes as much as 10 ft. white clay is also available in Drug district. Fire clay is often found in the Indian coal measures, associated with coal-seams, frequently as an under-clay, and could probably be obtained from most of the coalfields of the Central Provinces if required. Upper Gondwana clays of Jubbulpore are found to be exceedingly refractory and are used in pottery works.

ALUMINIUM ORE

Large quantities of aluminium ore occur in Baihar plateau in the Balaghat district and near Katni in the Jubbulpore district. Mandla and Seoni districts, too, have some good deposits. In recent years some deposits with 60 per cent of alumina have been found to occur near Bhabei and further south in Nandgaon State.

Both red and yellow ochres occur at several localities in the province. Red ochre is mined at Jauli in the Jubbulpore district and is also available in the Gandai and in the Salitekri hills in the Balaghat district. Small lenses of earthy haematite which should prove useful as a paint material are found between the Sukkur river and the Narsinghpur-Chhindwara road. Steatite is reported from several localities, the best known of which is the Marble Rocks near Jubbulpore. There are also deposits at Gowari and Lalpur to the south of the Narbada and near Rupaund on the Katni-Bilaspur branch of the Bengal Nagpur Railway. Pot-stone and steatitic schist have been reported from several localities in the Bhandara district, whilst at Jambal Ghat in the crystalline area of Chanda is a dark-coloured pot-stone formerly used for carving into idols and household vessels. Similar rock from near Kilokora in the Drug district is also worked for making utensils. Soapstone has also been reported from near Wun.

IRON ORES

The most valuable and abundant of the Central Provinces iron ores occur in the Dharwarian rocks, particularly in the Chanda and Drug districts and in Bastar State. At least ten separate deposits, some of which are of large size, have been located in the Chanda district. The most striking occurrence in the Drug district is the ridge which includes the Dhalli and Rajhara hills, extending for some 20 miles in a zig-zag, almost continuous line, and rising to a height of some 400 feet above the general level of the flat country around. In the Rajhara hills there exists 2½ million tons of ore carrying about 67·5 per cent of iron. The reserves of ore in the Bastar State are estimated to be 114 and 610 million tons, and the ore is of excellent quality. Though occurrence of mica, quartzite, copper, lead, silver, foul-spar felspar, wolfram varieties are also reported, the discoveries have not hitherto proved to be of much value.

SALT RESOURCES

There are four hot springs in the province. The crater lake near the village of Lonar, in the Buldana district, Berar, contains a large proportion of carbonate of soda which crystallises out on the evaporation of the lake during the hot season and is used in the manufacture of glass and soap. A certain quantity of salt is also obtained as a bye-product in the manufacture of carbonate of soda from the brine of the Lonar lake. A deposit of saliferous sand or clayey sandstone has also been noted beneath the alluvial deposits of Western Chanda.

MEDICINE & PUBLIC HEALTH

New Syphilis Cure

A NEW method of curing syphilis has been reported from the Manhattan Mount Sinai Hospital in eastern U. S. From the bottom of a glass jar suspended above a syphilitic patient's bed a yellowish fluid trickles through a flexible glass tube into a needle inserted in the vein between his elbow and wrist. The appartus is an ordinary "Murphy drip," long used for glucose feedings. In the jar is a sugar solution of mapharsen, one of the earlier of the 950-odd arsenic compounds invented by Paul Ehrlich, and the drug seeped two drops every three seconds into the patient's veins. With the drip method, early syphilis is expected to be cured in five days.

The slow dripping of mapharsen into the blood-stream of the patient for eight hours a day eliminates the "shock" of relatively large injections, builds up blood tolerance to huge concentrations of the essential arsenic. During a five-day treatment, a patient absorbs about two and a half gallons of mapharsen solution.

The doctors first tried neoarsphenamine in their Murphy drip, but found it "too dangerous." Maphrsen, which is less toxic, was discarded by Ehrlich because it was too unstable. But modern chemists have "set" the drug. The entire course costs only $82 a patient, as contrasted with an average of $300 for the standard 18 months of arsphenamine injections. There is however a drawback to mass cures in this technique as it can be used only in hospitals, not in doctor's chambers.

Grass for Health

WHEN Nebuchadnezzar, the Babylonian king, was feeling low, he crawled on his hands and knees and ate grass. But Nebuchadnezzar also drove the Egyptians out of Asia, conquered Syria, destroyed Jerusalem. After four years of analysis and experiment, *Time* reports that it has been proved that grain grass contains all the vitamins except D, has 28 times more vitamins per pound than dried fruits or vegetables. It has 23 times more vitamin A than carrots; nine times more vitamin B_1 than leafy green vegetables; 22 times more vitamin B_2 than lettuce; 14 times more vitamin C than tomatoes and citrus fruits.

The scientists ate this grass, in a form made fit for consumption by mixing it with other food-stuff, all winter, caught no colds, and enjoyed excellent health. Three U. S. factories and one Canadian are now making powdered grass. The approximate cost is 6 cents per lb. It was reported to the American Chemical Society meeting in Cincinnati in April last that the use of only twelve pounds of powdered grass a year would supply the necessary factors for a liberal diet to all U. S. families at a price they could afford for the first time in history.

Doctors have already begun to feed powdered grass solution to new-born infants with haemorrhages. Of the 20-odd vitamins known to science, about ten can be extracted from plants or produced artificially. Most important vitamins on the physician's shelf are

(*i*) Vitamin A: for night blindness and certain skin diseases.

(*ii*) Vitamin B complex (consisting of some 15 related vitamins): for pellagra, and for deafness caused by deterioration of the auditory nerve.

(*iii*) Vitamin B_1 (thiamin): for beriberi, anorexia, certain heart disturbances, inadequate lactation, nerve diseases of alcoholism, facial neuralgia, cirrhosis of the liver, sciatica.

(*iv*) Vitamin B_2 (riboflavin): for blindness caused by inflammation of the cornea, certain skin disorders.

(*v*) Vitamin C (ascorbic acid): for scurvy, pyorrhoea, rheumatic fever, wound healing, haemorrhage, cataract, insomnia, inflammation of bone marrow.

(*vi*) Vitamin D (calciferol): for rickets, nervous spasms, softening of the bones, acne, psoriasis.

(*vii*) Vitamin E (alpha-tocopherol) : for sterility, muscle weakness, diseases caused by degeneration of nerves.

(*viii*) Vitamin K : for haemorrhage.

Drug Difficulty in India

IN the economy of drugs, due to the present difficulty of supply, medical men should avoid noncritical and indiscriminate use of drugs and too much drugging. They should further avoid proprietary medicines whose potency and usefulness in Indian market at least cannot be guaranteed. To tide over the anticipated shortage of drugs Dr B. Mukerji of the Biochemical Standardization Laboratory in the course of a lecture delivered at Burdwan Medical School suggested the use of 'substitutes' or 'equivalents' for prepartions which have already become scarce or which are considered necessary to conserve against the eventuality of their supplies being completely cut off. Synthetic remedies and organometallic products like Veronal, Medinal, Luminal, Adalin, Novalgin, Veramon, Eukodal, Phenacetin, Pyramidon, Resorcin, Omnadin, Hexamine, Yatren, Solustibosan, Neo-stibosan, Neo-salvarsan, Progynon, Proluton, Prontosil, Campolon, Atebrin, Plasmoquin, Protargol, etc., will not be available for some time to come. It is understood that attempts are being made to procure from neutral countries at least one of the two 'long-acting' barbituric acid derivatives and another member of the 'short-acting' barbiturate class like 'amytal', and practitioners will be well advised to stick to them whenever required in preference to other similar German preparations like Evipan, or Evipan-sodium. Surgeons will have to concentrate on the use of general anæsthetics like sulphuric ether and chloroform. Ethyl chloride, nitrous oxide, vinyl ether, cyclopropane, etc., may not be available at all after some time. In the group of local anaesthetics, it will perhaps be found advisable to call for only the standard ones like procaine, orthocaine and benzocaine rather than prescribe pantocaine or percaine. Though 'Prontosil' will be largely missed by practitioners, equivalent or perhaps more potent derivatives of the same type may soon be manufactured in England and Indian supplies of 'sulphonamides' should in all probability be maintained. 'Myosalvarsan' and 'Neo-salvarsan' will be scarce but equivalent preparations of British and American make will be procurable. In place of Protargol, a preparation of silver proteinate of British manufacture is available. A local firm (Bengal Chemical) has also produced one which seems to be almost identical in laboratory tests. 'Atebrin' and 'Plasmoquine' will have to be forgotten for some time until their manufacture on a commercial scale is achieved in India. Injectable liver extracts have been put out by local firms and these must supplant 'Campolon' for some time to come.

Regarding the vegetable drug resources of India and her other potential chemical resources, Dr Mukerji thought it curious that India, the house of medicinal herbs and drugs, should remain dependent to such an extent on foreign imports. Nature has been particularly bountiful to her in this regard as will be evident from the fact that nearly three fourths of the drugs mentioned in the British and other pharmacopoeias grow here in a state of nature and the remaining one fourth can be easily cultivated. Where pharmacopoeial species do not grow, allied species are available which may be used as substitutes.

The Association of British Chemical Manufacturers has already published a list of British 'substitutes' or 'equivalents' of foreign pharmaceutical preparations for which a likely shortage exists. This list has been reproduced in the *British Medical Journal* and in the *Journal of the Indian Medical Association*. A similar list with Indian equivalents is in the course of preparation in the Biochemical Standardization Laboratory.

It should, however, be emphasised that this can only be treated as a temporary measure. Our efforts should be concentrated on the manufacture of all these products in India, for which our resources are ample and scientific talents are available.

Loss of Vitamin B_1 from Rice

NUTRITION researches under Dr W. R. Aykroyd at Coonoor have shown that Vitamin B_1 is progressively lost with each polishing of rice. If however the rice is previously parboiled, resulting thereby in a diffusion of vitamin B_1 from the germ and pericarp into the grain, subsequent milling causes only slight loss. Therefore when the staple food is raw milled rice, beri-beri is more likely to occur than with a staple food of parboiled milled rice. Many food factors in rice being soluble in water are readily lost on washing and cooking if the cooking water is discarded. The losses are of the following order—calories—15% ; protein—10% ; iron—75% ; calcium and phosphorus—50% ; vitamin B_1 and nicotinic acid —40 to 50%. Working with milled parboiled rice in Bengal, Dr S. Banerjee (SCIENCE AND CULTURE, *5*, 262, 1939) has shown that in the usual cooking process in which the water after boiling is discarded, rice suffers the following losses—protein 3·7% ; iron 47% ; calcium 70% ; phosphorus 18%. Considering that the ordinary diet in India is deficient in many respects, it would seem advisable that the water used in cooking rice should not be discarded.

P. K. C.

Vitamin C and Toxins

OBSERVATIONS by B. Ghosh (*J. Ind. Chem. Soc.*, *16*, 241, 1939) on the effect of diphtheria toxins on the ascorbic acid contents of blood and various organs and on its excretion in the urine at the University College of Science and Technology, Calcutta, showed a decrease of ascorbic acid content most marked in the adrenal glands. The ascorbic excretion in urine showed a decrease in the free acid and an increase in the combined acid. These observations support the view that vitamin C is of major importance in the detoxicating process.

P. K. C.

Physics in Aid of Medicine *

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AND

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PHYSICAL APPARATUS IN USE BY MEDICAL MEN

MEDICINE, the science of healing, has to lay almost all the basic sciences under contribution, and the prevailing impression is that the lion's share is monopolised by chemistry. But if an impartial jury were today set up, to adjudicate between the claims of chemistry and physics, the chance is nearly 50 : 50 that they will find in favour of physics. Physics has given medical men instruments, apparatus and appliances which are almost in daily use by the general practitioner. One need mention only the thermometer, the stethoscope, the ophthalmoscope, and the sphygmomanometer. But experts today, both in medicine proper and in subjects connected with medical research, use a vast number of physical apparatus and appliances about which the average man has hardly any idea. One need mention only the use of X-rays by surgeons, of radium for the cure of cancer and skin diseases. Another physical instrument, the spectroscope, has been found very useful in vitamin chemistry and recently with its aid, the important discovery has been made that deficiency of certain minerals which occur in our foodstuff in minute proportions may give rise to many diseases and ailments, the origin of which has been so long obscure, amongst men and beasts.

The lecturer visited some four years ago the International Congress of Physical Medicine which was held in London in 1936 and was attended by delegates from almost all the countries of the world. There he realised for the first time the great part which physics was destined to play in the near future in the art and profession of healing. Later he attended the Harvard Tercentenary where Prof. Krogh of the University of Copenhagen gave a lecture on the use of isotopes as indicators in biological research. Last year the Rockefeller Foundation of New York devoted a large part of its Report to the description of the cyclotron, the latest physical apparatus used for "Nucleus—busting" and the development of the science of molecular biology, which makes use of recent advances in the physics of the nucleus of the atom. All these indicate the growing importance attached by medical men to the recent discoveries in physics and their eagerness to utilise them for medical research.

PHYSICAL IDEAS IN MEDICAL RESEARCH

When one goes into the working of these methods, it is very difficult for a scientist to obtain any intellectual satisfaction. The position is very well expressed by an acute observer. "The medical man uses physical apparatus just to enhance his clinical sense, but has not yet learnt to use physical ideas for understanding the human body and its

* Based on a public lecture delivered by Professor Saha at the Royal Asiatic Society of Bengal.

ailments." As an example of this attitude, we can take the case of radium which has been used for the treatment of cancer and many other diseases from the time when Bequerel and Pierre Curie discovered that bottles containing small quantities of radium, which they used to carry in their pockets, produced burns in their skin. But in spite of 40 years of work on the use of radium on the human body it is rather surprising to read the following remarks in the introduction to a well-known monograph on Radium and Cancer.

"Moreover, after years of labour and of the most painstaking research there is no general agreement* on the best methods of application or even as to the period over which the treatment should extend. London regards as inadequate a period under 14 days, Stockholm is satisfied that a period of four hours is ample, whilst America, as might perhaps be expected, uses a stop watch. And yet all claim, so far as we can see, to obtain very similar results."

Perhaps part of the confusion arises from the fact that in radium, surgeons are using a tool the action of which they can scarcely be expected to understand since it involves a knowledge of physics which they cannot reasonably be expected to possess, whilst on the other hand, the physicists cannot possibly grasp all the difficult clinical and biological problems which confront these surgeons. The lecturer was further surprised to read in this book that even after 40 years of work the ways in which the different rays from radium—alpha, beta and gamma,—work upon the cells are not definitely known. It proves that in the attack on human disease and on biological problems by medical men where physical methods are going to be applied the need of co-operation by competent physicists is necessary, and without that intelligent co-operation many of the results are likely to prove spurious.

If this be the position in European countries, one can easily understand the lack of system which exists in this country. It is reported that a scheme is pending before the Government of Bengal for the Medical College Hospital at Calcutta for large-scale use of radium. A similar scheme is in operation at the Tata Memorial Cancer Hospital at Bombay. We are not aware whether sponsors of these schemes have in view the employment of trained research physicists. At present there is hardly any medical college or a first-rate hospital which employs physicists well-versed in research work, or conversant with the latest developments in physics. Their place cannot be taken by those who are employed for giving elementary lessons in physics to fresh students of medicine or to act as technical assistants to medical men in the manipulation of physical apparatus. Even some of the hospitals in this country possessing large amounts of radium (one hospital possesses as much as 1600 milligrams), and X-ray apparatus for deep therapy hardly employ physicists with research experience for a systematic well-planned attack with their appliances on tropical diseases. In this connection, attention may be drawn to a letter which Prof. D. M. Bose, now Director of the Bose Research Institute, and the senior writer wrote to the press when, four years ago, the Calcutta Medical College celebrated its centenary, and purchased, out of the subscription raised on the occasion, 250 milligrams of radium to which a further lot of 50 milligrams has since been added. We pointed out that the radium, instead of being kept in small amounts in tubes of glass or metals, may be at least partly kept in the form of a solution, from which radon tubes (seeds) may be prepared by a trained physicist regularly, and distributed for a small payment to general medical practitioners. This is the custom in most radium hospitals in Europe, and the other day it was given out that the Dublin Radium Hospital distributed in course of a year about 11000 radon tubes amongst the general practitioners in Ireland. This practice has got great advantages ; the original amount of radium remains intact, and absolutely safe under lock and key. The radon tubes are quite as good as the original radium so far as curative properties are concerned, for about a week. It becomes possible for the practitioner who has no connection with the hospital, and who cannot afford the luxury of having his own store of radium, to use radium rays on his patients, whilst under the present system, the use of radium is confined only to medical men who are directly connected with the hospital, and to patients who can afford to come to the hospital. The adoption of the measure advocated by us will bring the benefits of radium treatment to a far wider circle of patients, and though it involves the employment of a trained physicist, the cost is justified on humanitarian as well as utilitarian grounds, and it is hoped that the authorities of the two medical colleges at Calcutta will see their way in giving effect to our suggestions.

As a further example of the way in which medicine may derive benefit by the employment of trained physicists, I may refer to shortwaves having wavelengths between 3 to 30 metres now being used for local heating of the tissues. While reading a medical report on short wave therapy, I was amazed

* It has been reported that dosage has been worked out very accurately on physical principles and that Stockholm uses the shorter periods in order to be able to treat a larger number of patients. What is aimed at now in the case of malignant disease is to get a uniform distribution of radiation and in the case of carcinomata to try and get a dose of something like 8000 r. units at the centre of the tumour mass.

at the amount of contradictions in the results reported by well-known medical authorities. Some claim that these waves have a selective action on certain tissues and others entirely deny that, but there seems to be general agreement that by means of shortwaves, the temperature of parts of the body can be locally raised and many cures can be effected. Here also co-operation of physicists who are well-trained in the manipulation of short waves with a biologist is bound to lead to very fruitful results.

HUMAN BODY AS A PIECE OF PHYSICAL APPARATUS

In an assembly of medical men, one has to be cautious in his expressions, but the lecturer has hopes that the study of the human body as a piece of physical apparatus is likely to lead to great and fruitful results. By the application of well-known principles of physics, many operations hitherto considered impossible by surgeons, have been successfully tackled. One may mention the discovery of the artificial heart, an elaborate piece of physical machinery, which can take over the function of the heart for a short time, thus enabling the surgeon to perform operations on that delicate organ which, a few years ago, were considered impossible. It is reported that Dr Gibbon has invented an artificial heart, which can pump blood from the jugular vein and thus temporarily take over the functions of the heart. Operations were performed a year ago on the hearts of six cats, while they were kept alive during the time of operation by the artificial heart. Of the six cats so operated, all are alive and healthy, and one has brought out a litter of six kittens. The invention of the artificial lungs has rendered operations on the lungs possible, and has opened a way for a successful attack on pulmonary diseases. Of great interest is the discovery of the Perfusion Pump by Carrel and Lindbergh, which enables a piece of tissue to be maintained in suitable atmosphere, fed automatically and thus kept alive for an indefinite period. The discovery of the Perfusion Pump was possible because there was co-operation between a man well-versed in mechanical engineering and another who is the great pioneer of tissue culture.

EMPIRICAL NATURE OF MEDICAL RESEARCH

In recent years, we have heard much about the cyclotron, the wonderful machine that has rendered the alchemists' dream of transmuting one element to another a practical reality. But it is not so well known that this apparatus has opened a great future for biological and medical research, and it was stated in a recent symposium on biophysics that the time is possibly near when a cyclotron manufacturing 'radioactive atom' will be as familiar a feature of first class medical colleges and hospitals as an X-ray machine is at the present moment. Let us see what the new machine means for the medical men and the biologist.

Even medical men will admit that the action of drugs on the human system is yet far from being clearly understood. The successful practitioner has mostly to depend on his sixth sense, when he prescribes a medicine for a certain ailment.

The position has much improved since the great pioneer Ehrlich showed that bacteria of certain diseases can be successfully tackled by properly designed molecules. One can refer to his epoch-making work, whereby the foul disease of syphilis was successfully combated by the use of Salvarsan, discovered after 606 trials. Since his times, his example has been emulated in many countries, not excluding ours. Here Sir U. N. Brahmachari found after hundreds of unsuccessful experiments, that the kala-azar parasite (Leishmann-Donovan bodies) can be successfully combated by the application of antimony in the form of Urea Stibamine, a discovery which has led to the conquest of kala-azar, and has saved millions of lives in this country.

But a far large number of unsuccessful investigations shows that the specific action of drugs on the human system and the way in which they lead to the cure of drugs is mostly a "terra incognita", and even the combination of chemistry and bacteriology has not given us a royal road. If success crowns any investigator's efforts, it is as much due to his doggedness as to luck, or some brain wave. For example, in spite of thousands of attempts, an infallible remedy against malarial fever in all its stages, like Urea Stibamine against Kala-azar, has not yet been found.

What is the reason for this state of affairs? The difficulty can be appreciated if we try to approach the problem from the physicists' point of view. A gm. molecule of matter contains about a quadrillion molecules (6 followed by 23 zeros) ; when even the smallest dose of a medicine is administered to the human body, say a milligram of quinine we add to the human system about 2 trillion molecules (2 followed 18 zeros), they get distributed throughout the whole system, sometimes preferring certain regions and avoiding others. It becomes almost an impossible task to track how the molecules have distributed themselves in the different parts of the system, what reactions they are producing there, and which of these reactions in particular is responsible for the cure of the disease. The position can be rendered clear by an analogy : suppose we take the Ganges river, and release near its source a ton of sand particles and we ask the hydraulic engineer

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to find out how these sand particles have distributed themselves in the main stream, in the branches, and tributaries, and in the estuaries. Can he do it? The answer will be a decided "No", because a fair-sized river from its sources to the mouth contains about 10^{15} c.c. of water, and one ton contains about 10^{9} sand particles, hence there will be barely one particle in 100 liters of water, and this will mix up with host of other sand particles from which it is undistinguishable. But suppose we find out a way of giving the original sand particles a label—a hall-mark, by which it can be easily identified even when it is mixed up with hundreds of thousands of common sand-particles. Then the task will no longer appear impossible. The prospector has only to look for the "labelled sand particles" in any sample of water which he fishes out. This is exactly what the cyclotron and newer technique in physics promises to achieve. The ordinary atoms of which a drug is composed cannot be distinguished from its fellow-atoms of the same variety. But the cyclotron can impress upon atoms "a hall-mark", which does not interfere with its ordinary chemical or physical properties, but by means of this 'hall-mark', the particular atom, tagged atom as it is called, can be distinguished from the myriads of its fellow-atoms, and the method is so sensitive that even single atoms can be detected.

HOW A HALL-MARK IS IMPARTED ON INDIVIDUAL ATOMS

To understand how this 'hall-mark' is imparted to atoms and how they can be individually detected, let us make a little digression into atomic physics. You must be aware that the atom was split up nearly forty-four years ago. It is now known that the atom consists of two broad parts ; the nucleus or the heart of the atom, and the outer shell of electrons. When we take an element like copper which is the twentyninth element in the periodic tale, we can take it that it has a 'nucleus' or heart which has a positive charge of 29 and nearly all the 'mass' of the atom which is 63 in this case. It is surrounded by 29 electrons. Now, it has been proved that all the chemical and physical properties are caused by the action of the outer shell of electrons. They give to the copper atom its valency of one or two, enabling it to form CuCl or $CuCl_2$ etc. The outer shell of electrons, when excited by bombardment with electrons of sufficient energy from an outside source, give us the characteristic green light of copper or better the ultra-violet light by which it can be identified. The chemical and physical reactions which we attribute to an atom are all due to the activity of the outermost electrons. But the innermost electrons can also be dislodged ; then the atom gives its characteristic X-rays which are used by the surgeon, or the X-ray therapist.

In all these reactions, the nucleus takes no direct part, and none of these reactions can be detected unless we handle nearly 10^{15} atoms. For example, if we want to find out whether there is sufficient amount of iodine in some part of the human body, say the thyroid gland, we have to take a quantity of tissues weighing about 20 to 25 gms ; for the least number of iodine atoms which can be detected either by its spectrum or by the sensitive starch reaction is at least 10^{15} to 10^{17}, and thyroid gland issues contain only 2 per cent of iodine. How much it would mean for the progress of medical research, if some method could be discovered by which a concentration of 10^{5} or 10^{6} atoms of iodine in some part of the human system could be detected? The method will be 10^{9} times more sensitive than any existing chemical or spectroscopic method.

We now turn to the 'nucleus' of the atom. It is not quite correct that the 'nucleus' is entirely indifferent to the electrons in action. Though it takes no direct part, it indirectly controls all their activity. The part it plays may be made clear by an analogy. It may be a matter of experience to you that if you wish to get anything done by a political party, it is no use trying to convert the rank and file to your views. You have to try to change the heart of the 'Boss' who controls the party machinery and convert him to your views. If you succeed in doing that, the rank and file and the rabble will automatically range themselves on your side. Need we say, that the changed behaviour of the rank and file will be to the invisible influence of the 'Boss'.

The atom is, in many respects, like a well-organised political party machinery. If you want the mercury atom to behave like gold as the older alchemists wanted to do, it is no good trying any physical or chemical method, *i.e.*, trying merely to influence the external electrons, or following our analogy, the rank and file of the party. They will not listen to you unless you strike at the 'heart' or the nucleus of the atom and try to persuade "him" to behave in a different way. But a few years back, however, we saw no way of achieving this ideal.

This is because the nucleus, like the political boss, is a highly strong personage and it resents any attempt on the part of the 'rank and file' coming near it. The electron also has an inexplicable shyness for the nucleus. No amount of cajoling on the part of the physicist has been able to persuade it to enter the nucleus. If we wish to convert the nucleus, we must send to it a fundamental particle of its own caste, *e.g.*, a proton, which is the nucleus of the lightest element hydrogen, or an alpha particle which is the nucleus of the second element helium, or better still, a neutron, a new fundamental particle which has no charge or the deuteron which is the nucleus of heavy hydrogen. The charged particles must be provided with enormous energy, otherwise they will be turned back before they can reach within a striking distance of the nucleus. This energy is of the order of a million volts.

It need hardly be added that the energies of all chemical and physical reactions can now be rated in terms of the electrical unit of energy. This is the electron volt, *i.e.*, the energy of an electron when it falls though a potential difference of one volt. When we excite a copper atom to emit its peacock green light, we impart to the outermost electron an energy of about 5 volts. When copper forms a union with chlorine atom, a somewhat smaller amount of energy is liberated.

When a medical man uses X-rays from copper, he is probably not conscious that he is using very high-energy particles. These are the electrons which are allowed to fall through a potential difference of about ten thousand volts. When such high-energy electrons strike a target, *i.e.*, the anticathode, their energy is converted to X-rays, which can pass through the human body, and expose to the surgeon's view any foreign matter embedded inside the body. Here the radiologist should be reminded of his indebtedness to the physicist. If the latter did not bring out a fool-proof hundred thousand volt generator, no X-rays could have been produced.

But even the energy required to produce X-rays is insignificant compared to that required to produce nuclear reactions. We must have a generator capable of producing several million volts, and should be able to make the positively charged particle fall through this huge potential, and thus endow it with the energy which will enable it to approach the nucleus. Once contact with the nucleus is established, we get a new nucleus—we have effected 'Transmutation of Elements'.

This brings you face to face with the difficulties of the task. A million volt generator will give a spark of tens of feet, and is most unsafe to work with. We must have specially designed rooms, and arrangements to handle it. After ten years of work, a number of such apparatus has been produced and used for 'Nucleus-busting' as the Americans say, such is the Van de Graff Generator which is merely the old Wimhurst machine in a new guise. A modification of it, the Herb Generator, has been used to produce half million volt X-rays. The second is the Cascade Generator, which was used by the late Lord Rutherford and his school in their pioneer work on "Nucleus-busting". By consensus of opinion, the cyclotron*, an invention of Prof. E. O. Lawrence of the University of California, is the most powerful of such apparatus, though others have their own advantages. It can give us about 25 million volt protons. Armed with these particles, we can bombard any nucleus, and watch what happens to it.

To be continued.

* An account of the working of the cyclotron was published in this journal in the issue of January, 1940, pp. 403—9.

LOCUSTS AS PAYING PESTS

THE cost of fighting the locust pest is tremendous and the damage still done is immense, but since it was found that locust oil—owing to its capacity for remaining liquid at very low temperatures—is of great value for aeroplane engines, a means has suggested itself of transforming an apparently inevitable plague into a form of profit. In Johannesburg some years ago a factory was established for the conversion of dead locusts into fertiliser ; and as food for cattle and poultry, consignments of the insects have been shipped abroad.

IT is not too far-fetched to picture locusts as contributing towards the future prosperity of nations, especially as investigation has already led to many and interesting discoveries regarding the habits of these pests. For instance, the direction of the wind definitely influences their flight, and it has been proved that once they fly off, they do not return to the scene of their departure. Some, however, always remain at the original site—a fact which has facilitated the tracking of various gathering grounds near the Red Sea and in some of the desert regions of India.

Eggs are laid in the sand, and it is apparently during years of heavy winter rainfall that they hatch out in vast numbers. For about two months they have no wings—a factor taken into consideration in measures for destruction and they feed on desert plants until they are ready to fly.

—*The Statesman.*

Research Notes

Scattering of Light by Binary Liquid Mixtures

It was first reported by R. S. Krishnan (*Proc. Ind. Acad. Sc., 1,* 211, 1934) that the light scattered by some binary liquid mixtures, *e.g.*, carbon-disulphide, methyl alcohol, water-isobutyric acid etc., at the respective critical solution temperatures, the value of ρ_h is greater than unity, where ρ_h is the factor of depolarisation of light scattered in the direction parallel to the electric vector of the incident plane polarised parallel beam of light. Comparing these experimental results with those of the theoretical investigations on the scattering of light by large particles put forward previously by Lord Rayleigh (*Scientific Papers, 5,* 547), Mie (*Ann. de Phys., 35,* 377, 1908) and Shulejkin (*Phil. Mag., 48,* 307, 1924), Krishnan drew the conclusion that large clusters of molecules are formed in the mixtures at and in the neighbourhood of the critical solution temperature. The phenomenon mentioned above was called the 'Krishnan effect' by Gans (*Phys. Zeit.,* 37, 917, 1936), who put forward a theory to explain the anomalous values of ρ_h by assuming the formation of large clusters of molecules in the mixtures. Vrkljan and Katalinic (*Phys. Zeit.,* 37, 482, 1936) also made some theoretical investigations on the relation between values of ρ_h and the size and shape of the clusters. Later on, Hans Mueller (*Proc. Roy. Soc., A, 166,* 425, 1938) put forward a new theory of light scattering based on the experimental results of Krishnan. Recently a paper entitled "On The Theory of Light Scattering" by S. Parthasarathy has appeared (*Phil. Mag., 29,* 148, 1940) in which the author has pointed out that values of ρ_h greater than unity are obtained in some cases if the incident light be slightly convergent instead of being strictly parallel. He has also shown that the results obtained by Krishnan in the case of a few binary liquid mixtures can be explained by the ordinary theory of scattering of light by pure liquids if the convergence of incident light actually obtaining in the experimental arrangements made by Krishnan is taken into account. He has thus pointed out that the results obtained by Krishnan do not exhibit any new phenomenon but they actually show how anomalous values of ρ_h are obtained if the incident light be not strictly parallel. He has thus shown that Krishnan's hypothesis that clusters of molecules are formed in binary liquid mixtures at critical solution temperatures is not correct.

S. C. S.

The B Vitamins and Fat Metabolism

Bender and Supplee (*J. Am. Chem. Soc., 59,* 1178, 1937) saw that rice polishing concentrate had a supplemental effect upon body weight. They correlated the weight changes with the presence and absence of dermititis, interpreting their results to mean that the factor in rice polishing concentrate affecting growth was vitamin B_6. McHenry (*J. Physiol., 89,* 287, 1937) saw that high fat diet free from choline and supplemented with thiamine caused a great increase in liver fat. In a study of vitamin B_6 deficiency in rats, Halliday (*J. Nutrition, 16,* 285, 1937) found significantly heavier livers containing a higher percentage of total fatty acids in different animals. The addition of choline remedied this condition to a large extent but even massive doses failed to bring the liver weight and total fatty acid content quite to normal. McHenry and Gavin (*J. Biol. Chem., 125,* 653, 1938) showed that rice polishing concentrate used as a dietary supplement in conjunction with thiamine and riboflavin caused an appreciable increase in the body fats of rats. In order to determine which factor of the vitamin B-complex is responsible to influence the weight and body fat in rats Gavin and McHenry (*J. Biol. Chem., 132,* 41, 1940) recently made an elaborate study of the fact and have shown that (*a*) when thiamine was the only supplement, a body could synthesise fat from carbohydrate ; (*b*) the administration of vitamin B_6 in conjunction with thiamine, riboflavin and choline to rats fed a fat-free diet caused a slight increase in body fat and an increase in body weight ; (*c*) nicotinic acid slighty augments the effect of vitamin B_6, upon body fat but not upon body weight. Neither vitamin B_6, nicotinic acid nor riboflavin could prevent the deposition of fat in the liver which results when thiamine was administered. The amount of liver fat was normal when choline was supplemented either alone or with any combination of the above facts. They could not get any satisfactory explanation of Halliday's experiment. Recently Hastings *et al* (*J. Biol. Chem., 129,* 295, 1939) noted a decrease in liver metabolism associated with fatty infiltration when rats were kept on a basal diet without added yeast extract. After the administration of yeast extract, neither effect was evident. György and Goldblall (*J. Exp. Med. 70,* 185, 1939) reported liver injury occurring in some rats kept on a diet deficient in the vitamin B-complex and supplemented with thiamine, riboflavin and purified vitamin B_6 preparation.

According to Gavin and McHenry (*loc. cit.*) the presence of choline which is one of the constituents of yeast extracts would explain the ability of yeast extract to prevent the development of fatty livers and their injury.

A. C. M.

Neanderthal Man in Italy

Mr A. C. Blanc discovered in February 1939 the fossil remains of a Neanderthal skull in the Guattari Cave, Monte Circeo, Italy. Particulars about the objects and their discovery are now available from a recently published article in *Revue Scientifique* contributed by the discoverer himself. The fossil skull was found on the bed of a chamber which is reached after passing through two other communicating chambers. It lay on the ground surrounded by a ring of stones. There are evidences which point out that this chamber was subjected to a prolonged flood. Marks on the skull also show that it remained half-submerged for a long time. "The disposition of the skull and the evidently intentional enlargement of the foramen, which has been completely destroyed, point to funerary and magical rites, possibly a ritual feast. This would account for the absence of skeletal bones". Monte Circeo skull is placed later in date than the Sacchopastore skull. The cave presumably remained undisturbed from Würm II, when it was closed by rockfalls, till its opening by Mr Blanc.

T. C. D.

LOW-TEMPERATURE DRYING OF FOODSTUFFS

Rapid freezing, with subsequent storage at low temperatures, is probably the most effective way of preserving the desirable properties of foodstuffs. If, however, the moisture present in the frozen foodstuffs in the form of ice is removed by evaporation in a high vacuum, the desiccated products can be transported and stored without the need for refrigeration, and there is in addition a large saving of weight. In view of these possibilities, a small-scale plant, designed to dry foodstuffs at low temperatures, has been in operation at the Low Temperature Research Station during the past year on behalf of the Food Investigation Board of the Department of Scientific and Industrial Research. Many different foods have been dried such as fruit, vegetables, fruit-juices, meat, eggs, butter and milk, and it is now clear that the products obtained are in general superior to those obtained by othermethods of drying.

—The Chemical Age

BOOK REVIEW

Essays in Polynesian Ethnology —by ROBERT W. WILLIAMSON, M.Sc. Edited by RALPH PIDDINGTON, M.A., Ph.D. Published by the Cambridge University Press, London, 1939. *Pp. xlii+373. Price 25s. net.*

The name of Williamson is well known in the field of Polynesian ethnology. Before his death he collected a large number of notes bearing on different topics of Polynesian culture. The first part of the book under review is derived from these posthumous manuscripts. The five chapters of this part deal with warfare in Central Polynesia, Kava in Samoa, Tonga and other Polynesian islands ; the society known as *Arioi ;* and sex, courtship and infanticide in Polynesian society. The materials for these chapters were not derived from personal fieldwork but were collected from the vast literature dealing with Polynesia. Williamson does not seem to have examined the reliability of the statements of his authorities, which is necessary when one draws his materials indiscriminately from the writings of travellers, sailors, merchants, missionaries and scientific investigators. In spite of this defect, these accounts will be of real help to the future workers as they would find all possible information on the interesting topics collected in a nutshell. It is refreshing however to note that Williamson did not base any conclusion on these data but had merely narrated the facts as they had been recorded by his authorities.

Primitive warfare is rarely dealt with in anthropological literature. European domination over the coloured races, roughly for the last two centuries, has practically driven out of tribal life all relics of fighting, save and except family quarrels and village faction fights. Thus the trained anthropologist of today does not find any opportunity to study this institution under direct observation. He has to depend on the accounts left by his predecessors in the field—the travellers, merchants, soldiers and others of the kind. The chapter on warfare in Central Polynesia has the additional advantage of a number of traditional accounts which have preserved the details of this native institution for the area under consideration. Kava is the "infusion of the roots of the plant *Piper methysticum*" which was the most important beverage of Central Polynesia especially of Samoa and Tonga. It was not a mere 'drink' but had been the centre of a complicated series of social and magico-religious ceremonials. It may be compared with the *Soma* of the Vedic Indians and the tea of the ancient Chinese and Japanese people. Kava is spoken of as the source of magico-religious inspiration to priests and preparers of this divine drink. The account of the *Arioi* places before us Williamson's views upon the "possible historical connection of this institution with the secret societies of Melanesia". The discourse on sex, courtship and infanticide introduces, us, among others, to the data relating to the "allegations of gross immorality of Polynesian women in their relations with visiting travellers". The customs of lending women and of the *Tayo* should not be studied out of their context. They were integrated with the socio-religious complex of ideas which dominated the life of the Polynesians and their ethical value cannot be judged with coloured eyes. This brings us to the end of the first part of the book.

The second part of this treatise has been written entirely by Dr Piddington. It consists of four chapters and an appendix which deal with the factors of stability and change in Polynesian culture, theories relating to the origin of Polynesian culture, relations between Polynesia and Melanesia, considerations about the past and present in Polynesia, and Assam parallels. These chapters do not merely aim at delineating certain Polynesian conditions but is "concerned with certain recent theories of Polynesian origins and these have a bearing on the controversy between the historical and functional schools." Anthropologists are now divided between the two schools - functional and historical, in place of the former evolutionist and diffusionist camps. The functionalists are accused of lacking in historic sense but Dr Piddington claims that they have too much of it and that is why they do not postulate past events on inadequate evidence. They do not hunt

for 'origins' but are interested in observing the social institutions in action. Of course, this does not mean that their study is an artificial cross-section of social life cut off from the main stream at a particular point of time just like a moving picture temporarily immobilized. They pay due considerations to both the past and the present and even do not hesitate to throw out suggestions for the future. Thus, according to our author, "differential emphasis is the real issue between the historical and functional methods."

In order to illustrate the superiority of the functional method over the historical one he turns his attention to a consideration of the historical ethnology of Polynesia and evaluates the attainments of the historical school in this particular field. "Throughout the Polynesian area we find a general cultural homogeneity, of language, religion, technology, and social organization, combined with certain striking differences between the various island groups." The attempts to explain these *striking differences* have in most cases led to the assumption "that there was an original archaic Polynesian culture, possessing certain features which may be seen surviving, though perhaps in a modified form, in the existing cultures of Polynesia ; that by a process or processes of migration from outside Polynesia a new culture was superimposed upon this older one ; and that features belonging to this more recent cultural influence may also be detected in Polynesia today, side by side with the co-existing archaic elements." Against this 'two-strata' theory differently named as Pre-Tangaroan and Tangaroan by Williamson, Indo-Polynesian and Tangaloa-Polynesian by Handy and Palae-Polynesian and Neo-Polynesian by Stimson, Dr Piddington suggests an alternative 'one-stratum' hypothesis. He assumes that "there was only one migration to Polynesia ; that the migrants landed on one of the islands, increased their population, some of them subsequently migrating to other areas until the whole of Polynesia was populated ; and that this was followed by a period of intermittent, occasional and unsystematic migration and cultural interchange between the various islands." He claims that there is absolutely no necessity to bring in a second cultural influx from outside Polynesia in order to explain the *striking differences* in the cultural traits already referred to. He is of opinion that Polynesian culture possesses both factors of stability and factors of change which are sufficient to account for the existence of these two types of cultural traits namely the so-called archaic and the intrusive ones. By an analysis of the social organization, religion and a particular trait-complex of material culture (Maori clothing) he shows that the archaic traits may reasonably develop into the so-called intrusive ones owing to the dynamic forces inherent in Polynesian culture. The synoptic tables very clearly show the forces held responsible by Dr Piddington for this change.

In the appendix, which is especially interesting to the students of Indian anthropology, Dr Piddington exposes the weakness of Prof. Hutton's conclusion about the existence in the past of a cultural connection between Assam and Oceania founded on the similarity of certain cultural traits of Assam on the one hand and Fiji, the Marquesas and Madagascar on the other. Prof. Hutton attributes this similarity ultimately to diffusion from a common Indonesian culture which stretched its influence towards the east and west of Oceania and towards the north to Assam. While attributing similarities of traits within this region to historic connection, Prof. Hutton does not take into consideration the possibility of independent development nor does he try to explain the occurrence of parallel traits beyond this region, which cannot be explained on the basis of historic connection. To bring out more clearly the inherent impossibility of the situation, Dr Piddington mentions a number of parallel traits occurring in the Society Islands and among the Ashanti and also refers to parallels between Assam on one hand and Africa and America on the other. Evidently no explanation on the basis of historic connection is possible in these cases. Dr Piddington, however, does not categorically deny the possibility of historic connections under the circumstances but he draws our attention to the inadequacy of the proofs. In assessing the methodological approach of Prof. Hutton, Dr Piddington states that "the type of interpretation which has been criticised, even if correct, would reveal nothing which is relevant to modern scientific anthropology. On the contrary, the procedure adopted implies a negation of its basic principles ; to dismember in a haphazard way an integrated human culture ; to lump together disparate and unrelated cultural fragments . . . . ; to tear elements of culture out of the context which alone makes them intelligible ; to postulate migrations or processes of diffusion about which we shall never know anything significant, ... all such procedures are not only irrelevant, but directly antithetical, to the method of approach, which has revolutionized the study of primitive culture." These are strong strictures which invite immediate refutation and we shall wait with interest for a reply.

We congratulate Dr Piddington for his clear exposition of the aims and methods of the functional school together with its view on the part which history should play in anthropological studies.

T. C. D.

Where Theosophy and Science Meet, Parts III & IV—Edited by D. D. KANGA, I.E.S. (Retd.). Published by the Adyar Library Association, Adyar, Madras. *Pp. Part III 260 & Part IV 223 with indexes. Price Rs. 2/4 each.*

The above publications fully maintain the excellence of the first two parts of the series. The monographs are very lucidly written and are as interesting as those in the first two parts. The efforts made by the editor to establish the main proposition, *viz.*, that theosophy and science have met, by the collective publication of these monographs on different branches of human knowledge, are really praiseworthy. A distinct and valuable service has been rendered by him for the cause of theosophy, as a perusal of these four volumes will give a good idea to the layman as to the real purpose and object of theosophical research. It is well known that a good deal of misconception exists in the minds of the non-theosophical section of the public about the doctrines of theosophy, which, according to many, mainly deal with spirits and ghosts and their doings. All such people will derive immense benefit by the perusal of the monographs contained in these volumes. Though the methods of clairvoyance have not yet been reduced to the same common denominator as the ordinary scientific methods of research, the greater the publicity given to the results of theosophical research, the greater will be the understanding by all concerned, of the true significance of the theosophical method.

As to the different monographs contained in these two volumes, those on astrology, mystery of magnetic variation and mythology will be found to be particularly attractive. Students of science are invited to read them. They are sure to derive profit and pleasure by their perusal, though it is quite possible that the conclusions sought to be derived, may not be accepted in all cases. The symbolical interpretation of mythological stories is certainly fascinating. Such interpretations have also been given of the Indian *Puranas* by scholars and others, and the *Puranas* have actually been considered to be social and national histories of the ancient times expressed in symbolical forms, their contents being supposed to be intelligible as soon as the key for their interpretation is discovered. This view of the matter has, however, yet to be readily accepted.

Be that as it may, the reviewer has nothing but admiration for the great pains taken by Mr Kanga, the editor, in compiling these volumes. He deserves the greatest praise for the excellence of these publications. It is hoped that his laudable endeavour will be fully appreciated by the enlightened and educated public for whose benefit these books have been specially published.

H. P. B.

NITRATE INCREASE FOLLOWING SHORT FALLOW

PRELIMINARY results of an experiment at Woollongbar Experiment Farm have shown that, following a short fallow, the nitrate nitrogen content of the soil is considerably increased. The experiment in question was initiated to investigate changes in the amount of the various forms of nitrogen in "Big Scrub" soils brought about by various cultural practices, including green-manuring.

Half of the experimental plots were fallowed for about two months, the other half remaining under pasture. Analysis at the end of the above period showed that the plots under pasture contained an average of 4·5 parts per million of nitrate nitrogen, whilst the fallowed plots averaged 60 parts per million.

The effect of this greatly increased supply of readily available nitrogen on the establishment of sown pastures is being investigated.

—The Agricultural Gazette of New South Wales.

LETTERS TO THE EDITOR

The Distribution of the Root-Mean-Square of the Second type of the Multiple Correlation Co-efficient

The sampling distribution of R the multiple correlation coefficient of the one variate with $(p-1)$ other variates was worked out by Professor Fisher in 1928 under two different sets of conditions leading to different forms of distribution function. The first set of conditions consisted in the assumption that the bunch of readings in a sample for each of the $(p-1)$ variates remained constant from sample to sample, but only the bunch of readings for the first variate (whose multiple correlation with the $(p-1)$ other variates comes into the picture) changed from sample to sample ; there were also certain additional well-known assumptions which are common to the usual theory of linear regression. The resulting distribution of 'R' is also well known and was quoted by us in a recent issue of SCIENCE AND CULTURE[1]. This we shall call the first type of 'R' distribution. We found and announced in this Journal in the issue just mentioned that the root-mean-square of R is distributed (under the first type of conditions just referred to) in the same general manner (with only change of parameters) as 'R' itself. That is, the type of the distribution is conserved when we proceed to the mean. The second set of conditions consisted in the assumption that the variates constituted a multivariate normal population and that the bunch of readings for the $(p-1)$ other variates as also for the first variate changed from sample to sample. Under such assumptions it was found by Professor Fisher in 1928 that 'R' is distributed in the form

$$\text{Const. } R^{p-2}(1-R^2)^{\frac{n-p-2}{2}}\, dR.$$

$$\times {}_2F_1\left(\frac{n-1}{2}, \frac{n-1}{2}; \frac{p-1}{2}; \beta^2 R^2\right) \quad . \quad . \quad (1)$$

where p is of course the numbers of characters, n is the size of the sample and β is the population value for the multiple correlation of the first variate with the $(p-1)$ others. This we call the second type of 'R' distribution.

Considering m such random samples each of size n from a multivariate normal population and denoting the root-mean square of the different 'R's of the different samples by $\bar{R}$, we have recently found that $\bar{R}$ is distributed in the form

$$\text{Const } \bar{R}^{m(p-1)-1}(1-\bar{R}^2)^{\frac{m(n-p)-2}{2}}$$

$$\times {}_2F_1\left[\frac{m(n-1)}{2}, \frac{m(n-1)}{2}; \frac{m(p-2)+1}{2}; \beta^2\bar{R}^2\right] d\bar{R} \quad (2)$$

Comparison of (1) and (2) shows that the root-mean-square of 'R' under the second type of conditions is distributed in the same general manner (with change of parameters) as 'R' itself. The property that the type of the distribution is conserved when we proceed to the mean holds therefore for both the two different types of 'R' distribution.

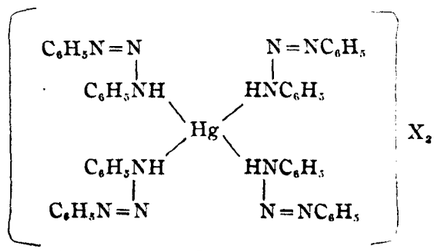
Statistical Laboratory, S. N. Roy
Presidency College, Purnendu Bose
Calcutta, 6-6-1940.

[1] S. N. Roy and Purnendu Bose, SCIENCE AND CULTURE, 5, 714, 1940.

4-Co-ordinated Aryl Diazo-amino Mercuric Salts

That mercury could possess an unusual co-ordination valency of four was shown in a series of benzidine-piperidine mercuric compounds which included the complex halides[1]. A number of 4-co-ordinated mercuric salts belonging to a different series have been prepared. These very interesting compounds contain diazo groups in the complex and are obtained by precipitating solutions of mercuric

salts with diazo-aminobenzene (m.p. 98°) dissolved in alcohol. They may be represented by the general formula,



(X=Cl, Br, NO_3 and CH_3CO_2)

The diazo-amino mercuric compounds are brilliant yellow in colour and differ from one another only in shades. They are remarkably stable in air, light having no action on them. All of them are insoluble in water but dissolve readily in chloroform. They melt with decomposition, the chloride melting at 220°C. That mercury can attain a maximum co-ordination valency of four even in the complex halides is, therefore, further proved by the preparation of this new series of organo-mercuric compounds.

Chemistry Laboratory,
Presidency College, Kanai Lal Mandal.
Calcutta, 5-6-1940.

[1] Kanai Lal Mandal, SCIENCE AND CULTURE, *5*, 719, 1940.

SCIENCE AND CULTURE

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Drug Control in India

ALONG with the progress of scientific civilisation, the art of medical treatment which has been practised empirically during all the ages has steadily burst the bounds of empiricism and has largely developed into a science. Today the scientific system of medicine is prevalent in a great part of the world, though in the less progressive countries the age-old regional systems are still popular with large sections of the people. In India, the Ayurvedic and Unani systems have considerable allegiance and have frequently demanded recognition as scientific systems. But there cannot obviously be two different scientific systems and the best course would be to accept the Western scientific system as the core and enrich it with such knowledge from Ayurvedic and Unani sources as can stand strict scientific tests. Public opinion in this country does not appear to be alive to the need of the control of Ayurvedic and Unani drugs, the composition of many of which is kept a secret. Very often these drugs are prepared by the prescribing medical men themselves and not by specialised manufacturers. But one good consequence of the development of medicine on scientific lines in Western countries has been that medical practitioners have specialised in the direction of diagnosis and treatment, while the preparation of drugs, which is exceedingly complex, has been taken up by manufacturers employing highly trained scientific personnel. This division of labour has resulted in great progress and phenomenal advances have been made during recent years by co-operation between medical men and trained scientists, specialising in the preparation of drugs. At the same time in almost all civilised countries the State has found it necessary to control drug manufacture and drug trade and prevent the traffic in adulterated, under-strength and misbranded products in the interests of both the consumer and the honest producer.

In India drug production and drug trade are still uncontrolled. That for long years both the honest producers and the consuming public have suffered from this absence of control has been evident even to the casual observer. The extent of the harm done was crystallised in the Report of the Drug Enquiry Committee presided over by Bt.-Col. R. N. Chopra, which was submitted in 1931. After many years' delay the Government of India have now passed a Drugs Act, which can definitely improve the present position provided it is properly implemented *on right lines*. This warning is necessary. In this country many good schemes fail and even render more harm than good because they are wrongly operated or operated with wrong personnel.

The Drugs Act of 1940 is intended to regulate the import, manufacture, distribution and sale of drugs and it will have obviously far-reaching influence on every aspect of the drug industry and drug consumption in this country. It provides for the formation of a Central Drugs Technical Advisory Board and of a Drugs Consultative Committee representing the different provincial governments. Both provisions are sound. The first is essential for

framing uniform rules and standards, which require considerable expert technical knowledge, and for setting up the right kind of organisation for testing and analysing drugs and for all technical aspects of drug control. The second is necessary for the enforcement of the Drugs Act in the different provinces in a uniform manner. After the Central Drugs Technical Advisory Board and the Drugs Consultative Committee have met and framed their recommendations with due care, it will presumably be the duty of the provincial governments to set up provincial Advisory Boards for bringing into existence the provincial testing laboratories and keep control of the provincial drug trade generally. The whole machinery of drug control in this country will therefore depend on the formulation of correct lines by the Central Drugs Technical Advisory Board and by the Drugs Consultative Committee and on the organisation of the Central Drug Control Laboratory *on right lines and with proper personnel*. It is obvious that the discharge of such a grave responsibility requires very careful deliberation and adequate consideration of the measures adopted in other advanced countries for drug control.

The drug control organisation of the United States of America appears particularly suitable for careful consideration, because that country offers a good parallel to this country in several respects. India is populous and divided into provinces requiring inter-provincial regulations like the inter-State regulatons in America. There is a uniformity in the enforcement of the different drugs, food, insecticide Acts, etc., in the United States, as the inspection and control are consolidated in one organisation called the Food, Drug and Insecticide Administration. This uniformity is relatively lacking in Great Britain, where, as the Secretary of the Pharmaceutical Society of Great Britain points out, the trade of chemists and druggists is affected by many statutes, for the enforcement of which different authorities are responsible. It is desirable that in taking concrete steps for drug control in India, we should aim at the uniformity that happily exists in America.

The organisation of the Food, Drug and Insecticide Administration of the United States is well worth detailed study. It can indeed serve as a general model to India, though it naturally will have to be adapted to local conditions. The Food, Drug and Insecticide Administration is responsible for the enforcement of several Acts concerning food and drugs, tea, naval stores, insecticides and fungicides, milk and caustic poisons. The Administration is divided into three branches: (*i*) Executive Supervision, (*ii*) Technical Control and (*iii*) Field Service. There is a chief of the entire Administration who exercises supervision and control over all these branches and thus complete co-ordination is effected. The Executive Supervision Branch is responsible for administrative activities and has the following offices: (*a*) Office of Business and Informational Supervision, (*b*) Office of Insecticide Act and Caustic Poison Act Supervision, (*c*) Office of Import Supervision, (*d*) Office of State and City Co-operation, (*e*) Office of inter-State Supervision. The Technical Control Branch is responsible for regulatory activities and has got the following divisions: (*a*) Food Control, (*b*) Drug Control, (*c*) Insecticide, Fungicide and Caustic Poison Control, (*d*) Tea Control, (*e*) Naval Stores Control, (*f*) Special Collaborative Investigation. The Field Service Branch consists of the Food and Drug Inspection Stations, which are distributed over three Districts, called Eastern, Central and Western, each of which comprises several States in that particular geographical zone.

There is one feature of the above Administration to which attention may be drawn. Except where business, informational or purely administrative work is necessary, all the heads of the branches and of the subdivisions under the branches are chemists and also the majority of officers under the Administration are chemists. Although medical men were the first to introduce the world to drugs, the highly technical nature of drug manufacture has so developed that in all progressive countries technical posts concerning drugs are not held by medical men *qua* medical men but by trained chemists and pharmacists, who may or may not have medical qualification in addition to their technical qualification. In this country this aspect of the question requires to be emphasised as the association of ideas between medical men as such and the manufacture and control of drugs still persists. In this connection it may further be pointed out that in India there is still a confusion between the terms pharmacy and pharmacology, which is having its repercussion on the problem of drug control organisation. While pharmacy includes a certain amount of pharmacology (which relates to the biological action and assay of drugs), it mainly consists of pharmaceutical chemistry (which refers to the chemistry of the preparation and assay of drugs) along with pharmacognosy (or the identification of drugs and drug sources). In fact, the major portion of the preparation and assay of the drugs mentioned in the official pharmacopoeia of all countries is entirely chemical in nature. A pharmacologist is thus not necessarily a pharmacist, although a pharmacist should know something of pharmacology or the methods of biological assay. It is therefore not strange that both in the Technical Control Branch and in the Field Service Branch of the Food, Drug and Insecticide Administration of U.S.A. the chief as well as the superior posts and also the larger number of posts are held by trained chemists and not by pharmacologists as such.

The question of the type of qualification necessary for efficient drug control work is exceedingly important, as the success or otherwise of the Central Drug Control Laboratory to be set up by the Government of India will obviously depend in the main on the appointment of the right type of personnel particularly in the chief and superior posts. This personnel should possess exactly the right kind of technical qualification in order to inspire confidence in the minds of both the drug manufacturers, particularly the indigenous manufacturers, and of the consuming public.

We would congratulate the Government on their having taken up seriously the work of drug control. It is also good to have been assured by the Government that a Pharmacy Act which should really run *pari passu* with the Drugs Act is shortly going to be taken in hand. Without these two Acts working together it is not possible to have the best results from the present endeavours. And we trust that in formulating concrete steps for drug control in near future the Central Technical Drugs Advisory Committee and the Drugs Consultative Committee set up by the Central Government will take into consideration the observations set forth in this article.

THE TRUE MISSION OF THE RACE.

THERE is still a duty to keep the torch of pure science lit, and this duty is only the greater under stress. All the long struggle of a harsh evolution, the pitting of species against the environment, has produced a being whose primary distinction is conscious cerebration, and whose crowning attribute is his intellectual curiosity concerning his complex environment and a thirst for knowledge transcending the mere struggle for existence. If there is no abiding value in a Beethoven symphony, or a theory of the cosmos, or the tracing of an ancient culture, then the Carnegie Institution of Washington has scant reason for existence. If it is really good that man should look at the stars and should contemplate his great destiny, then it is imperative that in those regions which enjoy the blessings of peace the search for the eternal verities should continue.

The dual character of science influences much of our outlook. We look at the starts, and we build yet greater machines to aid our vision, for two reasons. The stars are a laboratory, wherein are pressures and temperatures far beyond those we can artificially produce; which we can merely observe and not manipulate. Nevertheless, through thus observing we have already learned many things which have advanced the science of physics and in turn its applications. All this is to be welcomed, yet it should not completely dominate our thought. We also look at the stars for the same reason that inspired the shepherd on the ancient hill, because we are bound to think of greater things than the comforts or dangers of the morrow, perhaps because thus to inquire and to speculate is the true mission of the race.

—*Report of the President of the Carnegie Institution of Washington, 1939.*

America and Indic Studies

HORACE I. POLEMAN

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IN America academic activity in Indic studies has been limited to a few universities, and this more toward linguistic research than toward effective presentation of the broad scope of Indic culture to the student world. American institutions can be proud, however, of this academic research. The names and work of Warren, Whitney, Hopkins, Bloomfield, and Lanman form a glorious chapter in the history of Indic studies.

However, India in the first half of this century has become headline news, not as a land of vague philosophies and abstruse tongues, but as a developing nation with a live culture. We in America have seen the need of a wider approach to Indic studies in educational work, without, of course, relaxing one bit the intense research in India's past, for there lie the deep roots of her culture. And many of these roots have not yet been traced to their tips.

The Library of Congress in Washington has long demonstrated under the vigorous leadership of its former Librarian, Dr Herbert Putnam, its vitality as a national centre for the organization and use of research and educational material in various fields, and notably in the Far Eastern field. Without committing itself to a definite programme the Library readily lent its assistance with private financial support to the survey of existing materials in American institutions for the pursuit of the study of Indian culture. First, printed books were completely listed wherever they existed in America, then manuscripts, and finally all museum resources and the use has been made of these materials in the curriculums of colleges and universities. It at once became apparent that the Library should become the centre for the exploitation of this material by making its use available to government officials, to scholars, to journalists, and to the public at large. With the financial assistance of the Carnegie Corporation of New York the development of Indic studies at the Library was begun two years ago. Students today are being prepared for life in the latter half of this century when the Orient will be far more important to them than it has been to us. The survey of college instruction which has been mentioned made it apparent that there has been a neglect in American universities of the study of the Middle Orient—its history, religion and philosophy, its science, its warfare and its peaceful arts—which have so influenced our civilization that scarcely a college subject is untouched by it. We are asking whether we can afford to neglect in our educational scheme an area which numbers well over a fifth of the human race with a culture older even than the Egyptian.

There are at present seven large universities in America offering competent linguistic training in the Indic field. A few others offer something on the art, history, sociology, and philosophy. We feel that perhaps a half-dozen universities in addition must be encouraged to add courses in the languages of India. But by far the most important project will be that of interesting colleges and universities throughout the breadth of the land to include in their philosophy, economics, sociology, history, and fine arts departments an adequate treatment of the Middle East. The case has been admirably stated by my colleague, W. Norman Brown, as follows in his article on "India and Humanistic Studies in America": "Here in the West we still largely confine our humanistic studies to our own civilization. We are concerned with its roots—primitive, prehistoric, and historic—its evolution into its modern state, and the interrelationships of its subdivisions (British, American, French, German, Italian, Russian, etc.). Where the European-Christian culture has clashed with the Far Eastern, the Indic, or the Islamic, we have generally viewed the clash from the point of view of our own narrower prepossessions, with little, if any, comprehension of the reason why the Chinese, the Indians, or the Moslems of Arabia or elsewhere have acted as they have, and without taking a wider world-view, of the meaning of these clashes. We have satisfied ourselves with inspecting a single side of the medal, and have assumed that we need not know the other; our history has only one dimension. To state the matter so—even with allowance for some degree of overstatement is to reveal its fallacy.

"It is a fortunate sign that agencies in this country which have at heart the promotion of knowledge for the good of all have in recent years been steadily increasing the amount of their attention to Far Eastern civilization, our cultural neighbour across the Pacific, with which we have close and dynamic contact. More attention than at present should also be given to Islamic culture and the peoples living by it today, in the Near East, and elsewhere in Asia and Africa.

"If trade were to be the extent of Western contact with India, we might not see in it alone a sufficient basis for studying her culture, but so narrow a view of our prospective relations with that country is unwarranted, as it is also in the case of the Far East. India's highly organized and relatively homogeneous civilization is bound to come in ever closer touch with our own; for as intercourse between remote parts of the world beomes increasingly easy, India's relative intellectual isolation must decrease along with her relative economic isolation. Her achievements in the art of living are at our disposal, as ours are at hers; her problems too will become ours as those of Europe and the Far East have been brought into our life. We shall need to reconcile our civilization and hers, to the change of both. For she can contribute to us, as we are now contributing to her."

The inevitable point of departure for the servicing of such a programme at the Library of Congress was the establishing of firm contacts with Indian scholars, culture groups and institutions, and with the sources of materials for study and research. Of course, we cannot hope to succeed in our work in America without the active and whole-hearted support of India. In eight months time I have received the needed encouragement from India. The material accomplishments so necessary for implementation of the work have been immense. And what is probably most important, the contacts made will become increasingly firm to the advantage of both the Americans and the Indians, at least in the cultural field.

From a recent report of the Library of Congress I quote: The universities and colleges of India are growing in size, numbers, and enterprise. They are becoming increasingly important as publication centres. They display a marked tendency to supplement curriculums based largely on Western patterns with a new and rigorous study of Indian culture and achievements. It is evident therefore that these institutions are strategic points of contact between India and the Library. A number of contacts have been enjoyed in the past with some of the older universities. These will continue on an increased scale, and where fresh ground has been broken, real co-operation will materialize in the exchange of publications and the mutual use of resources to whatever extent possible.

The museums of India have for the most part suffered from a lack of funds. However, the Archaeological Department of the Government of India has been most generous in the disposition of antiquarian material. Further, many curators, in spite of the limited resources at their disposal, have by their individual industry frequently accomplished remarkable results. The already existing bonds between the Library of Congress and a few of the large museums have been strengthened, while additional institutions have expressed their willingness to co-operate with Indic studies at the Library.

The list of cultural organizations in India is legion. Many have enjoyed long years of fruitful service in research and publication. From these there has been universal expression of appreciation that there is now at the Library of Congress an American centre for Indic studies to which they can communicate information on their work, and in return be posted on the activities of American scholars and educators in the Indic field.

Exchange of publication has been arranged with the various libraries of India. Most of the libraries owning valuable manuscript collections have been enlisted in a plan to be described later under a discussion of micro-filming, which will afford American and Indian scholars considerably easier access to these valuable research sources than they have had in the past. It may be noted that the Bengal Library Association, the Madras Library Association, and the Indian Library Association are doing excellent work in standardizing and organizing library methods and expansion.

All of the important publishing firms and book-dealers have been visited or contacted. Their lists will now be sent regularly to the Library. In addition much bibliographical data on past publications

have been collected. As a result, the Library should be in a unique position to furnish all interested scholars, institutions, and laymen with accurate information on books published in India which deal with India. In view of the disorganized state of Indian publishers the maintenance of this service will be of the greatest value to all concerned. This work will complement the cataloguing and bibliographical plans at the Indic Studies department of the Library of Congress, which first centred about the Library's editions of the Tanjur and Kanjur, rare in the West. The Choni edition, unique in the West, has never before been catalogued. The completion of this catalogue will be a valuable contribution to Tibetan scholarship. Many works at the Library in the various languages and scripts of India and Greater India are being classified and catalogued for the first time. Plans are being developed for a complete classified bibliography of printed Middle Eastern material with a notation for each item of the publisher and whether in or out of print. The bibliography will be in the form of a card file which can be added to constantly and copied in whole or in part by the microfilming process. The co-operation of Indian scholars will be needed.

Several hundred books have been acquired for the Library in general and for the Law Library. Many of these are rare and of antiquarian value. Recent publications in modern affairs are also included. The complete list is a notable addition to the Indic collection at the Library and will greatly implement further research.

Several collections of old manuscripts in Sanskrit, Prakrit, Hindi, and other vernaculars have been purchased. The collections contain a number of manuscripts not listed in any manuscript catalogue. The printed catalogue of these manuscripts will appear in a supplement to the *Journal of the American Oriental Society*. The following are a few of the important items: *Vyavasthāsārasaṃgraha* by Rāmagovinda, *Dāyasāra* by Govindānanda, *Āśaucasaṃkṣepa* by Madhusundanavācaspati, *Kṛṣipaddhati* by Kapālabhṛt, *Ācārādarśa* by Srīdattopādhyaya, *Tithitattva* by Raghunandana, *Rudrakalaśasnānavidhi* by Nārāyaṇa Bhaṭṭa, *Rāmāyaṇa* with commentary by Maheśvaratīrtha, and *Yāsaśiksā*.

Through the means of a survey made by the Indian Gramophone Company recordings presenting the various forms of Indian music have been purchased for the Music Division. The work done on this survey was exhaustive so far as the industry is concerned, and I think that a unique collection of records for Western ears has been assembled.

Motion pictures and many stills have been taken. One of the cinema films pictures some of the very old Vedic rituals of the Malabar coast. These include a marriage and a tonsure ceremony according to the Āśvalāyanagṛhyasūtra. It is believed that this film document is unique. The motion picture film industry of India has been investigated. Several films will be recommended for acquisition and distribution by the Film Library of the Museum of Modern Art of New York City. This visual work again cottons with project now being launched by the Library of Congress in co-operation with the American Council of Learned Societies to survey Islamic and Indic resources in America for visual education, including slides, photographs of art objects and miniatures, maps, graphic ethnological material, charts, blue-prints, etc. An index is to be prepared at the Library and complete copies of the material in microfile will be made. A visual archive of this type will supply a need long felt by educational institutions, which have in the past been unable to have more that chance knowledge of the existing materials in America for lecture and educational purposes, particularly in the field of oriental art and architecture.

As a result of visits made to officials of Indian States and provinces many official publications will now be available to the various United States Government bureaus and interested individuals.

More than six thousand pages of rare Indian manuscripts in Sanskrit and the dialects have been photographed by the microfilming process. These film records will be deposited at the Library of Congress. Among them are important ritualistic texts, rare Jain manuscripts, a rare manuscript of the *Vetālapañcaviṃśati*, and old Tantric texts. Arrangements have been made with the important manuscript libraries whereby further microfilm copies of manuscripts desired by American scholars can be easily secured. Microfilm facilities now exist at strategic cultural and geographical points in India including the machine at the Royal Asiatic Society of Bengal, so that all manuscript sources can be tapped. This developing service will greatly benefit Indian and American scholars alike, not only in making research materials more accessible, but also in preserving old and valuable documents from extinction.

To set forth some of the advantages to the scholars and to libraries of microfilm and of the international service now existing in America for the benefit of scholars everywhere, I offer some extracts from the reports of the American Documentation Institute or ADI in short:

> The invention of printing was the first major advance in methods of documentation. In the early days of this republic, however, printing had already outgrown the means of knowing what was in print and where. Our early learned men maintained a running guide to printed research materials by constant correspondence among their own few members.
>
> Our present world with its thousands of scholars, thousands of institutions, government bureaus and commercial research departments, and millions of printed pages, produces untold wealth in scholarly material, both original and adapted. This mass has far outgrown the means of finding it when published, and the means of publishing it.

The American Documentation Institute was created by important national scholarly groups to help them solve the problem. Having no matter of its own to publish, no journals to maintain, no institution to aggrandize, no profit to earn, it exists only to push the work of others out in front where those who need it may see it. It is constantly thinking about bibliography, publication, reproduction, circulation. No one-page scholar's note is too small, and no thousand-volume collection too large, to receive its help in getting somehow into the right hands.

ADI is not committed to any one plan or technique but uses regular printing, offset, blueprint and all the near-print methods cheapest and best for the particular case. Where a single copy or a small edition is needed and the need can be cheapest served thereby, it has its Bibliofilm Service to copy the material in the form of microfilm comfortably legible in a projector or reading machine, which is now commercially available but still about a third the cost of photostats, and readable without optical aid.

Bibliofilm Service is operated by ADI on a non-profit basis, with the best laid out microphotographic laboratories in the country, with three years of scientific pioneer development costing some $25,000 behind it, and with, to show for the struggle, one of the most technically expert staffs and the latest and most highly improved and efficient electrically operated equipment. It is in the fortunate position of being able to turn out work, which has passed beyond the experimental stage and attained a proven high standard grade, with a speed, efficiency, reliability, and hence economy, exceeding anything heretofore achieved.

ADI's Bibliofilm Service laboratories are operated in the U. S. Department of Agriculture Library, Washington, D. C., under a co-operative agreement with that Department, and its additional microphotographic copying cameras are installed in the Army Medical Library and the Library of Congress. One use of the installations thus serving these three great libraries, is to copy for scholars extracts from books and journals needed in their research. This copying is done at cost, the rates being a fixed charge of 20 cents, plus 1 cent per page for microfilm copying or 10 cents per page for photoprint.

Scholarly societies have at hand, in the further services of Bibliofilm Service which ADI has made available to the learned world, a means of publication without the cost which faces anyone who otherwise plans to print something, or near-print something in an edition, however small.

This is because publication is accomplished by the group's editor by merely depositing the matter with ADI, which lodges it in the custody of the U. S. Department of Agriculture Library where it is safe and immediately available, it is offered to the public through a journal; and orders for it are filled at its regular low cost rates by ADI, ordinarily by making a microfilm copy, or photoprint copy, but equally well by furnishing any other sort of copy, such as full-size black-letter-on-white-paper by a new photographic process, as may be ordered by the scholar or library wanting the material.

This Auxiliary Publication Service is available to the editors of journal in any field, without cost to the editor, the journal or the author. It enables the journal to publish more or longer articles without spending more money. It enables the author to tell the whole story without

being held to five, ten or any limited number of pages. It enables the publication of unlimited pages of tables without the cost of that expensive sort of special compositions. It enables the publication of photographs, graphs and charts without the cost of cuts. It enables the journal editor to demand, as several learned societies are insisting that he should demand, that the author should furnish with the article all the basic data, working papers, full or supplementary text, illustrative and supporting matter upon which he based his conclusions.

This is the way the Auxiliary Publication works in the case of a paper submitted to a journal, proceedings, transactions, bulletin or compiled publication series. The author submits to the editor the complete contribution. The editor alone decides (1) whether he will publish it at all; (2) how much he will print and (3) how much he will issue through ADI. Having decided to publish the contribution, the editor divides it as he prefers. He may: (*a*) print the whole contribution, *i.e.*, all the text and all supporting data, when nothing is issued through ADI, (*b*) print the summary only, together with a note stating that the complete paper is available from ADI as Document No. —, at a cost of — cents in microfilm or — cents in photoprint, (number and price being notified to him by ADI, see below), and (*c*) print all the text of the paper, together with a note stating that the supporting data is available from ADI as Document No. —, at a cost of — or —.

In both the latter cases the editor forwards that part of the contribution, which he has decided to issue through ADI, to ADI giving the title, author, and the issue of the journal in which the matter which he has decided to print will appear. If he does not yet know in which issue he will print the contribution, he may send the matter at once and advise ADI of the issue later. ADI receives the matter on permanent deposit, gives it a Document Number and fixes the price for a copy, according to its regular copying rates, and at once advises the editor of number and price.

Reprints of the matter deposited with ADI may be obtained by the author in unlimited number from ADI at its usual cost rates, either in microfilm or photoprint. Or if the author wants to order a definite number reproduced by printing, or any of the modern methods such as offset printing, blueprint or black-on-white print, ADI will be glad to make such an edition for him on a non-profit basis.

Auxiliary Publication is also used apart from journal articles. It is available to an institution or scholarly society for the publication of monographs, books, reports, studies, bibliographies, sets of specimens, sets of X-ray photographs, or any other results of their work.

The original matter is deposited with ADI by the society or institution, and the latter makes known its availability by notice in the journals of the group, bulletin, circular announcements, each reference giving the document number and cost of a copy in microfilm and in photoprint. The reader desiring a copy orders it direct from ADI.*

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* The following quotation from the statement of the American Documentation Institute will be of further interest.

In only one instance is an entire bibliofilm library planned, that being a library to be developed from scratch.

For the going library, the role of a bibliofilm collection is to supplement the printed accessions. Four separate purposes are served:

A. To fill volume gaps in existing sets.

B. To augment the library's completeness by adding bibliofilm sets of the rarer and more wanted journals.

C. To increase the permanence of the library's holdings.

D. To improve documentation for research.

A. Within the library such bibliofilm volumes are accessioned in the same manner as printed items and entered on the title card of the serial. When a call slip is put for such a volume, the bibliofilm is delivered at the central desk instead of a printed book, and the reader is directed to a reading machine, where either he or a staff member puts the roll on the machine.

B. Adding Bibliofilm Journal Sets. Of much greater importance than odd volumes is the present opportunity offered by the initiative of the American Documentation Institute with the aid of a limited grant, under which the non-profit Bibliofilm Service is permitted for the time being to fill orders for bibliofilm copying sets, *i.e.*, any properly copyable 10 or more consecutive volumes of a serial scientific or learned periodical, set of year-books, memoirs, transactions, proceedings, etc., at a special rate of ½ cent. per page.

This effort is not confined to any arbitrary list of titles. The library knows best its own pressing needs. The survey made under a grant from the Committee on Scientific Aids to Learning developed however a list of fundamental journals widely lacking and widely desired by libraries. Inquiries and orders received, while including many other items as well, have centred heavily on the journals so listed.

C. Increasing the Permanence of the Library's Holdings. American librarians, who easily lead the world in techniques of their profession and in scientific knowledge of paper, binding, and preservation, are aware that the bulk of the learned and scientific journals are on impermanent paper.

In examining thousands of these volumes, the Bibliofilm Service has found that they already show signs of decay and disintegration. There will come a time, not far off for some of them when no matter how many copies on the original paper are held in no matter how many places, they will all, approximately simultaneously, crumble to dust.

According to a scientific study made by the Bureau of Standards, microfilm properly processed and kept has a life equal to that of pure rag paper, which we know has already lasted some centuries.

When the expensive bound sets go, therefore, along with those of all other libraries, the bibliofilm sets will still be serving research.

The American Documentation Institute in providing this effort is interested in helping libraries augment their holdings, in improving documentation for research, and also in our duty to hand on intact to the future the record of scientific and learned achievement up to now.

D. Improving Documentation for Research. The ADI survey brought out an interesting fact, namely that there are two separate categories of the rarer journals used for research:

(*a*) A list of about 3000 journals, to which references are spasmodic. No library has, or can have, them all. The practice is to obtain for the research reader the extract desired—usually from 1 to 15 pages—by an order for bibliofilm extract copying. The Bibliofilm Service alone is filling extract orders to the amount of 20,000 pages per month, covering an enormous range of journals.

(*b*) As against the above 3000 journals, a small list of a few journals, not more than about 40, which account for 20 per cent of all use.

They appear in the abstracting journals several hundred times as frequently as the others.

They are constantly in use in the few source libraries which have them constantly out on loan to divisions, frequently in the bindery for repairs, hence constant delays in availability for copying. Because of constant need for use, interlibrary loans are not permissible.

For these few journals the method of copying from others' distant volumes whether by hand, photostat or microfilm, no longer answers. These few journals must be in the places where research is done.

The Address of American Documentation Institute is Care Offices of Science Service, 2101 Constitution Ave., Washington, D. C., U. S. A.

Microphotographic copying services exist to a gradually increasing extent, in London, Paris, Berlin, Rome, and other European cities, Latin America, Japan, India, etc., and Bibliofilm Service maintains relations with these services. Copying orders received by Bibliofilm Service for material not in the United States are filled through such foreign sources for bibliofilm users. International standards are encouraged to the end that material, size, orientation result in microfilms usable on the standard equipment in vogue.

Indian scholars and institutions can make use of this service and gradually build up something similar within India. The nuclei of such a service have already been established. The Royal Asiatic Society of Bengal stands ready to do its part with the equipment and facilities now at its command. Mutual benefits on an exchange basis with ADI and the Library of Congress will soon be forthcoming. I have demonstrated the equipment everywhere in India, and it is to be expected that whatever institutions now have such equipment will co-operate in assisting each other and the scholars of India. The great advantage of microfilming is the speed and cheapness of copying. The machine set up at the Royal Asiatic Society of Bengal when operated by one person is capable of photographing on 35 mm. film 120 pages per hour at a cost of from ½ to 1 anna per page. The negative can be read by means of the magnifying reading machine or can be enlarged in a positive reproduction.

It is the hope of those Americans interested in spreading the study of India in America that microfilming will greatly facilitate their programme. But this is only a part. I have already referred to plans to add to the number of those colleges and universities in America which now offer work in Indian languages and culture. Further, it is expected that one day an American school will be established in India to which young Americans may come to study and do research. Similarly it is hoped that the services of Indian scholars can in the future be more widely used in America. All these measures must inevitably lead not only to an increase in the volume and quality of Indic research, but more important, also to a new and reasonable conception among Americans of India's role in the history of the past and her importance to the world of the future. Such an understanding must be attained by the Americans not through the sporadic and temporary adoption of "spiritual" fads, nor through the zealous and colourful efforts of journalism, but through the slow, steady processes of intelligent study and clear evaluation. Only so can this understanding be not a pastime, but a tool and guide for the future.*

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*Lecture delivered at the Royal Asiatic Society of Bengal on July 31, 1940.

Artificial Fertilizers in Indian Soils

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INTRODUCTION

THOUGH recently a great deal of information has been gathered on the manuring of Indian soils, much has yet to be learnt about manures and manuring under Indian conditions for which a series of manurial experiments are being carried out (including the standard manurial experiments with paddy and sugarcane under I.C.A.R.) at different agricultural farms in the country. Manurial experiments so far carried out at different farms in India indicate that artificial fertilizer or organic manure alone does not give the best result but it is the combination of both organic manure and artificial fertilizer that gives the best result. In fact, the present view is that artificials should come in only if there is a dearth of suitable organic matter or to supplement organic matter. The use of artificial fertilizer alone is however recommended if the amount of organic matter in the soil is high and it is suggested by many that organic manures help the utilization of artificial fertilisers by the crop.

Instead of going into a detailed discussion of manurial experiments carried out in different parts of India, a selected number of such experiments with artificial fertilizers alone or in combination with organic manures are noted in Table I and II, which will give some idea of artificial fertilizers found effective in different types of soil in India.

EFFECTS OF MANURES IN DIFFERENT TYPES OF SOILS.

TABLE I—ARTIFICIAL FERTILIZER ALONE OR IN COMBINATION WITH OTHER ARTIFICIALS.

No.	*Experimental farm.*	*Soil.*	*Crop & rotation.*	*Treatments per acre giving significant increases in yields.*	*Period of experiment and remarks.*
*1.	Samalkot (Madras)	Clayey and of average fertility	Paddy (Paddy—black-gram)	(1) Ammonium sulphate 112 lbs. plus superphosphate 224 lbs. (2) Superphosphate 224 lbs. (1)>(2)	1927-28—1930-31
*2.	Akyab (Burma)	Poor sandy soil	Paddy after paddy	Ammonium sulphate 30 lbs. N. plus superphosphate 30 lbs. P_2O_5 plus potash 20 lbs. K_2O>N.M. (No manure).	1925-26—1927-28
*3.	Hagari (Madras)	Black cotton soil	Sorghum — cotton (Direct effect on sorghum & residual effect on cotton)	Superphosphate 20 lbs. P_2O_5 plus ammonium sulphate 40 lbs. N>N.M.	1929-30 and 1930-31
*4.	Gaya	Soil calcareous clay, deficient in phosphates	Sugarcane	Superphosphate 30 lbs. P_2O_5>N.M.	1928-29
*5.	Bankura (Bengal)	Soil of poor fertility.	*Aus* paddy	Nitrophoska or ammophos or nitrochalk or leunaphos or nicifos (each 20 lbs. N) with no difference between treatments. Each >N.M.	1928-29—1930-31
*6.	Comilla (Bengal)	Low-lying, loamy, deficient in nitrogen	*Aman* paddy	Diammophos 200 lbs. (40 lbs. N. +100 lbs. P_2O_5)>N.M.	1928-29—1930-31

No.	*Experimental farm.*	*Soil.*	*Crop & rotation.*	*Treatments per acre giving significant increases in yields.*	*Period of experiment and remarks.*
*7.	Cuttack	Soil deficient in phosphates	Paddy (after paddy)	Ammophos 25 lbs. N>N.M.	1926-27
*8.	Cuttack	,,	,,	Diammophos (12 lbs. N plus 30 lbs. P_2O_5)>N.M.	1928-29
*9.	Karjat (Bombay)	Sandy loam	Paddy	Ammonium sulphate in doses of 40 lbs. N, 60 lbs. N, 80 lbs. N and 100 lbs. N. Each dose>N.M., but difference between different doses was not significant.	1923 and 1926-28
*10.	Dacca (Bengal)	Soil of average fertility	*Aman* paddy	160 lbs. Ammonium sulphate (32 lbs. N.)>N.M.	1928-29—1930-31
*11.	Kanki	Soil clayey deficient in phosphates and of low fertility.	Paddy (after paddy)	Ammonium sulphate (32 lbs. N) >N.M.	1926-27
*12.	Cuttack	Soil poor, deficient in phosphates	Sugarcane	Ammonium sulphate 50 lbs. N (at planting) plus the same 30 lbs. N (in May) plus the same 40 lbs. in June>Ammonium sulphate 120 lbs. N applied after June.	1926-27
*13.	Gurdaspur (Punjab)	Soil—Heavy clayey loam	Sugarcane	Ammonium sulphate 45 lbs. N> N.M.	1926-27—1929-30
*14.	Cawnpore (U.P.)	Medium loam	Wheat	Ammonium sulphate 24 lbs. N> N.M.	1926-27 and 1927-28
*15.	Totkon (Burma)	Sandy loam, deficient in P_2O_5	Ground nut	Nicifos (17/45) 100 lbs.>N.M.	1931
*16.	Hmawbi (Burma)	Swamp paddy land poor soil	Paddy (after paddy)	Basic slag 90 lbs. P_2O_5>N.M. (with residual effects for 7 years).	1924-31

TABLE II—ARTIFICIAL FERTILIZER IN COMBINATION WITH ORGANIC MANURE.

No.	*Experimental farm.*	*Soil.*	*Crop & rotation.*	*Treatments per acre giving significant increases in yields.*	*Period of experiment and remarks.*
*1.	Cuttack	Soil low-lying deficient in phosphates	Wheat (fallow cane-wheat)	Ammophos (20 lbs. N plus 20 lbs. P_2O_5)>oil cake (20 lbs. N).	1926-27
*2.	Kumta (Bombay)	Soil laterite	Paddy	F.Y.M. 5 carts plus ammonium sulphate 40 lbs. N>either treatment. (F.Y.M. 5 carts or ammonium sulphate 50 lbs. N alone.	1924-26
*3.	Palur (Madras)	Soil alluvial	Sugarcane	Groundnut cake plus ammonium sulphate totalling 200 lbs. N>the same 50 lbs. N.	1929-30—1930-31
*4.	Cuttack	—	Paddy (after paddy)	Green manure plus super 160 lbs. per acre>Green manure alone.	1926-27
*5.	Cuttack	—	Paddy (after paddy)	Bone-meal 18 lbs. P_2O_5 plus ammonium sulphate 16 lbs. N>N.M.	1930-31
6.	Shahjahanpur	Loam	Sugarcane (Co. 313)	(1) No manure, (2) 60 lbs. N (in equal quantities from castor cake, ammonium sulphate and cowdung), (3) 120 lbs. N (in equal quantities from castor cake, ammonium sulphate and cowdung), (4) 180 lbs. N (in equal quantities from castor cake, ammonium sulphate and cowdung). Doses compare as 180 lbs. N=120 lbs. N> 60 lbs. N>N.M.	1934-35

No.	Experimental farm.	Soil.	Crop & rotation.	Treatments per acre giving significant increases in yields.	Period of experiment and remarks.
7.	Jorhat	Reddish sandy loam, acid	Sugarcane (Co. 361) —plant cane	(A) Control. (B) Green manuring with cowpea. (C) → (B) + cowdung 50 lbs. N. (D) → (B) + oilcake 50 lbs. N. (E) → (B) + nicifos 50 lbs. N.	1936-37 (E) = (B), *i.e.*, addition of nicifos does not increase the yield significantly. (C) > (A) = (B) (B) > (A) (E) > (A) (C) > (E)
8.	Jorhat	Reddish sandy loam, acid.	(*a*) Sugarcane (Poj. 2714)—plant cane	(*a*) 0 lb. P_2O_5 + 0 lb. K_2O (*b*) 60 lbs. P_2O_5 + 0 lb. K_2O (*c*) 90 lbs. P_2O_5 + 0 lb. K_2O (*d*) 0 lb. P_2O_5 + 100 lbs. K_2O (*e*) 60 lbs. P_2O_5 + 100 lbs. K_2O (*f*) 90 lbs. P_2O_5 + 100 lbs. K_2O (*g*) 0 lb. P_2O_5 + 150 lbs. K_2O (*h*) 60 lbs. P_2O_5 + 150 lbs. K_2O (*i*) 90 lbs. P_2O_5 + 150 lbs. K_2O All plot received a basal dressing of 300 mds. Cowdung + 1000 lbs. oilcake per acre. P_2O_5 was applied in the form of alphos, while K_2O was applied in the form of pot. sulphate. Only the effect of potash was significant, 100 lbs. K_2O and 150 lbs. K_2O, each yielding significantly greater than "no" K_2O.	1936-37
			(*b*) Do. ratoon canes	Residual effects of the above treatments. Residual effect of 90 lbs. P_2O_5 was significantly greater than "no" P_2O_5. Residual effect of 150 lbs. K_2O was significantly greater than "no" K_2O.	1937-38
9.	Jorhat	Reddish sandy loam, acid.	Sugarcane (Co. 419 —plant cane)	A. Control. B. Cowdung 175 mds. + mustard cake 1000 lbs. (= 120 lbs. N in total). (C) Granular calcium cynamide 600 lbs. (120 lbs. N) all plots including A received a common dressing of 125 mds. cowdung). B > C > A	1938-39
10.	Muzaffarnagar	—	Sugarcane (Co. 312)	(1) No manure. (2) F.Y.M. 120 lbs. N. (3) Neem cake 120 lbs. N. (4) Ammonium sulphate 120 lbs. N. (5) F.Y.M. 60 lbs. N plus ammonium sulphate 60 lbs. N. (6) Neem cake 60 lbs. N plus ammonium sulphate 60 lbs. N. (6) = (5) > (2) > (1) (3) = (4) > (1)	1935-36 The advisability of adding an organic manure to an inorganic whenever the latter has to be applied.
11.	Muzaffarnagar	—	Sugarcane (Co. 312)	To find the profitable dose of organic and inorganic manures and their mixture. Treatments :— Manures— (A) F.Y. manure. (B) Ammonium sulphate.	1937-38 Manures—Am. sulphate = F.Y.M. + Amo. sulphate > F.Y.M. Doses—48 lbs., 64 lbs., 80 lbs., 96 lbs., N. doses per acre did not give significant results.

No.	Experimental farm.	Soil.	Crop & rotation.	Treatments per acre giving significant increases in yields.	Period of experiment and remarks.
	Muzaffarnagar	—	Sugarcane (Co. 312)	*(continued from the last page)* (C) F.Y. manure + Ammonium sulphate in equal doses on N basis. Doses—(1) 48 lbs. N, (2) 64 lbs. N, (3) 80 lbs. N, (4) 96 lbs. N.	Profit—A mixture of F.Y.M. and ammonium sulphate on equal nitrogen basis at 96 lbs. N. per acre is the most profitable followed by ammonium sulphate at 48 lbs.
12.	Upper Shillong Farm	Higher lands coarse and reddish loam, low-lands clayey loam with a fair supply of all essential elements of plant food.	Potato	(1) Control. (2) Ammophos 225 lbs. (3) Nicifos 200 lbs. (4) Ammophos 225 lbs. plus sulphate of potash 200 lbs. (5) Nicifos 200 lbs. plus sulphate of potash 200 lbs. (All plots received a common dressing of 100 mds. cowdung per acre). (5) > (1) ; (4) > (1) ; (3) > (1) (1) = (2).	1935-36

N.B. Experiments marked with asterisk (*) have been noted from *"Analysis of Manurial Experiments in India"*—Vol. I, by M. Vaidyanathan (1934). The rest are recorded from the respective annual reports of schemes under I. C. A. R., excepting No. 12 of Table II, which is recorded from the Annual Reports of the Assam Agricultural Department for 1935-36.

The importance of artificial fertilizers that are in use in India and also the demand for them will bring home to the readers the importance and scope of extension and improvement of the hitherto neglected indigenous artificial fertilizer industry. The important crops requiring the use of artificial fertilizers in India are sugarcane, tea and paddy. Potatoes, vegetables, millets and tobacco also require fertilizers but in much smaller amount in comparison with that of any of the three noted before. Such important crops as wheat, cotton, jute, up to the present time, consume but negligible amount of artificial fertilizer.

IMPORTANT ARTIFICIAL FERTILIZERS

(*i*) *Ammonium sulphate.*—Considerable amounts of artificial fertilizers are imported every year, of which the most important is ammonium sulphate. According to Hendry (1940) before the outbreak of the present war, over 100,000 tons of ammonium sulphate were used in India per year, and more than three-fourths of this quantity were used by the ryot. Only a small fraction of the annual requirement of this fertilizer, about 18,000 tons, is produced every year by the Sulphate of Ammonia Federation in Bengal and Bihar. In Mysore a plant has very recently been installed for production of synthetic ammonia. This marks an important development in the manufacture of artificial fertilizers in India. According to Ghosh (1940), "This would yield 6000 tons of ammonium sulphate which will fertilize the sugarcane fields of the State. The success of this enterprise will be watched with keen interest by Indian technologists and it is hoped that before long plants for the synthesis of ammonia and its conversion either to fertilizer or nitric acid will be set up in many parts of India where cheap electric power or cheap coal is available to meet the expanding requirement of these materials, under a system of well-planned economy in industry and agriculture". There is sufficient scope for increasing the output of ammonium sulphate from the present concerns and also for starting a few more manufacturing plants to meet its demand in India. Chatterjee (1938) has given a scheme including details for the manufacture of ammonium sulphate from synthetic ammonia, suitable for Indian conditions, which deserves attention.

According to Acharya (1938), India possesses in coal industry a potential source of over 200,000 tons

of ammonium sulphate per year, but unfortunately the coking industry is not at all well-organised in India, so he thinks that an annual production of 20,000 tons of by-product ammonium sulphate can be expected at present. The most effective way of meeting the demand of inorganic nitrogenous manures in India however would be to develop the manufacture of synthetic ammonia which will offer the best starting point for covering the whole field of nitrogenous fertilizers, *e.g.*, ammonium sulphate, nitrates, etc., and such compound fertilizers as calcium ammonium nitrate, ammonium sulphonitrate, bone-meal ammonium nitrate, etc.

(*ii*) *Nitrates.*—Sodium nitrate is another artificial fertilizer which is imported into India, but its import has considerably decreased during recent years. Deposits of Indian saltpetre (potassium nitrate) occur in parts of India. The crude Indian saltpetre and also the earths from which it is extracted are used locally as manure to some extent. But its major portion is refined into potassium nitrate for purpose of export. Many are not very enthusiastic about the advantages of Indian saltpetre manufacture from the point of view of its manurial use in India.

(*iii*) *Compound fertilizers.*—These are a series of compounds containing both nitrogen and phosphoric acid in different proportions and are cheap imported stuffs which are in use to some extent in India. Of these, we have different grades of ammophos containing 11%—16% nitrogen and 48%—20% phosphoric acid (P_2O_5) and different grades of nicifos containing 14%—18% nitrogen and 41%—18% phosphoric acid (P_2O_5). They are important in the sense that they contain two important fertilizing ingredients, *viz.*, nitrogen and phosphoric acid and have an advantage in weight in comparison with manures like superphosphate. There is some demand for these fertilizers and it will be well to investigate the possibility of their manufacture, or that of similar fertilizer from Indian resources at a cheap rate.

(*iv*) *Superphosphate.*—This is an important phosphatic fertilizer in use in India, whose import has for some years been nearly 7,000 tons per annum. Some 2,000 tons per annum are manufactured by Messrs. Parry & Co., of Madras and this is the only firm at present engaged in superphosphate manufacture in India, most of which is made from bones. There is obviously scope for extension of superphosphate manufacture in this country.

Opinion however is divided with regard to suitability of superphosphate and many would prefer to use ammophos, nicifos, etc., as they are cheaper than superphosphates and also have an advantage in weight.

(*v*) *Natural phosphates* are found in Madras and Bihar. These, as have been recorded by the Royal Commission on Agriculture (1928) in India, do not offer any important possibility.

A discussion on phosphatic fertilizers in India will not be complete without mentioning the case of bone-meal which, though not an artificial fertilizer, has attracted a good deal of attention in connection with phosphatic manuring of Indian soils.

From a rough estimate of the annual production of bones in India (made under the suggestion of I.C.A.R.) and from a rough average of the annual export of bones from India, it appears that only a small fraction of total bones is exported in various forms, while the major portion remains unutilized in India. Bones which are used in the form of bone-meals as manure in India form but a very small fraction of the total production of bones, and are obtained chiefly from bone mills. There are a number of bone mills, chiefly in Bombay, Madras, Bengal and United Provinces, manufacturing either bone-meal or crushed bones and bone-meal.

Bone-meal available from bone mills is rather costly to cultivators and increasing attention is therefore being paid (*a*) to produce cheap bone-meal, by developing production of bone-meal as a cottage industry, so that cultivators may use bone-meal with sufficient profit and also (*b*) to extend the use of bone-meal.

(*vi*) As most Indian soils are not deficient in potash, the demand for potassic fertilizers is small and consequently their imports are also small in comparison with those of other fertilizers. They are effective for certain special crops such as tobacco. India does not produce any potassic fertilizer except Indian saltpetre which, as has been discussed before, is not important from indigenous manurial point of view, although it contains two important fertilizing ingredients, *viz.*, potash and nitrogen. Prospects of use as fertilizers of potassium salts, which are present among beds of rock salt in the Salt Range of the Punjab, appear to be highly doubtful.

(*vii*) Fertilizers such as basic-slag, calcium cyanamide are used only to a very limited extent in India. Large amounts of calcium cyanamide were imported in the past, but its consumption has recently been much reduced. No cyanamide is produced in this country and there appears to be little prospects of its manufacture in India.

CONCLUSION

Details which have so far been discussed refer mainly to normal condition just preceding the present war. In an emergency such as the present war, the increase in price of imported fertilizers is inevitable. As such the need of organised manufacture of artificial fertilizer in India is now felt more than at any time before.

It is quite in the fitness of things that the manufacture of artificial fertilizers is attracting increasing attention in India. It is now recognised in India, as Ghosh (1940) says, that the main objective of planning the national economy should be to attain as far as possible national self-sufficiency ; and so far as food stuffs are concerned, this ideal can be attained with the arable land at our disposal and with the help of 50% of the population, if only modern methods of cultivation are introduced. Regular and systematic manuring of soils will, as a necessity, form an important part of these modern methods of cultivation, and more manures will have to be added than at present. It appears from our present knowledge and experience of manuring of Indian soils that artificial fertilizers will supply the smaller fraction of this increased demand (while organic manures will supply the bigger fraction), but then India must have at her disposal a much greater amount of cheap artificial fertilizers than at present. There is thus enough scope for extension of the hitherto neglected artificial fertilizer industry in India.

This industry has justly attracted attention of the National Planning Committee, whose findings and recommendations with regard to its developments with Indian resources will undoubtedly help in its advancement. Greater attention needs to be paid to this industry for its extension and improvement which will add to national wealth and prosperity.*

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PAVED ROADS REDUCE AUTOMOBILE COSTS

LIKE an elderly book-keeper's metatarsals, the automobile performs most effectively on hard, smooth pavement. At the Iowa State College, a study of rural mail-carrying vehicles shows that gasoline and oil costs go up substantially as the road changes from pavement to earth, and that maintenance costs are even more quickly affected by the nature of the road surface. For the cars used in the test and on a basis of 15,000 miles annually a car, the cost of operation is 36 per cent higher on earth roads than it is on paved roads.

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Mysteries of the Microbe

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PASTEUR discovered the existence of billions upon billions of hidden lives so minute in size that some of them are discernible only by magnification from 600 to 1300 times ; others are still invisible even by the largest magnification that a microscope can produce. The existence of those, which are invisible even through the largest magnification of a microscope, can be demonstrated only by experimental transmission of the disease germ into animals and plants. In bacteriology these latter micro-organisms are called ultramicroscopic viruses. Hydrophobia, encephalitis lethargica (sleeping fever), small-pox and mosaic diseases of plants are caused by these viruses. A little brain substance or spinal cord of a dog dead of hydrophobia injected into the brain of a rabbit will produce the infection within 4 to 7 days. Similarly a little brain substance of a case of encephalitis put on the cornea of a rabbit after a tiny scratch on it by a needle will produce typical sleeping fever in the rabbit. Pus from the pustules of a case of small-pox can produce small-pox when inoculated into a cow or calf. The virus plant diseases are in most cases hereditary. In the plants grown from seeds of infected parent plants the manifestations of the disease can be seen as soon as the leaves come out.

Though Pasteur was the first to discover the existence of micro-organisms, it would not have been possible to obtain precise data of their existence, shape, size, method of multiplication etc., without the invention of the microscope in 1670, by the Dutch scientist, Leewenhoek. With the help of the microscope and test tubes, hundreds of varieties of these tiny beings have been discovered by producing infection caused by these organisms in laboratory animals and by biochemical methods. It would however be a mistake to hold the micro-organisms as capable only of doing damage to us. It is not generally known that most of them are friendly to human beings, helping them in various ways. Some seem to be neutral and only a limited number are harmful. The viciousness of these limited numbers has earned a very bad name for all of them. For a long time scientists were engaged in identifying and isolating those micro-organisms which are inimical to human beings. Gradually however it has been revealed that the activities of the majority of these micro-organisms are actually beneficial to human and plant lives. This aspect of bacterial life is very little known except to scientists. Quietly, and beyond the range of human visibility, they perform their beneficial role in agriculture and industry, in the alimentary canals of man and animals, in the soil, in decaying matters, refuse heaps, and excreta. The rate of their multiplication is beyond imagination. We lately worked out the number of micro-organisms in the atmosphere of Calcutta. It came to 400 micro-organisms per litre of air. If nutrition is good, one micro-organism can multiply into 100 million in 24 hours.

The soil bacteria, of which there are a large variety, are responsible for increasing the fertility and for nitrification of the soil. The complex organic matter of leaves, dead trees, insects, animals, human and animal excreta are broken up by the soil bacteria into simpler substances which become readily assimilable to the plants for their healthy growth. Detailed study of these soil barteria is increasing, and soil-bacteriology has now become a specialised and extremely important subject of scientific study. Organic manure is nothing but the product of bacterial decomposition and fermentation of soil, of animal excreta, of dead leaves and trees, and of insects. In the nodules of the roots and in the joints of leguminous plants there are innumerable micro-organisms which convert the atmospheric nitrogen into nitrates which are then readily utilised by the plants. During their metabolism, the soil bacteria produce a certain amount of heat which helps in maintaining the temperature of the soil required for the growth of vegetable and plant lives.

The fermentative activity of micro-organisms is extensively utilised in various branches of industry,

such as in the preparation of bread, (yeast fermentation) in manufacturing wine, alcohol and beer. Acetic and citric acids also are now being manufactured by fermentation process, utilising certain varieties of moulds and bacteria. Plants for the preparation of acetic and citric acids by microbial fermentation are now being erected to give products cheaper than by the method now in use. The vitamins B and D, which are essential for human life, are also being prepared from yeast.

There is a fungus secreting an enzyme called diastase—the active principle of saliva, which converts starch into sugar. This diastase is isolated and used in medicine for the treatment of patients who are unable to digest starchy foods, or where salivary digestion is defective. This particular variety of fungus, called *Aspergilus oryzae,* is grown in wheat bran medium where it grows profusely within 48 to 72 hours. The starch splitting enzyme is obtained from the fluid in sufficient quantity.

In the human intestines there are innumerable micro-organisms which help the digestive process. *Dahi,* a product of great nutritive value, is made by the action of lactic acid bacillus on milk. Lactic acid bacillus has got the power of destroying other harmful bacteria of the intestines, and supplies a certain amount of vitamins. Cheese, another valuable article of food, is a product of bacterial decomposition of casein, a milk product. Running cheese, or what in American term is called 'lavatory cheese' is nothing but cheese in an advanced stage of decomposition by these same bacteria. The more decomposed the cheese, the more easily digestible does it become.

In industrial areas the help of micro-organisms is availed of in the sewage disposal. The septic tank is a place where the sewage is allowed to be acted upon by micro-organisms and rendered inoffensive. The solid matters of sewage are almost totally liquefied, and provide a rich source of manure for cultivation.

I have given above only an outline of the friendly activities of the micro-organisms. The study of the life history of these micro-organisms is extremely interesting. There is a vast possibility of utilising the activities of friendly micro-organisms more and more in agriculture and industry. For instance, the utilisation of bacteria, which act upon cellulose, are being studied for the production of alcohol from water hyacinth. It appears that the utilisation of bacteria, for transforming atmospheric nitrogen into nitrate, an essential chemical manure, is another subject worth investigating. In Europe it is not possible due to extremely cold weather, but in India the high temperature energizes their activity in the soil.

Some of the micro-organisms produce beautiful pigments—some golden in colour, others leaf green or citron colour, and some light scarlet. It is not impossible that some day these colouring pigments will be utilised as dyes. Some micro-organisms are phosphorescent, emitting distinct light with which the dial of a watch can be read easily. This phosphorescence is supposed to be due to the secretion by the micro-organisms of a substance called luciferin which when oxidised by atmospheric oxygen in presence of luciferase produces the light. This light can be experimentally produced if a fresh saltwater fish is kept for 48 hours in 5 per cent salt water with some glucose, peptone and glycerine added to it at 10°C. After 48 hours the fluid and the body of the fish will emit light.

Most of the micro-organisms prefer warmth for their activity and growth, but contrary to the general belief they can remain alive longer in cold. In cold drinks and ice-cream, the micro-organisms remain alive and as soon as they find suitable nutrition and warmth they begin to flourish and multiply as usual, often in the intestines of the person drinking cold drinks or eating ice-cream. We therefore seem to be constantly living in a danger zone. Fortunately there is the defensive mechanism of the human body working against all possible dangers of infection. The gastric juice containing hydrochloric acid can kill most of the micro-organisms, if the stomach is functioning normally. Experimental results show that cholera bacilli are killed by 1 per cent hydrochloric acid in less than 1 hour. Typhoid bacilli are killed in less than 3 hours. Infection takes place mostly if contaminated water is taken on an empty stomach when there is no hydrochloric acid available.

During the last war the army paid a heavy toll to gas gangrene. There are several varieties of these gas gangrene bacilli. At the Pasteur Institute of Paris, I had the opportunity of working on gas gangrene bacillus with one of the greatest authorities on gas gangrene, Prof. Weinberg, who was specially deputed by the French Government to investigate the cause of gas gangrene. One of these gas gangrene bacilli, called B. Histolyticus can entirely dissolve the skin, muscles, blood vessels, etc., of a living being

within 24 hours. It is a horrible sight to see an animal or a human being having B. Histolyticus infection.

Constant research work however has been in progress all over the world to find antidotes against each of these microscopic agents of destruction of human lives. Two different kinds of antidotes have been invented and used successfully against infection by these microbes, *viz.*, (*i*) specific biological products such as anti-sera and vaccines, and (*ii*) specific chemotherapeutic products, vegetable alkaloids and glucosides, such as Neosalvarsan, Hexamine, Emetine, Quinine, Mercurial derivatives, Sulphanilamide, etc. Thanks to the discovery of specific anti-sera, tetanus, diphtheria and gas gangrene infection can be controlled and cured if the serum can be administered in time. Towards the end of the last war when due to the rigorous blockade, anti-sera could not be imported into India, many patients died of tetanus, diphtheria, cellulitis and erysipelas. It is a matter of great satisfaction that India can now produce almost the entire need of anti-sera against these dangerous infections.

In recent years research has shown that micro-organisms are attacked by still tinier micro-organisms called bacteriophage, the existence of which was discovered by Wort and D'Herelle, rather accidentally. These bacteriophages can be isolated and when the specific bacteriophage is added to a culture of B. Dysentery, B. Typhoid or B. Cholera, they can liquefy the bacterial body and make them inert. These bacteriophages are now used successfully in the treatment of dysentery infection of the bacillary type, and also with fair success in typhoid and cholera.

Of the harmful micro-organisms against which unfortunately no specific remedies have yet been found, B. Tuberculosis is the most important. The late Professors Calmette and Koch devoted their lives to find a remedy against tubercular infection. Failing to find a specific remedy, either biological or chemotherapeutic, they turned their investigations to the prevention of tuberculosis. Prof. Calmette was able to prepare a prophylactic vaccine called B. C. G. vaccine which when given orally within a few weeks after the birth of a child tended to prevent infection in later life. Later more work showed that such vaccination could in later years avert mild infection by tubercular baccilli but it did not give absolute protection against massive tubercular infection. The present-day method of treatment of tuberculosis is based on rest and nutrition. Long confined rest of the affected lung, and good nutritious diet are the methods now adopted.

Though no specific remedy is available for the treatment of typhoid, cholera, plague and small-pox, these can be successfully prevented by prophylactic inoculation of the respective vaccines. The micro-organisms responsible for causing epidemic diseases, such as cholera, small-pox, plague and typhoid, have been long discovered, but the epidemiology has not yet been precisely understood. Why these diseases break out in epidemic form at certain seasons and at certain localities has not yet been solved definitely. Let us hope that intensive and patient research will find a solution of this problem in the near future.*

* Adapted from a lecture delivered by the author at a meeting of the Rotary Club of Calcutta.

An Account of Edible Mushrooms of India

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INTRODUCTION

IN India there is no cultivation of mushrooms. This is due to the superstitious nature of our countrymen. The idea of raising truffles and edible mushrooms on beds of horse-dung or any other dung is very repulsive to the feelings of the people of our country. The mushrooms are generally picked up from the field, and sold or consumed as such.

The Hindus and the Mahommedans are averse to eating mushrooms. They look down upon these as an inferior type of article of diet. To the non-Aryans mushrooms form an important constituent of their food. In the hills and jungles the Santal and *Paharia* women can be seen picking baskets of those mushrooms which they know to be edible. These grow so abundantly in forests and on uncultivated tracts that the primitive tribes have never found it necessary to cultivate them. These can be bought in bazars or *hats* wherever forest and jungle tribes abound.

The Santals have an idea that thunder causes the fungi to sprout. M. A. Henry, in an article in the *Scientific American* (Vol. 124. No. 6, 1921), has shown that continual discharges of artificial 'lightning' produced by a large static machine caused a very marked effect on speed of growth and size of the cultivated mushrooms. This experiment thus confirms the Santals' popular belief. The edible mushrooms are much used in curry, and some of these constitute first class delicacies. The Santals somehow have no difficulty in distinguishing the edible from the poisonous varieties. But on the other hand, cattle are known to die after taking poisonous mushrooms.

Here follows a list of the varieties of mushrooms eaten by the Santals. The probable botanical names are given side by side. In the *Memoirs* of the Royal Asiatic Society of Bengal (Vol. 10, part 2, 1940) Rev. P. O. Boding has given a long list of Santali names of edible mushrooms.

***Bin ot*, snake mushroom, so named from shape.** (Probably *Lepiota mastoides*).

***Bunum ot*,** lit. white-ant hill mushroom (*Entoloma macrocarpum*) so called because it is found on white-ant hills. Considered delicious.

***Busup ot*,** lit. straw mushroom (*Volvaria terastius*); found growing on old, often decayed straw. Considered good.

***Dak Mandi ot*,** lit. rice-gruel mushroom. Considered savoury. (*Entoloma microcarpum*).

***Gopha ot*,** a very large kind of edible mushroom (*Collybia albuminosa*).

***Gundri gopha ot*,** a mushroom said to be intoxicating but sometime eaten. (A variety of *Collybia albuminosa*).

***Hasa ot*,** lit. earth mushroom. Eaten boiled. Found in Asar and Bhadra (*Agaricus campestris*).

***Hati ot*,** lit. elephant mushroom (*Boletus sp.*), large, bad-smelling. Rare, said to be eaten only by old people.

***Hurut ot*,** lit. tree-stump mushroom (*Lentinus subnudus*). Eaten boiled. There are two species: *Sisir hurut ot*. lit. dew tree stump mushroom, also called simply *Sisir ot* found after the rains have ceased: and *pond ot*. lit. white mushroom (*Lentinus subnudus*) found during the rains. Both eaten boiled.

***Kat ot*,** lit. wood mushroom, found growing on tree-stumps (*Pleurotus ostereatus*).

***Karna ot*,** lit. bitter mushroom (Puff-ball); named due to the taste. Found in Bhadra.

***Karna patka ot*,** (variety of Puff-ball).

***Kod ot*, so called on account of its black colour, resembling the fruit of the *Kod*, Eugenia jambolana, Lamk. (*Coprinus comatus*).**

Mat ot, lit. bamboo mushroom (*Collybia sp.*) because it is found growing on stumps of the hill bamboo. Considered very savoury.

Motam ot, Besides being eaten as an ordinary food, it is given to persons suffering from small-pox, because it is believed to bring out the eruption. (*variety of Collybia albuminosa*).

Muci ot, lit. the Muchi's mushroom (a variety of *Entoloma microcarpum*).

Murum ot, possibly so named owing to its colour, as murum means reddish (*Clavaria sp*).

Or tot ot, lit. pulled out mushroom, so called, because the whole of the mushroom (rooting *Collybia albuminosa*) is pulled out of the ground.

Otec ot, lit. burst open mushroom (variety of *Collybia albuminosa*). It is white in colour and commonly found in August.

Patka ot, (Puff-ball).

Bond kat ot, lit. white wood mushroom, a variety of *Kat ot* (*Pleurotus sp*).

Pond tomar ot, a whitish variety of the tormat ot (a variety of *Geaster*).

Putka, the puff ball, a fungus of the *Lycoperdaceae* family. The Santals recognise the following edible varieties. *Erok putka* lit. sow puff ball, so called because it appears at sowing time, earlier than the other *putka* it is also called *hor putka, Lycoperdon giganteum, Calvatia sp.,* lit. man puff ball and *Ruhniputka,* because it may be gathered during ruhni; *rote putka,* lit. frog puff-ball, a small kind; *seta putka,* lit. dog puff ball (Truffle) which has a rough surface. The Santals very much relish eating these naturally in their early stage of growth.

Rote ot, lit, frog mushroom (small puff ball).

Seta ot, lit. dog mushroom; the same as seta putka (Truffle).

Sim ot, lit. fowl mushroom, reddish in colour (*Cantharellus cibarius*).

Sisir ot, lit. dew mushroom, found growing on stumps of the Sal tree (*Lentinus subnudus*).

Tormar ot, Eaten, but not very common (*Geaster sp*).

Tumba ot, lit. gourd-shell mushroom, of a large round shape (*Bovista gigantea*).

As regards mushrooms, a Santal writes, 'Mushrooms sprout from decayed leaves or straw, and from white-ant hill and cowdung. We boil them in oil adding spices, add a little rase, sauce, soup and eat them. Sometimes we also make a hash of them, cooking them with rice. A few kinds, we also eat raw'.

Baden Powell and others gathered a great deal of information on edible mushrooms in India. Their observations were published in *Indian Agriculturist, Journals* of the Agri-Horticultural Society of India, and other local journals (1863-1911). Baden Powell noted three kinds of edible mushrooms in the Punjab (1863): (*i*) The mushroom (*Agaricus campestris*), (*ii*) The morel (*Morchella esculenta*), and (*iii*) Truffle (*Tuber*).

Later in 1886, some fine specimens of mushrooms were grown by Mr. H. W. Newton and exhibited at the annual show of Agri-Horticultural Society of India. It was entirely a private attempt and created a good deal of interest. In 1908 there was a thorough and searching enquiry instituted by Sir David Prain about the edible mushrooms from all parts of India. It attracted his attention as it was used as famine-food in different parts of our country, specially among the poor during the famine of 1896-97.

FUNGI AS FOOD

Fungi have probably been eaten from prehistoric times. Pliny states that fungi are the 'only food which dainty voluptuaries themselves prepare with their own hands and thus, as it were, by anticipation feed on them, using amber knives and silver service'.

The delicate appearance of some of the edible fungi has from time immemorial tempted man to use them as articles of food. It is used extensively in the dry regions of Bengal, and also in the valley of Kashmir. There is a large demand for mushroom among the Burmese people. The varieties known in Bengal are the following (vide Protap Chandra Ghosa in *Indian Agriculturist,* April 3, 1886):

(*i*) *Phudki-Chhatu* (the small and the large), (ii) *Puwal-Chhatu,* (iii) *Kadan-Chhatu,* (iv) *Durga-Chhatu,* (v) *Urji-Chhatu,* (iv) *Kud-kudi Chattu,* (vii) *Kat-Chhatu,* (viii) *Govar-Chhatu,* (ix) *Indu-Chhatu,* (x) *Pachan-Chhatu,* (xi) *Kondka-Chhatu,* and (xii) *Gundura-Chhatu.*

Of these nos. (vii), (viii), (xi), are considered unfit for food. None of the above named 12 varieties of truffles and mushrooms are cultivated in Bengal. Some attempt to raise a few poor specimens of *Puwal-Chhatu* by allowing waste straw to rot in a heap. They depend on chance for the germination of these mushrooms.

The nutritive quality of fungi has been questioned in recent years. Numerous analyses have been made of edible fungi. The composition varies for different species, and there is considerable variation in the analyses given for the same fungus, probably owing to the composition varying with age and

differing in different parts; a young specimen is more nutritious than an old one, the cap more nutritious than the stem.

Chemical analysis of some local mushrooms were carried out by Dr C. B. Roy, late Demonstrator of Chemical physiology at the Calcutta Medical College, to whom our sincere thanks are due. From the following table of analysis, it will appear that some of them are even superior to the English mushroom:

LOCAL EDIBLE VARIETIES.

	Protein	*Carbo-hydrates*	*Fats* (ether extractives)	*Ash*	*Moisture*
	Per cent.	Per cent.	Per cent.		
Volvaria terastius	2·28	trace	0·18	...	Analysed in dried condition
Collybia albuminosa	12·8	14·8	trace	...	Analysed in dried condition
Agaricus campestris	2·736	1·6	0·37	0·15	95·2%
Puff balls	2·2	1·35	0·56	0·916	93·85%

ENGLISH EDIBLE MUSHROOM.
(*Agaricus campestris*)
[According to G. Massee.]

Agaricus campestris	0·18	0·46	0·03	...	.....

AMERICAN EDIBLE MUSHROOM.
[*U. S. Dept. Agri. Bull.*]
No. 79.

Agaricus campestris	2·25	4·95	0·20		91·30%

From the table it is evident that our local *Agricus campestris* (Fig. 1) is much richer in protein than the English Agaricus, it is also richer in fat than both the English and the American members of the same species. *Collybia albuminosa,* which is called in local vernacular *"Durga Chattu",* is much richer than others. In the amount of water they contain, fungi resemble green vegetables. In certain regions either where the country is infertile or where primitive tribes abound, fungi form the main food, as in Fuegia, where Cyttaria is staple food during many months of the year. The amount of nutrient in mushrooms is very small. It is mainly as condiments that they are valuable. Meat, bread,



FIG. 1. Edible mushroom
Local *Agaricus campestris*

beans, are very nourishing, but who wants to eat these at all times? The chief value of mushrooms is that they act as appetisers, giving variety and flavour to other more nutritious food. They are also very rich in vitamins.

POISONOUS MUSHROOMS

At most there are not more than a dozen poisonous kinds that must be avoided at all cost whereas the edible species number more than a hundred. Prof. Peck lists close to 200 species that have an unblemished reputation for edibility. In order to avoid poisoning by mushroom the best way is to know the killers first—to recognise them by sight and then to be able to pick out the edible kinds. Many writers give general rules as to the kinds of mushrooms to avoid, such as those with a volva or a sack, those

with pink spores, those growing in woods etc. These rules are of some value. But the one golden rule, not to eat a fungus until its identity is certain, will avoid accidents. The fungus selected may be sent to a specialist for determination.

Among the poisonous mushrooms the deadly Amanitas and false morels (*Gyromitra*) take the lead. The worst poisonous species are in the genus *Amanita* (*Amanita phalloides* and *Amanita muscaria*) (Fig. 2).

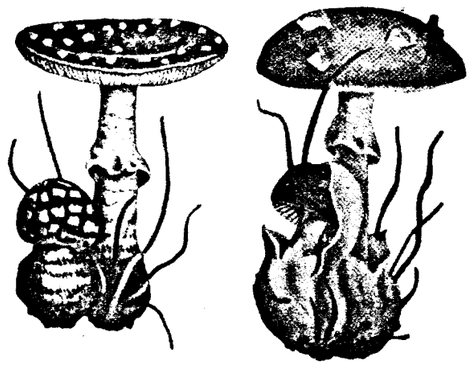


FIG. 2. Two poisonous mushrooms
(a) Amanita muscaria, (b) Amanita phalloides

So it is always safer to go by some general rules for the beginners in order to avoid the genus *Amanita*, and to avoid all that are no longer fresh and firm or which have small burrows due to grubs. Avoid all that have a powerful peppery or nauseous taste. Avoid those with a milky juice. To know the easily recognised *Amanita* group settles the question of any great danger to life in eating mushrooms.

Let us dwell a little on the characters by which they are recognised. First of all, when young "in the button", they are egg-shaped and completely enclosed in a veil or sac (called volva) which ruptures, as the cap pushes upwards, and remains attached at or near the bulbous base as a cup with fragments or warts (appropriately known as the "death cup"). In order to recognise this most important marking it may be necessary to dig up the *Amanita* with care as the cup may be concealed below the ground. If you cut off the fungus above the cup, you might easily be led to exclaim "No cup, therefore safe to eat". Secondly, the *Amanitas* have a ring on the stem above the cup, just below the cap. The *Amanitas* grow on the ground, never on trees. Lastly, many of the poisonous *Amanitas* are further distinguished from our edible mushrooms by having white gills, and if the caps are laid on a piece of paper when mature, they all shed white spores whereas *Psalliota* (*Agaricus*) *campestris* sheds dark purplish spores. In "*Prabashi*" of Aswin, 1337 (Sept. 1930) (a Bengali monthly from Calcutta) one of us (S. R. Bose) described in detail, the points of distinction between the common edible mushrooms and the deadly poisonous ones in the field, with coloured plates of the edible *Agaricus campestris* and the poisonous *Amanita muscaria* as well as of the *Amanita phalloides*.

Russula emetica is poisonous (muscarin is present in this species). In *Gyromitra esculenta* the cap is more or less convoluted, brain-like in appearance. Its poisonous principle, helvellic acid, has been isolated. In the purple-brown spored group *Hypholoma fasciculare* and several species of *Stropharia* are reckoned as undesirable stuff. *Panaeolus* species with their black spores, though not extremely poisonous, can be the cause of considerable anxiety.

TYPES OF MUSHROOM-POISONING

Ford recognizes five types of mushroom-poisoning.

(1) Gastro-intestinal type, characterised by early symptoms of nausea, vomiting and diarrhoea. Rarely fatal. Causative mushroom: *Russula emetica.*

(2) Choleriform type, gastro-intestinal symptoms developing in from 10 to 15 hours, followed by rapid loss of strength and weight. The death rate is high. Causative mushroom: *Amanita phalloides* (and closely related species). It is reported that an anti-toxic serum against the poisons of *Amanita phalloides* has been prepared. In the Bayer's laboratory at Munich they isolated in October 1938 the poisonous principle of *A. phalloides*, which they have named "Phalloidin". It generally causes rapid fall of the blood sugar which can be restored by administration of a suitable amount of glucose.

(3) Nerve-affecting type, early gastro-intestinal symptoms terminating in violent convulsions, delirium, coma and often in death. The active poisonous principle is muscarin, for which the perfect antidote is atropin. Causative mushroom: *Amanita muscaria.*

(4) Blood-dissolving type, abdominal distress, followed by jaundice. Death may occur. Blood transfusion is suggested by Ford as the logical treatment. Causative mushroom: *Gyromitra esculenta.*

(5) Cerebral type, transient symptoms appear shortly after the meal. They are exhilaration, staggering gait, and queer disturbances of vision. Causative mushrooms: various species of *Panaeolus.*

COMMON EDIBLE MUSHROOMS

Among the edible mushrooms the names of Puff-balls, the Morel, the Golden chantrelle, the Cepe, and the cultivated meadow mushroom are well known. In the *Agricultural Journal of India* vol. XVI, 1921, a list of common edible mushrooms has been given by one of us (S. R. Bose) with chemical analyses of some. Among the common edible mushrooms of Bengal the following may be mentioned:—*Volvaria terastius, Volvaria diplasia, Collybia albuminosa, Lepiota mastoides, Entoloma microcarpum, Agaricus campestris* and some small puff-balls from Bankura. *Collybia albuminosa* is called in local vernacular *'Durga-Chhatu'* (as it appears in September to October, usually during the time of Durga Puja ceremony). *Urji-Chhatu* is considered as the most delicate in flavour in Bengal. They are found generally under the ant-hills. In Bankura and Birbhum districts these are collected by the low-caste dwellers of the forest, and sold to the villagers in exchange of rice, tobacco, or salt. A kind of *polao* is made with these mushrooms and it is considered not at all inferior to *polao* made with meat.

When in prime condition, the interior of the large puff-balls is solid and pure white. Indeed the mushroom simulates a good sized ball of cottage cheese covered by a skin that later bursts and spores are set free. When the spore-ripening process starts, yellowish brown droplets appear as soon as a knife is passed through the body of the mushroom. At this stage the substance is no longer fit for food, a distinct bitterness having developed. There are 2 species worth mentioning viz., *Lycoperdon saccatum, L. giganteum.* The smaller puff-balls, *Lycoperdon gemmatum* and *L. piriforme* are also edible, but in these the spores ripen very soon and hence it is rather uncommon to find them in the proper stage for being eaten.

With the exception of *Clavaria dichotoma,* a slender, regularly branched, flaccid, pinkish-white species, all Clavarias are safe to eat. In *C. fusiformis* the plant consists of a tuft of clubs. These are not of the very best taste, but in the absence of better kinds or as bulk-makers with others, they are not to be ignored.

Perhaps the easiest of all edible mushrooms to recognize is the Morel, *Morchella esculenta.* It is a great favourite of the Europeans. The only poisonous species that may be collected in its place is the False Morel, *Gyromitra esculenta.* The distinction lies in the character of the cap. The true Morel has a pitted head, whereas the false one has the cap convoluted like a brain. *Cantharellus cibarius,* the Golden Chantrelle, is highly prized by mushroom-lovers. Bearing not less than two hundred pet names in the countries of Europe it has been a favourite for more than four centuries. It is a small mushroom with a trumpet-like shape, but with a solid, unperforated body, with blunt-edged and much inter-grown gills, and with a colour like that of the yolk of an egg fried hard. Both *Morchella esculenta* and *Cantharellus cibarius* (called in vernacular "Pastu") are sold in the markets of Peshwar and Lahore in the dried state at a high price. *Cantharellus aurantiacus* is an unwholesome species, though edible. In the Kashmere valley the *guchha* is much used. This mushroom has the closest resemblance to the truffles (=sp. of *Tuber*) of Europe. It is sold in Kashmir shops in a dry state, and the older the article the greater is its value. The Kashmiris seem to be aware of the fact that the objectionable properties of fungi are minimized by keeping.

Hydnum coralloides, growing on decomposed stumps of *Deodar* trees, has been reported to be edible from Dehra Dun area but Krieger remarks that it is not so tasteful. The trumpet-shaped *Craterellus, C. cornucopioides* is another fungus that can be gathered and eaten without trepidation.

Among the tough fleshy *Polypores* (bracket fungi) only young specimens of three or four species are sufficiently tender to serve as food. Perhaps the best known is the Beefsteak, *Fistulina hepatica;* it was reported from Darjeeling by Hooker. A sure sign that one has got the species is the strange movability of the skin of the upper surface. Due to the underlying gelatinous layer this skin can be pushed exactly like the skin on the back of an open hand. Only the young knob-like beginnings of caps of the chicken mushroom, *Polyporus sulphureus,* should be eaten, it grows on trunks of Eucalyptus trees in Shillong (Assam).

Coming to the white-spored gill mushrooms the danger zone is entered, for the deadly *Amanitas* belong to this group. The Umbrella mushroom, *Lepiota procera,* can be safely eaten. It is a tall mushroom, and though in common with the *Amanitas* it has white

spores, there are clear distinguishing features such as —the umbonate cap, the scales on the cap, the thick ring (which in older plants can be moved up and down like an encircling bracket) ; the base of the stem, though enlarged, bears no trace of scales, or bag-like volva. To those using a microscope the spores offer an additional means of identification. spores of *Lepiota procera* : Ovate, 18 μ in length ; spores of *Amanita muscaria* : Round, 9 μ in diameter. *Collybia velutipes* is also used by some enthusiasts. Its taste is rather insipid.

The purple-brown spored series is quite safe for the timid mycophagists. This is true, above all, of the genus *Psalliota* which contains the meadow mushroom *Psalliota (Agaricus) campestris*. A group of fairy rings of *Agaricus campestris* was noticed in the lawn of the compound of Prof. S. N. Bose, the Dean of the Faculty of Science of the Dacca University on 26th May, 1940 ; the specimen on examination was found to be mostly two-spored and some had three-spored basidia in the hymenium. On the southern side of the Calcutta Fort in the maidan in June, 1940, two fairy rings of *Agaricus campestris*, each 2 ft. 2 in. in diameter, were found ; these specimens on examination showed two to three spores on their basidia. Adjacent to this spot a wider ring (7 ft. 3 in. in diameter) of edible *Lycoperdon* (Puff ball) could be seen. These fairy rings of mushrooms are usually known to expand in diameter every year.

CULTIVATION OF MUSHROOMS

There is no regular cultivation of mushrooms in India for the market. It is rumoured that serious attempts are being made in Sind to cultivate mushrooms on a commercial scale. There is a large demand for mushrooms among the Burmese people. Recently in 1936, experiments on the cultivation of *Volvaria diplasia* (the edible mushroom) have been successfully carried out in the Agricultural College, Mandalay (Burma) from which the local people obtain supply of pure spawn to grow mushroom in their own fields. Spawns of *Volvaria diplasia* are sold in flasks by the Agricultural Department. The spawn is prepared in the laboratory. Spores can be germinated but it is found more convenient to take a piece of the tissue from the inside of a button which has been sterilised outside. The tissue is cultured first on Quaker oats, then on Brown's medium and ultimately transferred to sterilised straw or dung (of cow or horse). It becomes ready in about a month's time. In Burma, production is, of course, the best during the rains but it is possible to cultivate it from March to the end of October. Dr L. N. Seth of Mandalay is soon bringing out a paper on "Cultivation of Straw Mushroom (*Volvaria diplasia*) in Burma" in the *Indian Farming* in course of the current year.

There are many wild species of edible mushrooms in our country but those commonly used as food and grown privately are varieties of *Psalliota (Agaricus) campestris* and *P. arvensis*. Several other kinds of fleshy mushrooms are sold in Asia and Europe. The Cepes and truffles of Europe, the Kames of North Africa, the Shii-take and Matsu-take of Japan are familiar to the mycophagist. In Europe and America there is a great demand for cultivated mushrooms. In those countries the cultivation of mushrooms in specially constructed buildings, in old ice houses, in abandoned mines, tunnels, quarries, and in other places, has in the past few years steadily increased.

Mushroom can be grown all the year round, if the temperature suitable for their proper development can be maintained. In deep caves and mines this is possible without artificial heat in winter or refrigeration in summer ; above ground it is rather expensive to secure either of the conditions stated above. It is for this reason that the small grower begins operations in early winter.

MUSHROOM BED

In cultivating mushrooms a suitable place for growing them is the first consideration. A cool closed shade or outhouse, or a vacant room in a disused building, with only sufficient openings to admit of a little air and subdued light will make the most suitable plot for cultivation of mushrooms. The next step is the preparation of the bed (Fig. 3). This is done carefully in the following manner :—Fresh horse droppings, if possible of well-fed and sturdy animals, freed from grass and straw, is daily collected, and kept under cover of a shed or outhouse, spread thinly over the floor to prevent premature fermentation. When sufficient quantity has been collected to form a bed, 3 ft. broad, 3 ft. deep and any length from 6 ft. upwards, formation may then be commenced. To secure perfect drainage, the foundation of the bed should consist of a layer of broken bricks 3 inches deep. A layer of droppings, 10 inches deep, tramped firmly down, should then follow, next a layer of earth 2 inches deep, composed of two parts of good friable garden soil, one part of decomposed cowdung, and one part of decomposed sheep or goat dung ; then a second layer of droppings of the same depth as the first, trampled firmly down as before and covered with the mixture of soil as before ; and finally a third 10-inch layer of droppings, also trampled firmly down with a covering of earth, but the latter need only be an inch deep, and should not be added until after the first most violent fermentative action has passed off.

Spawn is contained in hard solid bricks, formed of dried cow and horse-dung. It should be broken into pieces two inches square, and inserted in the fermenting material of the bed an inch deep, and at 6 inches apart. After insertion of the spawn, the bed should be finished off with its final coating of earth, and the latter kept dry for a time. If the spawn is good, it will grow actively in 8 or 10 days, and in the course of 15 or 20 days it will take possession of the whole bed. It is however advisable to examine the bed every few days and replace such spawn as does not thrive, which can be seen by the absence of white filaments in the surrounding material. If culture is carried on in a closed room, nothing further requires to be done but to wait for the appearance of the crop, which may occur at any time from six weeks to two and a half months from the date of spawning. If, however, the bed is placed in the open, or in a structure not free from draughts of cold air, it must be covered with straw loosely thrown over to keep a uniform temperature all round it. After the mushrooms begin to appear or even before they begin to appear if the soil on the surface of the bed become very dry, lukewarm water should be given from a watering pot with a fine rose two or three times a week.



FIG. 3. Mushroom-beds ready for spawning

A second plan of forming beds is to mix the horse-droppings with decomposed cowdung, good garden soil, and goat or sheep dung. The last three ingredients should be in equal proportions and when mixed together, should be equal to one-fifth of the bulk of the droppings. The whole should then be well mixed and laid over the foundation of broken bricks to a depth of 3 feet, pressing firmly down, and finishing off with an inch of good soil as a covering, after active fermentation has ceased. Should the droppings become too dry after collection, they may be moistened with water before being formed into a bed, to the same degree as when freshly deposited. After a bed has been formed, it should be allowed to ferment for 12 or 15 days, and when the temperature has cooled down to 90° or 85°F., it is ready to receive spawn and its upper covering of the earth. The temperature may be taken by making a hole perpendicularly through the centre of the bed, large enough to insert a thermometer.

When beds first begin bearing, the crop is generally very prolific, but in course of time the quantity produced will naturally fall off. When this is seen

to be the case, the bed can be stimulated into renewed vigour by applying liquid manure twice a week made up as follows: Take fresh cow-dung 10 seers, goat or sheep dung 3 sheers, fowl manure ½ a seer, saltpetre 4 ounces, water 10 gallons, and stir the whole together, allow the solids to settle, and water with the supernatant liquid.

In order to maintain a succession of mushrooms, it is advisable to possess several beds made up at intervals of about six weeks. By having beds in bearing, and beds in course of formation in the same room, the heat given off in fermentation will be of great assistance in maintaining the temperature at an even genial figure.

RECENT METHOD OF PURE CULTURE OF SPAWN

While on the subject of the culture of the mushroom-spawn it may be pointed out that Dr Cayley (*Annals of Applied Biology*, Vol. XXIV, No. 2, pp. 311-322, May 1937) has remarked that the popular idea that the horse is necessary for the growth of the mushroom is a fallacy and that the cultivated varieties would develop normally without manure or urea in artificial media. She has tried artificial composts for growing spawns of all forms of mushrooms, both wild and cultivated. As a result of several trials she recommends the following standard unfermented compost: 2 g. dry chopped straw; 2 g. dry chopped hay per tube; 2 g. crushed oats and ½ oz. coarse sand (previously washed and dried). The straw and hay are thoroughly mixed and moistened with 10 c.c. rain water; the crushed oats and dry sand are then mixed in the compost placed in the tube and pressed down lightly, and a layer of dry sand placed on the surface of the compost. The whole is then again moistened with 10 c.c. of nutrient solution and sterilized on three successive days (Fig. 4). The compost will then be moist but not too wet, and the superfluous liquid which drains to the bottom of the tube should not be more than ½ to 1 c.c. deep. It is essential that the compost should not be saturated as the mycelium requires aeration. The crushed oats serve as additional nutriment.

In a subsequent paper Dr D. M. Cayley (*Annals of Applied Biology*, Vol. XXV, No. 2, Pp. 322-340, May, 1938) has supplied the details as to ingredients and methods of treating artificial composts. The results of her tests show that previous high temperature fermentation of the compost is not essential for the growth of the mushroom itself, although in the case of the saprophytic cultivated varieties, previous fermentation may make the necessary nutritive ingredients more easily available to the fungus. Her experiments definitely show that the two wild grass land species *Psalliota campestris* and *P. arvensis* will not grow on either fermented manure or any fermented artificial compost so far tested, but spawn grows quite freely on unfermented freshly sterilised straw and hay, and that mainly proteins, hemicellulose and cellulose are required by the fungus during the earlier stages of growth but



FIG. 4. Pure culture of mushroom—spawn in artificial compost. Edible mushrooms have appeared within 4 of the culture-jars.

that lignin or lignin-derivatives may possibly be necessary for fructification. At p. 324 she has remarked that 'in view of the fact that, up to the present time, stable manure has been almost exclusively used for mushroom beds by the trade and private growers, the ingredients for the artificial composts described in this paper were based on the food of horses, namely, hay, grass and crushed oats, with the addition of straw. These ingredients are easily obtainable in this country, and at a low cost'. In a paper in 1938 (*Journal of the Royal Horticultural Society*, Vol. IXIII, Part 7, pp. 325-333, 1938) she remarks that an ideal manure for mushrooms is still wanting.

RECENT LITERATURE ON EDIBLE MUSHROOMS

The Ministry of Agriculture and Fisheries, England, issued a handbook on mushroom-growing

in 1931 (*Bulletin* no. 34) where the recent methods of cultivation of edible mushrooms of England are fully set out; in 1934 they issued a handbook on edible and poisonous fungi with coloured plates as *Bulletin* no. 23. Ramsbottom (1929—*Fungi*. Benn's six penny library) has also briefly dealt with the common method of mushroom cultivation adopted in England. Recently in 1934, Dr J. B. Cleland brought out two volumes on *Toadstools and Mushrooms of South Australia*, where he has dealt with fungi as food and with preparation of mushrooms for food. L. C. C. Krieger, mycologist of the New York State Museum, published in 1936 a very informative volume—*The Mushroom Handbook*—with many photographs and coloured drawings of American mushrooms. In 1938, Sanshi Imai in the *Journal of the Faculty of Agriculture*, (Hokkaido Imperial University, Vol. XLII, Part 2) has dealt with Agaricaceae of Hokkaido where he remarked that 'the edible *Agarics* in Hokkaido comprise one hundred and eighty one species and four forms. Among them, the fungi suitable for market are seventy four species and two forms'. In the *Philippine Journal of Science* (Vol. 65 Nos. 1-2, Jan.—Feb., 1938) J. M. Mendoza has elaborately dealt with Philippine mushrooms, their methods of cultivation, preparation of mushrooms for the table etc., with several plates. An article by Dr L. N. Seth (of Agricultural College, Mandalay) on the "Cultivation of Straw Mushrooms (Volvaria diplasia)" in Burma is, we understand, soon coming out in "Indian Farming" (Agricultural Research Institute, New Delhi) in course of the current year (1940).

In Bengal steps should be immediately taken for the cultivation of our local edible mushrooms by the Bengal Agricultural Department according to the lines suggested by Prof. Bose in the concluding part of his paper on "Possibilities of Mushroom Industry in India by Cultivation" in *Agricultural Journal of India*, Vol. XVI, Part VI, 1921.

RELIGION IN SCIENTIFIC ERA

THE entire history of the contact of religion and science shows that the facts of the world and of life which are capable of observation and test, constitute a realm in which science is supreme. Science has not supplanted and cannot supplant or destroy religion in the proper sense. It can, however, give a setting to which our thoughts on religious matters must conform. Science has continually forced men to take an ever wider and grander concept of religion by breaking down artificial barriers of ignorance and superstition. Its whole tendency has been to emphasize the fundamentally spiritual character of religion as representing the highest ideals and aspirations of mankind as opposed to theological rules, doctrines, theories, and so on. Science has therefore had tremendous influence in shifting the emphasis of religion from the physical to the spiritual world, and we must not shut our eyes to the possibility of still further powerful influence of this sort.

Science has thus helped to make religion into a developing, dynamic spiritual force. I believe that the principal influence of science upon religion has been along the following lines: first, to break down "authority" and substitute reason based upon facts of observation; second, to eliminate superstition and chicanery from religion; third, to doom any religion of the static type and emphasize the necessity for a continual development of religious thought to keep pace with and interpret the increasing knowledge regarding all matters which pertain to man's activities and environment.

—*Karl T. Compton.*

Radio Fade-Outs and Their Origin

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INTRODUCTION

A REMARKABLE type of sudden and violent disturbance to world radio traffic has in recent years received considerable attention, not only of radio engineers but also of physicists and astrophysicists. The disturbance, commonly known as radio fade-out, consists in the weakening or complete cessation of short and medium wave radio signals, lasting from a few minutes to about an hour or more, over the whole sunlit hemisphere of the earth. The "fade-out" (of short and medium wave signals) is accompanied by enhancement of long wave signal strength and of atmospherics and by other terrestrial effects. The magnetic field at the surface of the earth as well as the "earth currents" in the sunlit portion of the hemisphere are observed to undergo sudden changes. Simultaneously with these, intensely luminous patches are found to have developed on the solar disc.

The effects associated with the fade-out, though they have been receiving attention only in recent years, did not escape the notice of earlier solar physicists. We may mention, for instance, that a possible relation between bright solar patches and sudden variation of terrestrial magnetism was hinted about 80 years ago by an English astronomer Carrington who had observed visually patches of intensely bright and white light on the solar disc while watching sunspots on September 1, 1859 at 11h. 18m. G.M.T. Having no photographic arrangement at hand, he drew a sketch of the observed patches shown in Fig. 1. Two days later it was discovered that almost simultaneously with this solar appearance magnetogram records at the Kew Observatory had registered sudden abnormal changes in all the three magnetic elements. The simultaneity of the two events excited considerable interest at that time but no importance was attached to its possible significance as it was thought that the observed coincidence of solar eruption and magnetic disturbance was a spurious one.

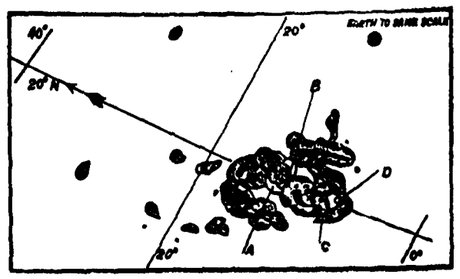


FIG. 1.

Appearance of bright and white patches (marked A and B) on solar disc as sketched by Carrington on September 1, 1859. It was subsequently discovered that simultaneously with the appearance of these patches the magnetogram records at the Kew Observatory had registered sudden and erratic variations of the magnetic elements. (The sketch was first made public by Balfour Stewart in 1861).

The immediate cause of the radio fade-out is a sudden change, detrimental to the propagation of short and medium waves, produced in the ionosphere —the radio roof of the world. Such changes are effected by extreme ultra-violet radiation emanated from the bright patches, called chromospheric eruptions, on the solar surface.

THE NATURE AND ORIGIN OF THE IONOSPHERE

In order to understand the various aspects of radio fade-outs it is necessary to have some idea of the nature and origin of the ionospheric regions which guide radio waves round the curved surface of the earth. The upper atmosphere extending from 50 to about 400 kilometres or even more, contains electrified particles such as electrons and ions. This vast electrified or ionized region, called the

ionosphere, is a conductor of electricity and reflects radio waves almost in the same way as a mirror reflects light.

The ionosphere is not uniformly ionized throughout its entire thickness. The concentration of the electrified particles is high in certain regions or layers between which they are relatively rare. This is represented pictorially in Fig. 2. It will be noticed that there are two main regions of very dense ionization. The upper one which has its densest portion at a height of about 250 km., is called Region F ; the lower one situated at about 100 km. is called Region E. At a height of about 60 km. may be discerned another ionized region of much lower density ; this is known as Region D. The relative distribution of electrons in the D, E and F regions is shown by the curve at the right of Fig. 2.

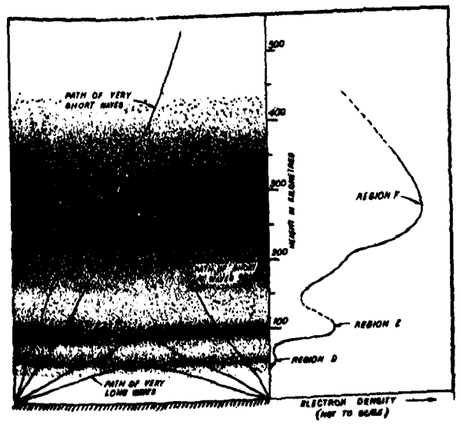


FIG. 2.

Illustrating the various ionized strata of the ionosphere and their relative ionization densities. Regions E and F are the reflecting regions and carry medium and short waves round the earth. Region D is reflecting only for very long waves; for short and medium waves it is absorbing.

It should be mentioned here that the ionized regions not only reflect but also absorb radio waves. The strength of absorption is dependent on the number of collisions which the electrons or ions make with the neutral molecules and atoms present in the medium per second. Thus an ionized region situated at a great height, where air density and hence the collisional frequency is small, causes little absorption of radio waves, while, a region located in the denser atmosphere below, where collisions are frequent, causes considerable absorption. It is therefore evident that the higher regions E and F will act in general as reflectors and the lower region D as absorber of radio waves. The increased absorption of short and medium waves observed in daytime is, in fact, principally due to increased ionization of Region D caused by the solar rays during day light hours. Region D, however, reacts in a different manner towards long waves. For such waves, increase of ionization causes copious reflection instead of absorption. This is because the long waves are unable to penetrate into the region and are simply thrown back, as it were, from the lower boundary.

The formation of these electrified regions is due to the ionizing action of extreme ultra-violet radiation from the sun. The sun, it is believed, radiates like a black body at a temperature of 6500°C. As such one would expect its spectrum to extend far into the ultra-violet. Actually however the solar spectrum, as observed near the surface of the earth, ends abruptly at a wavelength of 2900A. This is because the entire spectral region beyond this limit is absorbed by the upper atmospheric gases like ozone, molecular and atomic oxygen and molecular nitrogen. The absorption by these gases—of the different portions of the ultra-violet spectrum—leads to various types of photo-chemical, photo-ionizing and photo-exciting reactions. Of these we are concerned here mainly with absorption leading to ionization, *i.e.*, knocking off of one or more of the outer electrons from the absorbing atom or molecule. It is obvious that the active radiations which produce ionization of the different gases will be extinguished by absorption at different levels depending upon the value of the absorption coefficient and the mass of gas traversed from the top of the atmosphere. If the coefficient is large, it is extinguished at a great height ; if the coefficient is small it is fully extinguished only after it has penetrated down to very low heights. Each absorbing gas therefore produces its own region of ionization at a level which is determined by the strength of its absorption. The formation of the different ionized regions in this manner is further conditioned by the fact that the atmospheric gases are not thoroughly mixed up to the highest levels. The mixing exists only up to a height of about 100 km. The constituents up to this level are mainly molecular nitrogen and oxygen, and their proportion at any height is the same as that at the ground level. Above 100 km. molecular oxygen is split up into atomic oxygen. The constituents in the high atmosphere are therefore principally molecular

nitrogen and atomic oxygen. Unlike the gases in the region below 100 km., the two gases here are in a state of the so-called diffusive equilibrium; atomic oxygen being lighter occupies the highest levels floating as it were on the heavier molecular nitrogen below. Further, there is a region of transition lying between 80 and 130 km. levels within which molecular oxygen is gradually replaced by atomic oxygen.

We can now describe the formation characteristics of the different regions of the ionosphere pictured in Fig. 2. Region F is formed by the absorption of solar radiation at and below λ 660A by atomic oxygen.

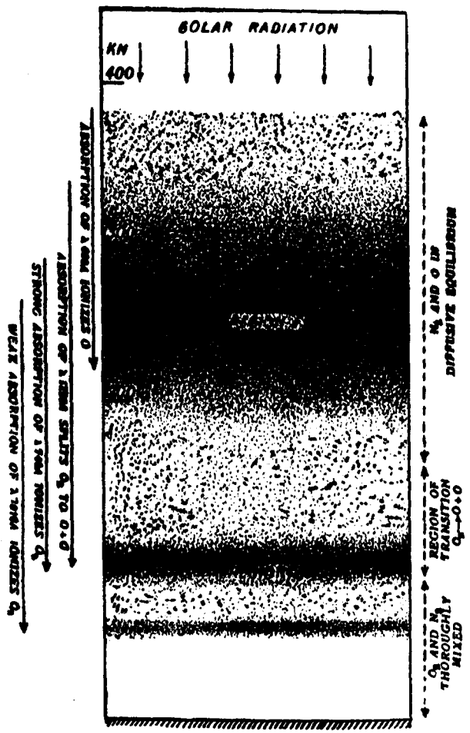


FIG. 3.

Illustrating the formation of the various ionospheric strata by absorption of different portions of the solar ultra-violet radiation.

The splitting of $O_2 \longrightarrow O + O$, in the region of transition round the 100 km. level, is caused by the absorption of radiation at and below λ 1750A. Region E is produced in this region of transition by the absorption of radiation λ 774A and below by molecular oxygen. Oxygen molecules also absorb, though rather weakly, radiation of wavelength at and below 1010A and are thereby ionized. This absorption is responsible for Region D at the 60 km. level.* The formation of these regions is pictured in Fig. 3.

It will be useful here to describe the ingenious experimental method by which the structure of the ionosphere described above has been discovered. A "packet" of radio waves of very short duration (a few ten-thousandths of a second) is sent up from a transmitter. This is reflected down by one or other of the conducting ionized strata of the ionosphere. If a receiver is placed at the ground not far removed from the transmitter, it will receive two signals due to a single wave-packet; one due to that portion of the wave which has travelled along the ground (direct pulse), and the other due to the portion reflected by the ionospheric stratum (indirect pulse) as shown in Fig. 4. The two received pulses are

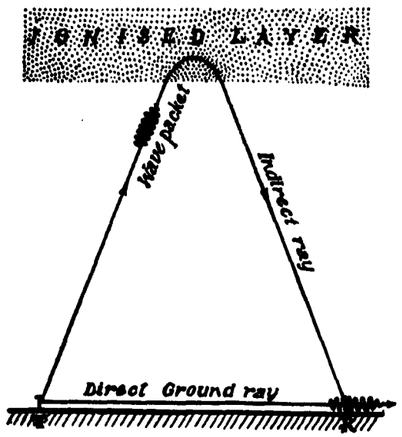


FIG. 4.

Illustrating the pulse-method of sounding the ionosphere. Trains of wave-packets are shot upwards from the transmitter (T). These, returned by one or other of the ionospheric strata, reach the receiver (R) a few milli-seconds after the corresponding packets travelling directly along the ground. The height of the reflecting stratum is easily computed from this interval. If the wave frequency is high, the wave-packet may pierce the stratum and fail to record any echo. The presence of an absorbing layer between the ground and the reflecting stratum may also obliterate the echoes.

* The absorptions of λ 1010A and λ 774A by O_2 both lead to ionization. The difference lies only in the state of the resulting ionized molecule. In the first case the molecule ionized is in its normal state whereas in the second case it is in an excited state. The energy required in the two cases are 12·2 and 16·5 electron volts respectively and are called the first and second ionization potentials.

separated by a time interval of the order of a few thousandths of a second and can be recorded on the screen of a cathode ray oscillograph. This interval is the time taken by the pulse to travel from the ground to the reflecting stratum and back. The velocity of radio waves being known (in free space it is equal to that of light, *viz.*, 3,00,000 km. per sec.), the height at which the ionized stratum is situated is easily calculated from a measurement of this interval.

The "pulse method" of exploring the ionosphere also enables one to calculate the electron density in the various ionized regions. For this purpose the frequency of the wave is gradually increased till the wave packets pierce through the stratum and fail to record any echo. The frequency for which this occurs is called the critical frequency and is related in a simple way to the electron density of the stratum which is just pierced.*

Ionospheric exploration by this method has been found so helpful for collecting data for use in connection with long-distance radio communication that quite a number of ionospheric observatories have been built in different parts of the world for keeping continuous records of the heights and the electron densities of the various ionospheric regions. The method of obtaining continuous records is shown in Fig. 5. G and E are respectively the direct and the indirect pulse reflected from an ionospheric region. With the aid of a suitable camera the pattern on the oscillographic screen is thrown on a continuously moving film. The whole screen is masked leaving only the horizontal line—the "time base". As the film slowly moves the bright horizontal line blackens the whole film leaving two gaps (shown by the two dark vertical traces) corresponding to the positions of G and E.

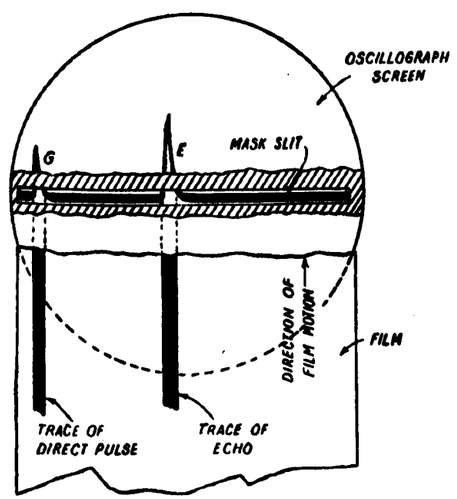


FIG. 5.

Illustrating the method of continuous recording of ionospheric echoes.
The shaded region is part of the mask which covers the whole of the oscillographic screen except the horizontal time-base. Any pulse appearing on the time-base brings in a discontinuity which leaves its trace on the moving film.

* The relation is $N = 1{\cdot}24 \times 10^{-3} f^2$, where N is the number of electrons per c.c. and f is the critical frequency in kilocycles per sec. This relation neglects the effect of the earth's magnetic field on the propagation of the waves in the ionosphere.

The separation between these traces gives the height of the reflecting stratum. If, at any time, the echo is absent for some reason or other, a discontinuity occurs in the trace. Records of this type are very useful for studying ionospheric conditions during a fade-out. We will now turn our attention to this.

SIMULTANEITY OF OCCURRENCE OF THE VARIOUS PHENOMENA

The simultaneity of the solar, radio, magnetic and earth-current effects during a fade-out is shown in Fig. 6. The spectroheliograms at the top of the Figure were taken at Mount Wilson Observatory on April 8, 1936 and show the appearance of a bright eruption at 16h. 49m. G.M.T. The ionospheric records made at Washington reveal that radio echoes ceased completely at 16h. 46m. G.M.T. The magnetic and earth-current records at Huancayo show sudden changes at the same instant. The phenomena which occurred on this date may perhaps be best described in the words of A. G. Mcnish[1]:

"Routine observations with the spectrohelioscope were in progress at the Huancayo Observatory at the Carnegie Institution's Department of Terrestrial Magnetism at this time. The observer on duty noticed a remarkable brightening of the H-alpha light in the region of a large sunspot, beginning at 16h. 45m. G.M.T. This eruption was accompanied by certain terrestrial phenomena as shown in

[1] Mcnish, *Terrestrial Magnetism and Atmospheric Electricity*, 42, 109, 1937.

Fig. 6. The spectro-heliograms shown in the Figure were made at Mount Wilson before the eruption, while the eruption was at its maximum, and after the eruption had subsided. They show the brighten-

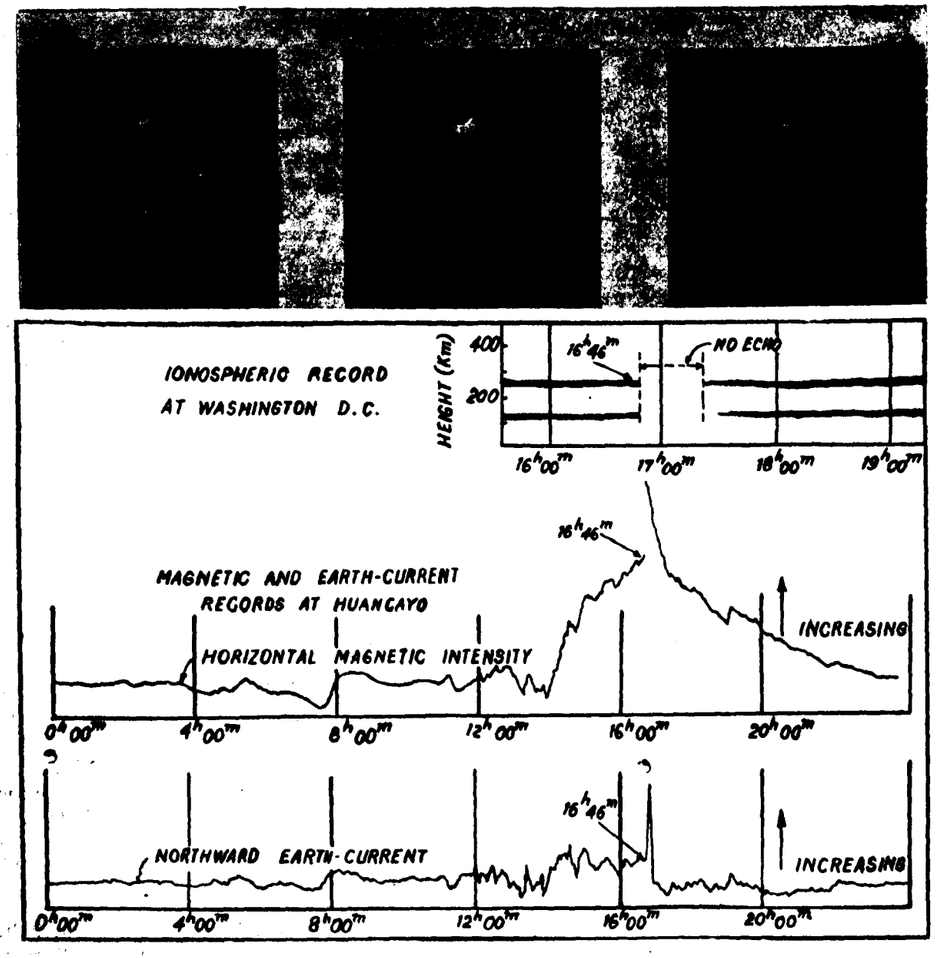


FIG. 6.
Illustrating the simultaneity of radio, magnetic and earth-current disturbances and the appearance of bright patches on the solar disc.
The ionospheric record shows complete cessation of echoes from the ionospheric regions E and F at heights 110 and 260 kms. during the appearance of the bright solar patches. At the same time the magnetogram and the earth-current records show sudden increases in the value of the horizontal magnetic intensity and of the earth-current.

ing of the sunspot, although high contrast of the negatives used permits little discrimination regarding intensity. The observers at Huancayo reported that 'from the viewpoint of extent and intensity' this was the most spectacular eruption which had been witnessed at the Observatory since beginning routine observations with the spectrohelioscope a year before.

"Ignorant of the solar fireworks in progress, the radio operator at the station, who was engaged at the time in making measurements on the ionosphere,

found it impossible to receive reflections on any frequency and began to search for defects in his equipment. Finding none, observations were resumed" and the echoes returned 55 minutes later. "The sudden changes in the Earth's magnetism and in the earth-currents which are continuously registered at the Observatory are conspicuous in the records at the bottom of the Figure. It may be noted that all the terrestrial effects began at 16h. 46m., one minute after brightening became perceptible in the sunspot-region."

Such simultaneous occurrences of the various phenomena—solar eruption, radio fade-out, terrestrial magnetic and earth-current disturbances—have been observed on numerous occasions. There are, however, instances on record of the occurrence of a radio fade-out with no accompanying solar eruption and, conversely, of the appearance of a solar eruption without fade-out effects.

RADIO AND MAGNETIC EFFECTS

We will now discuss in some detail the radio and the magnetic effects associated with a fade-out.

Radio Effects: The most spectacular aspect of the radio effect is, as already mentioned, sudden cessation of wireless traffic on short and medium waves. The other effects are enhancement of long wave signal strength and increase of atmospherics. (The latter, as is well-known, have a quasi-periodicity of the order of a few thousand cycles per second). Figure 7 shows the sudden rise in the atmospheric disturbance during the fade-out which occurred on April 8, 1936 when the recording equipment was tuned to 27 kc./sec. (11,100 metres). The inset shows that the nature of the increase of the strength of atmospherics is very similar to that of the decrease of short wave signal strength. The curve is a record of the intensity of long-distance signals on 9570 kc./sec. (31·34 metres) and is drawn with the ordinate reversed—a rise in the curve signifying a decrease of the intensity—to emphasize the similarity in the forms of the two curves. These effects receive an easy explanation if it is assumed that radiations emitted from the bright patches cause a sudden increase in the ionization of Region D which, as mentioned above, absorbs short and medium waves but reflects very long waves.

Earlier observations seemed to indicate that the ionospheric layers lying above Region D are unaffected during a fade-out. Recent observations made in Australia show, however, that changes in Region F do occur during a fade-out. These changes are firstly, a small diminution of the electron density and secondly, an increase in the height of Region F. Further, it is found that although the

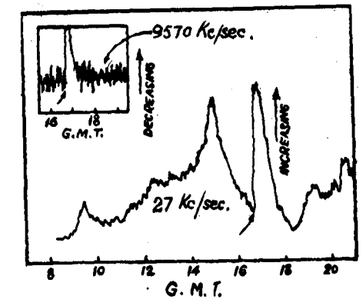


FIG. 7.
Illustrating intensification of long wave and disappearance of short wave signals during a fade-out. The arrows indicate the commencement of the fade-out which occurred on April 8, 1936.

fade-outs occur usually after the commencement of the chromospheric eruption (sometimes as long as 2 hours later), the changes in Region F begin almost simultaneously with it.

To summarise, the main effects associated with a fade-out are:

(*i*) An intensification of the ionization in the absorbing Region D.

This, on the one hand, obliterates radio echoes on short and medium waves (reflected by the upper ionized strata) and, on the other hand, strengthens the very long wave signals (reflected from Region D itself).

(*ii*) A small diminution of the ionic density and an increase in the height of Region F.

Magnetic Effects.—The magnetic effect, as mentioned above, consists of sudden changes in the magnetic elements notably in the horizontal magnetic intensity H. In Fig. 6 it will be noticed that H increased so much that for a few minutes the recording instrument failed to register its value. Detailed examination of the magnetic records during fade-outs shows that the change in the magnetic field for each observatory consists simply of an augmentation of the ordinary quiet day variation of each of

the magnetic elements (see SCIENCE AND CULTURE, p. 70, August, 1940). The magnetic changes are most noticeable in the observatories situated on the illuminated hemisphere of the globe; observatories at a distance of more than 70° from the sub-solar point scarcely show any measurable effect.

The above observations on magnetic and radio effects during a fade-out are of utmost importance in deciding between the three rival theories—drift-current, diamagnetic and dynamo theories—of the origin of the world-wide current system in the high atmosphere producing the diurnal terrestrial magnetic variation on a quiet day. According to the drift-current and diamagnetic theories the current system must lie in a region of the ionosphere where the frequency of collision is small, *i.e.*, above 100 km. According to the dynamo theory, however, the current system must lie in a region of high collisional frequency, *i.e.*, below 100 km. Now, as pointed out, the magnetic effect observed during a fade-out is merely an enhancement of the normal diurnal variation. It therefore follows that the cause of this enhancement must be an intensification of the current system producing the normal diurnal variation resulting from increased conductivity of the region in which it flows. Since, at the time of a fade-out, it is the ionization of Region D—the region of high collisional frequency—which is increased it may be concluded that the quiet-day diurnal variation current system flows in this region. This is therefore a strong evidence in support of the dynamo theory as against the other two theories.

ORIGIN OF THE FADE-OUT EFFECTS

From what has been said above there is little doubt that the immediate cause of the radio fade-out and of its associated effects is a sudden increase of ionization in the absorbing Region D of the ionosphere. The increase is caused by ultra-violet radiation emanated from the bright solar spots. In order to be complete and satisfactory this hypothesis must, however, explain all the observed details of the effect. For instance, it should explain:

(*i*) Why all observed solar eruptions are not accompanied by fade-outs and why during some fade-outs no bright solar eruption is observed?

(*ii*) What is the likely process by which the ionization below the E layer is increased?

(*iii*) What are the constituents of the atmosphere which are affected and by what wavelengths?

(*iv*) How does the ionic density of Region F decrease?

These are the points which the hypothesis should explain besides the origin of the primary cause, namely, the bright eruption.

With regard to (*i*) the natural explanation is that the solar eruption must attain a certain minimum intensity before it is able to produce increased ionization causing the fade-out. In previous observations little attention was paid to the intensity of the eruption. If one compares eruptions which are accompanied by fade-outs with those which are not so accompanied one cannot detect any difference between the two except that the former are brighter than the latter. If the intensity is designated on an arbitary scale 1, 2, 3 of increasing intensity it is found that practically all eruptions designated as intensity 3 are accompanied by radio fade-outs.

Regarding the converse phenomena, namely, radio fade-outs unaccompanied by solar eruption, one ought to take account of the fact that all radio fade-outs reported as such may not be really so. It might be recalled in this connection that, so far as the effect on Region F is concerned, the decrease of ionization occurs almost simultaneously with every solar eruption.

With regard to (*ii*) and (*iii*) it is sometimes suggested that the radiation which is responsible for the production of Region E (λ 744A), if intensified, might produce stronger ionization in the absorbing stratum below this region. This is hardly possible; because, the main effect of intensification of this radiation will merely be an increase of the ionization density at the level of Region E without any appreciable increase below. We have, however, already mentioned that during a fade-out, Region E ionization is affected very little if at all. It thus seems certain that the radiation causing fade-out is distinct from that which is responsible for producing Region E ionization. The probable nature of such radiations has been suggested by several authors and are discussed below.

The emission of the Balmer H-alpha line from an eruption must be accompanied by the Lyman lines of hydrogen. The wavelengths of the Lyman lines are such, that with certain plausible assumptions

in regard to the atmospheric constituents *in* the Region F and *below* the Region E, the decrease of ionization in the first and the increase of same in the second can be explained.

From what has been said above it is evident that below the Region E, between 60 and 100 kms., both O_2 and O are present. According to one view[2, 3] the increase of ionization in this region is due to the ionization of molecular oxygen and according to another view[4] to that of atomic oxygen. For reasons to be given presently it seems almost certain that the constituent affected by ionization is O_2 and not O.

Since the first ionization potential of O_2 is about 12.2 electron volts, it is evident that the ionizing wavelength must be equal to or below 1010A. The wavelength of L-β being 1026A (greater than λ1010A), the ionizing radiation should be L-γ (λ 973A). Absorption of this radiation, however, is relatively feeble and, as a consequence, it will be completely absorbed only after it has penetrated down to a considerable depth below Region E. Calculations made by Mitra, Bhar and Ghosh[2] on the assumption that the absorption coefficient of O_2 for this radiation is only one-thousandth of that for λ 744A (corresponding to the second ionization potential of O_2) show that the maximum ionization due to this absorption occurs at a height of about 55 km. It may therefore be concluded that a solar eruption accompanied by an intensification of the Lyman lines of hydrogen enhances the ionization of the absorbing Region D which lies at this height.

According to another view[3] the enhancement of ionization is due to the action of L-*a* on atomic oxygen which is assumed to be present in sufficient quantity even down to 60 km. The possible process of ionization suggested is as follows. Atomic oxygen is excited by the absorption of the L-*a* line. Such an excited atom may lose by collision an electron and an amount of energy of 0.75 electron volts, and thus revert to the normal state of ionized oxygen atom. For this to happen the number of collisions must be sufficiently high and the process will therefore occur at comparatively low levels. This hypothesis might, however, be criticised on the following grounds. In the first place the collision, in order to produce ionization must have to be sufficiently violent. It is questionable whether such violent collisions can occur in the relatively cool atmosphere of Region D. Secondly, calculations show that atomic oxygen, the presence of which is essential for this process to occur, cannot be present abundantly in this region.

In order to explain the decrease of the ionization density of Region F, observed during a fade-out, the presence of water vapour in this region is assumed. The temperature here is high—of the order of 1200° to 1500°C. Now, it may be shown that the equilibrium temperature of this region, if it consisted of atomic oxygen only, would be considerably higher—about 3500°C—due to the absorption of solar ultra-violet radiation of wavelength 1450A. If, however, water vapour also is present, the rise would be considerably less owing to the fact that water vapour is a good radiator of heat and the temperature would lie between 1000° and 2000°C. The assumption regarding the presence of water vapour in the high atmosphere thus appears to be justified. The L-*a* radiation which is strongly emitted during solar eruptions dissociates the molecules of the water vapour to H and OH (excited). The temperature of the region therefore goes up because water vapour is no longer present to check its rise due to the absorption of λ 1450A by the oxygen atoms. The atmosphere therefore expands upwards and its density decreases. Ionospheric observations thus show a decrease in the ionic density of Region F and an increase of its height.*

[2] Mitra, Bhar and Ghosh, *Ind. Jour. Phys.*, *12*, 455, 1938.
[3] Saha, *Proc. Nat. Inst. Sci. Ind.*, 5, 21, 1939.
[4] Martyn, Munro, Higgs and Williams, *Nature*, *140*, 603, 1937.

* The author has much pleasure in acknowledging with thanks the help he received from Prof. S. K. Mitra in the preparation of the article.

The Problem of Food Adulteration

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THE question of pure food supply is a pressing problem in India. It is even more important than the problem of drug control. It is obvious that if adulterated and injurious food constitutes the major portion of the common dietary that is consumed from birth till death, even pure drugs can avail but little. As a matter of fact, the trade in adulterated food has assumed the proportions of a scandal in this country. What is worse is that it is particularly the staple or the more commonly consumed food-stuffs that suffer from the most unscrupulous adulteration. In Bengal, for instance, *atta* (whole wheat flour), *moida* (white flour), *ghee* (clarified butter), mustard oil and milk are the principal commodities that are most highly adulterated. This adulteration is carried out on a large scale and very frequently with the help of expert scientific advice. For this purpose even small laboratories and machineries for grinding soapstone, gravel, etc., are maintained by the dealers concerned. As it is, the diet in most parts of India including Bengal is very ill-balanced and defective and if, in addition to that, adulterants, like soapstone, unwholesome fats and other toxic substances find their way into the stomach, the resulting situation can be well imagined.

Not that attempts at checking food adulteration have not been made. So far as Bengal is concerned, the Bengal Food Adulteration Act of 1919 was designed to prevent adulteration. But the measure has largely failed because firstly the Act itself has not been sufficiently comprehensive and had several lacunae. Secondly, the inspecting staff and others responsible for the enforcement of the Act have not always been sufficiently mindful of their civic duty. Thirdly, the ingeniousness of the dealers in the matter of adulteration has often defeated the ingeniousness of the scientists of the public health laboratories. One should also realise that the mischief is done more by the whole-sale dealers who release the commodities into the market ; the retail dealers are perhaps somewhat less to blame.

The Bengal Pure Food Bill of 1940 which has just been brought before the Bengal Legislative Assembly for enactment seeks to remedy some of the defects of the Bengal Food Adulteration Act of 1919. This is a desirable step. The Bill seeks to control the places where large scale adulteration is carried out which was not so easy under the old Act. It attempts also to remedy some of the defects of the old Act which have been revealed in the course of its operation during the last 20 years. But it should be fully realised that the success of the new Act would depend chiefly on the rules and bye-laws regarding standards of purity, etc., which will be framed later on by the Bengal Government under the provisions of the Act. The rules to be framed for such purpose demand a considerable amount of knowledge and scientific experience. In this country before now practically no attempts have been made by the Government to seek any advice other than that of their official experts in framing such rules concerning the limits of purity and the methods of analysis to be pursued. The Government experts have no doubt their qualifications. But the tendency has been to copy the standards and methods from those of other countries in a stereotyped way. While the right course for us is to adopt the methods of more advanced countries as the base line for our efforts, the food practices and food adulteration processes of our country require adaptations of those methods to our local conditions. Nor should it be forgotten that our knowledge of methods of analysis is progressive and a set of procedures adopted to-day is capable of considerable improvement tomorrow. This leads to the corollary that we must in the long

run depend on ourselves and the experience and researches of our public health laboratories together with those of the scientists in universities and other research institutions should provide the guide to the framing of the rules referred to above. In this country the necessary pooling of information between the public health laboratories doing analytical work and other research laboratories which have sometimes more competent personnel has not taken place. On such vital questions the opinion of expert scientific bodies like the Indian Chemical Society and the Institution of Chemists (India) should also be invited. As an instance of the relative detachment of the ordinary Government expert from other experts outside the pale of Government service we may cite the case of "Agmark Ghee". With reference to that commodity sufficient help has not been sought by the department of the Central Government concerned from scientists of universities, who have something to do with food technology or from an influencial body like the Indian Chemical Society, which could bring to bear a considerable amount of scientific knowledge on the problem in question. As a result, in the opinion of many experts, the standards set up by the Government for the aforesaid ghee are not sufficiently satisfactory. We would therefore urge upon the Bengal Government to circulate the Bengal Pure Food Bill to non-official scientists and scientific organisations and also to invite their opinion on the framing of the rules regarding purity, standards and methods of analysis. Much depends upon this.

The present measure that the Bengal Government is adopting concerns also the organisations of the public health laboratories and the question of public analysts. As we have said before, the knowledge of analysis is not in a static condition and the personnel of the public health laboratories should be such as cannot only carry out routine analyses but can also look at the problem of adulteration as a research problem so that new and more accurate methods may be devised to meet the local situation arising from the use of local adulterants which are peculiar to India. Mere copying of methods from standard books of analysis will not do. This requires that the scientific personnel of these laboratories should be well-paid and that there should be no nepotism in their appointment. They should be both able and above corruption. It is therefore desirable that all the District Public Health Laboratories, which are now run by District Boards, should be provincialised and should come more or less into the same category as the Public Health Laboratory of the Government of Bengal. The selection of the personnel should be left entirely to the discretion of a body like the Public Service Commission entirely uninfluenced by considerations other than that of the need of promoting the public health of the province. It should be fully realised that, if irrelevant considerations come into the picture and wrong appointments are made, more harm may be done through the new Act than good.

The question of public analysts is again a matter in which India is much behind the times. In all other countries it has been realised that the public analysts should be trained chemists or persons who have passed a rigid test concerning food analysis in all aspects. Dr G. E. Oates, Medical Officer of Health of the Metropolitan Borough of Paddington thus observes : "In most of the towns, however, the medical officer of health is responsible for this branch of public work (*i.e.* administration of the Food Adulteration Acts), and in order to obtain his qualifying diploma in public health he will have to pass a somewhat exacting test of his knowledge of food analysis. Needless to say, this in no way qualifies him to act as public analyst, the qualifications for this appointment involving a long and arduous training and a difficult examination test". It will thus be seen that a medical officer of health who has passed a good test for food analysis is, nevertheless, not considered competent to discharge the duties of a public analyst. It is high time that this was fully realised by all provincial Governments in India. In many places it is still the medical officer with no special knowledge of analysis who is still officially the public analyst and simply signs the analytical reports submitted by the chemist of the public health laboratory. When a prosecution results from the administration of the Food Adulteration Act, it is the actual analyst who has to submit to cross-examination. The position is obviously anomalous and is symptomatic of the general backwardness of our country. There is no harm of course in appointing medical people as public analysts if they have undergone the arduous chemical, bacteriological and other special training to which Dr. Oates refers.

We would also suggest that, even after the rules and standards are framed by co-operation and exchange of information between official and non-official experts, a permanent committee consisting of both these classes of experts should be set up by the Government for the purpose of directing researches on the question of standards, limits of purity and

methods of analysis. This kind of investigation is essential for solving our problems of food adulteration. Such a committee may be called the "Pure Food Technical Committee" and should undertake a comprehensive survey and investigation of the technical problems connected with food adulteration. This work should be carried out in perfect co-ordination between the public health laboratories and university and other laboratories, willing to participate in the joint endeavour. This Committee would be the most suitable both for formulating the problems to be attacked and for directing efforts at their solution. We hope that while the new Bill is on the legislative anvil, the considerations set forth above will receive due attention from the Government and the Legislature.

EFFECTS OF ENGINEERING IN PRESENT AGE.

In our present state in the western world we have reached an age when the effects of engineering run through all conditions of living. We of the western world have so profited by active prosecution of scientific discovery, invention and refinement of engineering processes that our conditions of life for all but the most wealthy are in strong (indeed startling) contrast with the woeful conditions of living available for the poor and the moderately well-to-do in those eastern countries which have failed to participate in such developments. We have further improvements to make. For illustration, it is a fact that we have not yet developed the human contacts, in those of our industrial organizations in which production by machines is prominent, so as to reproduce the friendly responses that are possible among industrial groups, and which were observable in the best of old-time hand-work conditions. Such defects, however, gradually become rectified as the modified social relations gain recognition.

Engineering processes and engineering devices have been (and are being) abused by use in warfare, and much of the poverty now found in various nations is an aftermath of costly wars which sacrificed productive men and valuable property.

It is not science or engineering which is at fault. The defects in human relations which arise in our day in local, national and international affairs are not due to faults in the fundamental ideal of a complete civilization, nor to a scientific engineering which has set up and continues to maintain the stage for a possible realization of that ideal. The fault lies in the lag of human intelligence with respect to its opportunities for bettering human conditions. The human mind, in mass, is very slow to change in character ; and stable improvements of mutual relations cannot be rushed to success by the vaguely applied efforts of professional reformers or dilettantes in social affairs. Such improvements may only be successfully produced slowly in association with sounder-growing mass-thought regarding living affairs in both material and ethical relationships.

Such processes are fraught with alternate states of success and discouragement. The influence of engineering is of primary importance for showing the ways to material betterment. Following in the wake of material betterment and increased leisure which are secured by improved engineering practices, intellectual improvement also usually comes as an ultimate contribution to social welfare.

—*Journal of the Franklin Institute.*

Notes and News

Petroleum Supply of the World

IT is generally believed that petroleum supplies are limited and irreplaceable and it has been computed by competent specialists that unless other new oil fields are discovered the present total world reserve would not last out more than only another 16 years. Contrary to the above belief Dr Gustav Egloff, of the Universal Oil Products Company of America, holds out the hope that petroleum is being continually formed underground on a substantial scale and even perhaps at a faster rate than human efforts are bringing it to the earth's surface. Though Dr Egloff cannot as yet claim to have fully substantiated his theory, his inference is based on the fact that there is a remarkable resemblance between some present-day fishes and molluscs found in abundance in lakes, rivers and oceans and those found in oilbearing formations. For example, in the Californian oil fields' geological formations are found fossils of plants identical with the microscopic plants known as diatoms now living in the seas. These plants are found to contain nearly 2% oil, and it is probable that even now these plants are being deposited in large quantities into what will be our future oil fields. Incidentally Dr Egloff forecasts that our oil wells in future will have increased depth of four to five miles as compared to the present depths of two to three miles.

Sulfanilamide as Promoter of Plant Growth

THE chemical sulfanilamide, which has proved to be a potent remedy for many human germ diseases due to checking the growth of bacteria, has now been found to possess other important properties having a bearing upon the growth of plants. The *Science News Letter* has published a report of some recent discoveries made by Dr Ernest L. Spencer of the Rockefeller Institute, who has observed that the chemical stimulates the growth of tobacco plant roots. Plants receiving from 20 to 40 parts per million of sulfanilamide were found to develop new roots much earlier than similar plants which did not receive a dose of the chemical. But uncut seedlings were not found to be stimulated and a dose of the chemical which stimulated root formation on cut plants was found to poison plants with normal root systems. This behaviour has not as yet been properly accounted for. If sulfanilamide is to be attempted as a cure for some forms of plant diseases, Dr Spencer thinks, it must be used in much smaller doses than can be safely used in treating human patients.

Collection of Archaeological Materials in Karnatak

A RICH collection of historical materials has been made by the Archaeological Survey of India as a result of a village-to-village survey of inscriptions in the districts of Bombay Karnatak for the last 15 years. The material is now being published and a further search is being made for materials other than inscriptions. The Director-General of Archaeology has suggested to the Government of Bombay the establishment at Dharwar, at the earliest possible moment, of a properly constituted museum, which will focus efforts hitherto made by research workers in Karnatak. There is ample material for such a museum, *e.g.*, rare manuscripts, sculptures and archaeological material from the earliest period of human history to the times of the Vijayanagar Empire.

A surprisingly large number of bronze images, copper plates, stone images, and minor antiquities have already been collected from different parts of Bombay Karnatak, which may be used as the nucleus of the proposed museum. The Director-General of Archaeology has also promised to use his good offices in procuring loans of archaeological material from other parts of India, so as to enhance the scientific and educative value of the collection.

The Government of Bombay have lately started a Kannada Research Office in Dharwar, and a director and two research fellows were appointed in October last. A programme of research work to be done by the Office was laid down in consultation with the Director-General of Archaeology, who also loaned the services of a trained scholar for appointment as director of research.

Control Problems in Sukkur Canals

THE Central Irrigation and Hydrodynamic Research Station, Khadakvasla, Poona, has succeeded in devising means to control silting of the Sukkur Right Bank canals, which has for some time past been a source of considerable anxiety to the authorities in Sind. The scheme evolved provides for a curved approach channel 5,000 feet long from its nose to the Sukkur Barrage and 2,250 feet long from the nose to the off-take, with a raised sill at the entrance to the pocket. The scheme has been tried on models, and experiments have shown that with this approach channel bed silt can be controlled as desired. Further experiments to determine the best methods of working the approarh channel are in progress.

The Sukkur Barrage spans the River Indus about three miles downstream of the gorge between Rohri and Sukkur. In the middle of the gorge there is an island. Four canals take off from the left bank and three from the right. Upstream of the gorge the river is unstable and swings within a width of 15 miles but is fairly stable between the gorge and the Barrage. In this length the river is slightly curved in plan, the left bank being concave and the right bank convex. It is known that where a canal takes off from the convex side of a bend, the canal draws bed water and a relatively high charge of silt. The right bank canals at Sukkur being on the convex bank of the river have thus unfavourable conditions for silt exclusion. As was foreseen, a silt bank was formed along the right bank. In the floods of 1936 the sand bank reached an immense size and silting occurred in the North West Canal.

The proportion of the discharge of the river which passes through the right and left branches of the gorge upstream of the Barrage varies from year to year according as the main stream shifts to one bank or the other. In 1938, the main stream shifted to the left bank of the river and the right gorge then drew only 20 per cent of the total discharge. Based on this observation, experiments were carried out on the model and it was found that the less the proportion of discharge passing through the right gorge, the less was the quantity of silt moving along the right bank into the right bank canals.

This method was however considered unsatisfactory as it did not ensure full control of the discharge and curvature of flow. The new design of an approach channel was thereafter devised.

The National Physical Laboratory

IN spite of the disturbing effects of the war there has not been any great falling off in the amount of useful work done by the National Physical Laboratory during the year 1939, as would be evident from the annual report of the Laboratory for the year 1939. In addition to experimental work done for and the advice given to various industries for immediate purposes and for long-range projects for opening up new possibilities, the laboratory carried on its usual routine work of testing of instruments and maintenance of exact standards of measurements. Additional new problems raised by the war also had to be tackled. Important investigations on the physical properties of carbon steels, light aluminium and magnesium alloys, ship propellers, new aircraft, the reduction of sound transmission in buildings, electrical insulating materials and the propagation of ultra-short radio waves were carried out during the year. Members of the staff gave lectures on the work of the laboratory at various centres as in other years, largely participated in the work of different technical committees and attended international conferences on scientific and technical questions abroad.

Annual Report of the Royal Observatory, Greenwich

THE Astronomer Royal's report of the work of the Royal Observatory, Greenwich for the year ending May 1, 1940 was presented to the Board of Visitors. On June 1, the war affected numerous activities of the observatory. The 28-inch refractor and the 26-inch refractor were dismounted for safety and work on both ceased from September 1939. Spectrographic work with the Yapp reflector (36-inch) however was continued. The expedition planned by the Observatory to observe the total solar eclipse in South Africa on October 1, 1940 had to be abandoned because of the war, but the Royal Observatory is going to send some equipments together with spectrographic instruments from the Solar Physics Observatory, Cambridge, for use by the combined expedition arranged by the Royal Observatory of Cape of Good Hope and the Union Observatory, Johannesburg.

The solar activity throughout the year was studied which seems to establish conclusively the downward trend of the 11-year cycle after the very high maximum observed in 1937-38. The relationship between bright chromospheric eruptions and magnetic storms has been studied at Greenwich during the past year. Magnetic and meteorological observations of a routine nature were continued as in previous years. During the year 30 magnetic storms were recorded of which 7 were 'great' and that on March 24 ranks among the greatest storms of the past century. As in last year's report, in this year's report the Astronomer Royal made reference to the deterioration of the conditions for astronomical observations at Greenwich and for the urgent necessity for removal to a site where conditions would be more favourable. The increasing magnetic disturbance at Abinger where the magnetic observations are recorded, due to development of electric traction, requires the removal of the observing station from the present site if any high precision is to be obtained. A number of possibilities have already been examined but the plants for removal have necessarily to be deferred till the conclusion of the war.

Following Civilisation by "Myths" and Metals

ACCUMULATED facts on the basis of excavations primarily have provided grounds for classifying ancient tales as real history. The claim of folklores to be regarded as basis of historical facts becomes all the more strong when these records of the past are uncontaminated by foreign influence. The Biblical myth of Deluge has now been interpreted as a result of excavations in Mesopotamia where remains of that historic event have been discovered. Folklores are now supplying much information about the ancestry and the prehistory of people who lived at a very distant date. Two collections of folklores known as *Elder Edda* and *Younger Edda* (since translated in English) constituted one side of the picture of the people living in that part of Europe. The other side has now been furnished by scientific investigations. In an article in a recent issue of the *Technology Review*, the history of north-western Europe as preserved in these time-old ballads has been correlated with recent archaeological and ethnological investigations. The ancient Teutonic races who lived in the north-western part of Europe had migrated towards east about 1000 A.D. and a large number of them from Scandinavia settled in Iceland. The above verses were collected in that island and are today taken to narrate the history of north-west Europe during the period between the years 2000 and 400 B.C. In these remote ages climate and physical environment helped to a large extent the birth and growth of civilisation at a particular place and in its later stages it is found that use of more and more metals marked the future developments.

In northwestern Europe about 2000 B.C. the climate was mild and dry and the levels of lakes gradually dropped exposing surfaces for human habitation. The people living around gathered together, built villages and cultivated lands. At this period bronze was the material for tools, utensils and weapons. Iron was a curiosity, and contaminated with nickel it was procured exclusively from meteorites. Bronze being a man-made alloy of copper and tin, searches had to be made over long areas for these two metals which were evidently obtained in alluvial forms. This stimulated long-distance trade contracts. In France alone from the sites of Bronze Age culture 48,000 bronze ares have been found. After a few hundred years the easy and simple life of the people received a rude shock when a terrible winter had set in at about 750 B.C. This date has been determined by studies of bog growth in Switzerland and Ireland and of growth of tree rings. The climatic wrath disintegrated the peaceful society of north-west Europe. During this wet cold period the sea shore of western Europe gradually settled down submerging many of the great Bronze Age megalithic monuments. Some of these have been reported to be visible at a very low tide. The oak and beech forests were replaced by spruce and the bogs deepened. People fled to the central and eastern European forests. Both these happenings of the birth of villages on the shores of the lakes and of the "Fimbul-winter" which destroyed the village life, are very vividly described in verse in the *Elder Edda*. The refugees from the north to the lower parts of Europe could not unfortunately stand against the iron-weaponed people living there. The first phase of the history of these people thus came to a close.

Bronze was now to be replaced by iron. The iron ores were first smelted by the Hittites living in Asia Minor. These people were known only in the Bible even as late as 50 years ago. Baked clay tablets discovered at their capital city near about the present Anatolia led to a series of excavations and investigations which have revealed the history of these people. This discovery of the use of iron by them was probably due to two causes. The first was the easily visible deposits of iron as exposed by erosion of rivers and the thickly wooded forests which made the production of charcoal a simple matter. Added to this was the strength of the Hittites with their big stone hammers, who were quite fit for manipulating the massive iron deposits into the furnaces. Gradually when trade flourished, iron found its way to distant places and Tutankhamen's Tomb dated 1350 B.C. revealed many important iron objects. About 1200 B.C. the Phrygians drove the Hittites from their homeland and the art of smelting iron spread to the neighbouring countries where the Hittites took shelter. At about 900 B.C. Iron Age in Europe was ushered in by those settling in the central Danubian basin, containing large deposits of iron ore. The Hallstatt period of Iron Age owes its name to a place in Austria where hordes of iron objects were dug out in 1846 A.D.

Researches on Indian Forests

THE work of the Imperial Forest Research Institute, Dehra Dun, done during the year 1938-39 has been outlined in the report entitled *Forest*

Research in India and Burma, 1938-39, Part I. In the report the activities in the different branches, *viz.*, silviculture, botany, entomology, utilisation, chemistry, timber development, have been dealt with. Many important investigations in each of the branches received due attention as far as funds and time permitted. These are natural regeneration, investigation on seeds, investigation on trees and crops of timber plants, artificial regeneration, nursery work, reclamation and afforestation under the silviculture branch; progressive studies in systematic botany, and mycology were continued under botanical branch of investigation, and studies of insects attacking some useful timber trees under the entomological branch. In the utilisation branch the subjects of study included wood technology, timber testing, wood seasoning, commercial installation, air seasoning, shuttle-making trials, wood for battery separators, wood for cricket bats, wood for pencil and wood preservation, and paper pulp investigation proceeded under paper pulp section and researches on plants having insecticidal properties and on plants yielding oils and fats were carried out in the branch of chemistry. There has been quite a large number of publications during the year by the research workers in each of the different sections. Some of these publications are of considerable value in the maintenance of the vast forest areas and in the utilisation of a large number of forest products of the country. From these various subjects of investigation it will be clear that there exists an unlimited scope of prolonged research works in many directions, the results of which will lead towards economic utilisation of India's timber and other forest products. It is gratifying that in addition to lecture work the staff at the Forest Research Institute have done valuable work both on pure and applied aspects of various investigations throughout the year.

It is quite natural that the growing interest of the Indian public in the industrial development of their country urge them to call upon the scientific experts and research workers in the various Government departments for their advice. There is no doubt that the impetus to the indigenous industry as given by the constitutional changes and in the wake of the industrial and scientific advancement in the world at large has been reflected in an increasing number of enquiries. It is stated in the general review that "questions connected with the manufacture of paper and plywood were probably the most numerous, but smaller industries such as the making of pencils, umbrella handles and cigarette holders, as well as enquiries regarding suitable woods for semi-industrial purposes, such as the use of bamboos as reinforcement in concrete structures and the chemical values of a large range of minor forest products, to mention only a few of the subjects upon which information was sought, kept the staff extremely busy during the year." It is all for the good of the country. The more the work of the department is utilised for the benefit of the country, the more it is encouraging for the workers themselves. It is curious however that some of the established scientific departments of great importance to the State received rather a setback instead of impetus for expanding their activities on proper lines along with the world progress. Undue pressure over the experts and research workers tells upon the health and energy of conscientious workers and it thus gradually leads to inefficiency. This has been hinted by the President, Forest Research Institute and College, Dehra Dun, in the general review. He rightly remarks, "Almost all provinces now employ an officer engaged solely on the investigation of silvicultural problems. The co-ordination of their work, as exemplified in working plans, and advising on complex statistical requirements to ensure significant results from the large volume of research work initiated by these specialists, taxed the staff of the Silvicultural Branch at the Institute to a degree which showed more clearly than ever that to continue with a staff no larger than that provided in 1924 was impossible without accumulating ever increasing arrears of work. That the heavy pressure of work was not confined only to the officers concerned with special lines of research, but extended throughout the whole Institute from the President down to the most junior subordinates, is a fact confirmed *inter alia* in a report submitted by Dr S. S. Bhatnagar to the Government of India."

It appears however that some of the work, such as cultivation of medicinal plants, nursery work (other than those which can be done under the climatic and edaphic conditions of Dehra Dun), taxonomical work on plants and insects and similar other investigations may, to a considerable extent, advantageously be distributed to such other Government institutions as the Royal Botanic Garden, Calcutta, Botanical Survey of India, Chinchona Cultivation in Bengal, Zoological Survey of India, and similar other institutions. By such a step the work on the applied aspect of investigation may better be concentrated at the headquarters. The work of some sections of investigations may also be carried on more efficiently, at least up to a certain stage, at the various provincial forest stations all over India with slight reorganisation and provision of a small nursery and laboratory attached to the forest office. Silvicultural, botanical (ecological) and chemical investigations, if done on the spot, will be more accurate. These results may conveniently be co-ordinated at the centre and some congestion of work might thus be profitably removed. A little expansion and organisation in certain directions and to a certain extent team work in co-operation with some of the professors of the universities are likely to pove fruitful in tackling many a problem in both the pure and the applied aspects of investigations relating to the betterment of India's enormous forest wealth.

Announcements

THE New York Academy of Sciences announces three prizes offered by Mr A. Cressy Morrison to be known after his name, all of which will be awarded in December 1940. Prize I of 500 dollars will be awarded for the best paper on solar and stellar energy, the competition being open to all. Prizes II and III will be awarded for the best papers on a scientific subject included within the field of the New York Academy of Sciences and its affiliated societies and are limited to members of the above bodies but non-members may become eligible by joining one of these organizations before the closing date.

DR S. K. Kulkarni Jatkar, D.Sc., F.I.I.Sc., F.I.C., F. Inst. P., was awarded the decree of doctor of science in chemistry of Bombay University at the recent convocation, for his thesis on Specific Heats of Organic Vapours from Supersonic Velocity. He is the second person to obtain the D.Sc. in chemistry from Bombay University, the first being Dr A. N. Yajnik of Lahore.

ANALYSIS OF SCIENTIFIC WORKERS IN THE U. S. A.

THERE were on November 1, 1939 a total of 41,912 civilian scientists in the employ of the Federal Government, each receiving an annual salary of at least $2,000, of whom 40,200 were males and 1,712 were females. There were, in addition, 17,615 representatives of other professions, such as accountants, architects, lawyers and librarians.

Of the scientists, the engineers were the most numerous, with a total of 17,702. The next largest group was the economists, with 6,300 males and 300 females. The physicians and dentists stand high with 2,650, of whom only 50 are women, followed closely in numbers by 2,000 veterinarians. If the word *scientist* has been interpreted rather more liberally in the foregoing than is customary, we may note that there were on the list 3,200 agriculturalists and botanists, 1,230 physical scientists and geologists, 1,335 chemists and metallurgists, 780 statisticians and mathematicians, 640 zoologists and naturalists and 1,015 entomologists and husbandmen. One of the interesting groups is the 445 reporters and editors, or one for every 94 scientists, even with the liberal interpretation of the term used above.

F. R. M.

SCIENCE IN INDUSTRY

Stainless Steel Improved by Silver

STAINLESS steels show a tendency to pitting forming microscopic holes which deepen when subjected to corrosive action, especially due to bjrine. A remedy has been found recently after three and half years of research at the Massachusetts Institute of Technology. A small quantity like 0·25% of silver, when added in the alloy as nickel-silver, increases resistance to pitting, improves machinability, lessens hardening under drawing and spinning processes, increases thermal conductivity by some 25%, and gives better surface polish. Great care is required in producing the alloy, but once formed, it is quite stable and may be remelted and poured, without any material change. Castings, sheets, and rods are easily produced. This improved variety will be much used in the marine and refrigerating fields where saline solutions are encountered.

N. K. S. G.

Boiler Scales Removed Chemically

HEAT efficiency of boilers and other steam-generating equipments falls to a very low value due to the formation of scales inside them. Much of the tube failures and boiler explosions are also due to the same cause. Consequently the prevention of the formation of scale and its removal are major problems in power plants. Formation of scale is prevented by softening the feed-water by chemical means. But until now all the methods for the removal of scales formed were mechanical. There are however certain inherent disadvantages in the mechanical cleaning methods. The boiler parts are to be completely dismantled, even then all points inside a boiler are not accessible, and in addition, fresh scale deposition is hastened on metal surfaces not thoroughly cleaned.

A chemical solvent is expected to do away with these disadvantages and recently the methods of application of suitable solvents have been perfected. For the proper selection of the solvent the scale is first analysed by X-ray powder diffraction method to reveal the nature of its components. Only a few milligrammes of scale sample are required for this analysis. The usual base for the majority of the industrial solvents for scale removal is an inhibited hydrochloric acid. To this base auxilliary chemicals, such as special inhibitors, catalysts, wetting agents, intensifiers, and reaction control agents, are added to facilitate results and to protect the exposed metal surfaces. Different scales require different inhibitors and auxiliary agents. Types of metals and treatment conditions also influence the selection of auxiliary chemicals.

Some scales are encountered which require special chlorinated solvents for complete removal, whereas others require organic solvents. While the same solvent is not effective on all types of scales, certain scales have been found for which no satisfactory solvent has been found yet. But if these insoluble constituents are present in small amounts, then the binder can be dissolved away and the loose disintegrated scales can be washed away with water afterwards.

After a careful examination of the sample of scale to be removed, the metals to be encountered, and the design of the unit to be cleaned, the solvents best suited for this particular treatment is determined along with the temperature, time, and method of circulation.

N. K. S. G.

Fire-Retardant Paint

Extensive researches are being carried out at the United States Forest Products Laboratories to prepare paints which will protect wood against fire. Up to date linseed oil paints containing finely ground borax have been found to be most satisfactory. Paints containing white lead as pigment have given the best results, but those using titanium, or zinc sulphide pigments are also effective. Typical formulas for fire-retardant paints are :

	PER CENT BY WEIGHT					
Pigment	Basic Carbonate (white lead) ...	41·0	Titanium-Calcium	30·0	Lithophone ...	24·0
Borax ...	32·0		35·0			39·5
Raw linseed oil ...	22·8		30·8			32·3
Turpentine ...	3·6		3·6			3·6
Japan drier ...	0·6		0·6			0·6

To secure maximum fire protection, at least one gallon per 125 sq. ft. (3 or 4 thick coats) are required. Although they will not protect wood effectively against continuous exposure to high temperature yet they are effective against spread of small fires. Moreover they are not satisfactory for exterior use because rain leaches out the soluble borax and the degree of fire retardance decreases with exposure. The paint gives a yellow tint but this tendency can probably be reduced by modifying the vehicle.

Such paints are yet in the developmental stage and much additional information will be needed to perfect them. Their use has been recommended only where resistance to fire is of greater importance than other properties.

N. K. S. G.

A New Type of Copper

AFTER ten years of strenuous research and expenditure of an enormous sum of money Phelps Dodge Copper Products Corp. of N. Y., U. S. A., has developed a new type of copper, which has been trademarked as PDCP, and is said to have greater conducting power, ductility, fatigue resistance, and surface qualities than ordinary copper.

One of the principal difficulties of the engineers and maintenance-men concerned with copper windings in motors and transformers is the existence of surface impurities in the copper, which are generally produced in the casting processes and by vibrations, due to which magnetic stress penetrates the insulation and causes failure by short circuits. Moreover silvers and oxides are more or less inherent in the hot-rolling processes. The new method has not only eliminated the casting process but also has improved the hot rolling process so that oxides and silvers are completely absent.

In the new method electrolytic cathode copper is plastically converted by tremendous pressures at a high temperature and in a reducing atmosphere into smooth dense, copper bars, rods, strips or other commercial products. Thus electrolytic copper, basically of the oxygen-free type, being not melted in the subsequent treatments, not only retains its original purity but further enhances it at the higher temperature and reducing atmosphere.

It has given outstanding performance in high-frequency and high voltage transformer windings, in high tension and submarine cables, in refrigeration and air-conditioning installations. It is particularly applicable for services where severe vibrations are encountered. Ductility being greater than ordinary copper, with this new type sharper bends, easier forming and drawing are possible. The metal is said to approach the malleability of gold.

N. K. S. G.

New Treatment for Boiler Feed Water

DUE to high pressures and severe conditions met in modern power plants the problem of feed water treatment has become more complicated. Mere water-softening does not suffice, but the water should also be conditioned with respect to its alkalinity and dissolved oxygen etc. Many of the important water-treating chemicals are sulphur compounds. The principal coagulants, for instance, are all sulphates, as alum, copperas, and ferric sulphate. Sodium sulphite as is used for subsequent chemical de-aeration and sulphates are being used for many years to establish the proportional concentrations between sodium sulphate and alkalinity for the prevention of the caustic embrittlement. In order to prevent the zeolite minerals or to control the formation of deposits in the feed water systems, pH value of the water is to be lowered, for which either sulphuric acid or an acid sulphate is frequently used.

Mr. S. T. Powell has presented a novel idea (Sulphur Burners Applied to Feed Water Treatment, *Power Plant Engineering*, May, 1940, p. 54) of treating the feed water directly with sulphur dioxide. Despite its apparent complications, the method may prove feasible in certain types of large plants. Mr Powell is applying this new method at the Hoskins' Mound Mine of the Freeport Sulphur Co., U. S. A. Sulphur burners for the purpose are of a somewhat special design and sulphur dioxide is introduced into the pre-softened feed water along with some catalyst to hasten oxidation. Normally 0·01 to 0·025 parts per million of copper as copper sulphate has been found sufficient as a good catalyst. Mixed with air sulphur dioxide reacts with iron to form either of the iron sulphate coagulants desired. Ferrous sulphate solutions are also oxidised to ferric sulphate with sulphur dioxide and air. In dilute solutions sulphur dioxide can replace sulphuric acid or acid sulphates for neutralising alkalinity and it also forms the alkaline sulphites useful for de-aeration.

According to the author there is substantial saving in the cost of the water-treating chemicals. An additional advantage of using sulphur dioxide instead of sodium sulphate and sodium sulphite is that there is practically no increase in the amount of dissolved solids in the water. This is particularly important in the operation of the high pressure boilers. When sulphur dioxide is used, there is practically no increase in the dissolved solids since each molecule of

sulphur dioxide liberates a molecule of carbon dioxide. On the other hand the use of sodium sulphate in the particular case added 650 lbs. of dissolved solids to each million gallon of water.

N. K. S. G.

Increasing the Uses of Lac

THE Annual Report for the year 1939-40 of the Indian Lac Research Institute has been just published. The chemical section of the Institute has made substantial progress in the different programmes of research. Besides the fundamental researches into the chemical and physical properties of lac and shellac, research results from commercial viewpoint show promising grounds for an indigenous plastic industry. The modification of shellac and shellac components by formaldehyde and urea has given rise to a resin which is a suitable material for moulding powders. The only defect is that the resin is not strictly thermo-hardening. It has also been found that melamine, obtained from calcium cyanamide, when mixed in place of urea and boiled produces a solution which on evaporation in vacuum yields a spongy mass to be broken into powder. The earlier defects of the moulding powder have now been removed and further work is expected to do away with brittleness. As the chemicals, formaldehyde and urea are imported from foreign countries, investigations are continuing with a view to develop moulding powders independent of foreign chemicals. The Institute has also designed two small-scale plants for the production of urea and formalin, which may be set up as adjuncts to a moulding powder factory. Casein, a milk product, which is also obtainable from vegetables like *karanja* oil cake has been combined with shellac, which resulting products are found to serve a large number of purposes for which plastic materials like bakelite are now used. Further, to prepare sheets and slabs for insulation and constructional purposes, dry coal tar has been compounded with shellac, and this reducing the quantities of formaldehyde and urea in the composition is expected to lower the cost of making. Ordinarily black colour is produced in this reaction. Suitable composition with fillers like wood flour, kaolin, paper pulp and jute fibres and chemicals like urea, tartaric acid etc., have been prepared for injection moulding and further improvements are under study, with a view towards gloss, heat-and water-resistance and the necessary fluidity for handling. Shellac injection moulding, as distinct from compression moulding, promises a great future in the production of electro-technical goods. Already the Institute has been able to produce by this method electrical switches which can be sold much more cheaply than those made by compression moulding due to the higher rate of production and the simplicity in the manufacture of the powder. Two other uses are likely to be made of the lac, one as a varnish and the other as recording discs. For the latter purpose it is proposed to coat aluminium discs or cheaper still, paste boards with shellac containing a small proportion of urea. Lacquers are also being prepared by compounding with nitrocellulose in spirit with a small proportion of ester.

In the field of entomological research the most important development during the year has been the initiation of a large-scale field experiment to test the practicability of biological control, *i.e.*, controlling of enemies of lac by their own insect enemies. Such control has in previous years been shown to be practicable under laboratory conditions.

The field experiment is at present only in its infancy, but results so far obtained show considerable promise. The Institute plantation has been fully utilised during the year and results obtained as regards the mortality and fertility of various strains of the lac insect have been recorded. Work has also been concentrated on two egg parasites of the major lac predators. These insects are being bred in the laboratory and indications, so far are that they are of great potential importance, in the control of these enemies of lac.

Vegetable Oils as Lubricants

A RECENT Bulletin of the industrial Research Bureau No. 18 indicates the amount of work that has been done to devise vegetable oil blends suitable for use as lubricants in internal combustion engines. The present issue covers the first part of the investigations and further work along these lines and the results of engine trials using stabilized vegetable oils will form the subject matter of separate papers. The important requirement of lubricants include chemical stability under working conditions, a high degree of 'oiliness' and a low co-efficient of static friction. Castor oil has been found to possess these qualities. Various patents have also been taken out in foreign countries dealing with processes for rendering castor oil soluble in mineral oil. The mixture has increased viscosity and lubricating power. During use however the high temperature causes oxidation of the lubricating oils which later deteriorates the quality and produces gum, carbon, sludge and acidic compounds. Mineral oils are made somewhat resistant to these destructive processes by refining, which removes asphaltic and unsaturated components, and then by adding certain anti-oxidants. But investigations with vegetable oils, which have been carried out so far, have not used refined oils. The present work has therefore started with refined oils and is devoted to remedy the defects not likely to be vitiated by some of the undesirable components of the oil. Work has been done on three Indian varieties of oils *viz.*, castor, groundnut and cottonseed oil. In course of work on the methods of stabilization against oxidation of oils the present refining processes have been followed. In the laboratory tests, change in viscosity, acid value and Conradson carbon residue were determined before and after oxidation according to British Air Ministry technique with modifications for acceleration of the processes. It appears that the extent of the unsaturation of a given oil and its acidic constituents determine whether or not it may be effectively stabilized. The exact machanism of the stabilizing action is still obscure, although phenolic and amino groups coupled with more than one benzene nucleus have been found to exert a stronger stabilizing action than compounds characterised by other groups.

Fibre Resources of Bombay

A PRELIMINARY survey of the fibre resources of Bombay province has been carried out by Mr J. K. Sircar, Fibre Expert of the Department of Industries, in pursuance of the scheme for the development of the fibre industry. The survey in the important fibre plant-growing districts of Ratnagiri, Belgaum, Ahmednagar, Thana, Poona and Nasik showed that existing plants useful for commercial and industrial utilisation are Sann hemp, Deccan hemp or "Ambadi", aloe fibre or sisal plant, linseed crops and "Kittul" fibre.

Sann hemp or "tag" is the most important fibre crop in the Province. During the war of 1914-18, when the flax and hemp supply from Russia was stopped, Britain imported Sann hemp from India in considerable quantities to use with the European soft hemp in the production of twines, ropes, canvas and other articles. This assisted considerably the export trade in Indian Sann hemp, specially the famous "Dewguddy" or "Devgad" type, which is produced in this province. The manufacture of fabrics, other than canvas, from hemp of Ratnagiri quality, which is generally more costly than jute, would not however prove profitable. If additional experimental chemical treatment and spinning tests prove successful, it would be possible to introduce a factory-scale industry to produce finer twines and canvas. The quantity of hemp manufactures imported for 1936-37 into Bombay was valued at Rs. 3,30,710 for pack-thread, cheap bazar twine, fishing twine, etc. The manufacture of these twines can be carried out in cottages with proper organisation. As people have no knowledge of the industry, the Bombay Government have recently sanctioned a peripatetic demonstration party to train villagers in twine-making.

Ambadi hemp is another major fibre crop of the province, but there is practically no trade in this fibre. Experiments with the existing quality of fibre have shown that, if it can be grown and retted properly, it could be utilised for the manufacture of gunny-bagging, set-sacking for carrying raw-cotton, carpets and unsized twine.

Regarding sisal hemp, experimental work has shown that commercial and profitable utilisation of existing Agave leaves on improved lines would play an important part in the rural economy of the countryside. This can be done by training the villagers in improved methods of extraction of fibre and the manufacture of commercial commodities. Further an investigation into the collection and marketing of "Kittul" fibre is expected to prove of benefit to villagers and helpful to brush manufacturers.

Marketing of Eggs in India

THE importance of poultry keeping in India and Burma is indicated by figures given in the latest of the Marketing Series, which takes the form of an abridged report on the marketing of eggs in India and Burma. The report states that India produces every year about 33,648,00,000 eggs and Burma about 1,636,00,000. The total value of the eggs sold in the course of the year amounts to Rs. 5,25,00,000. The value of the birds themselves is equal to approximately Rs. 7,50,00,000. In the course of marketing the loss due to 'staling' of eggs, breakages, etc., amounts, at some periods of the year, to as much as 25 per cent, and the total loss to industry from various causes is estimated by the report at over Rs. 57,00,000 a year. As an instance of wastage which occurs, the report states that losses in grading eggs due to the present haphazard methods of keeping poultry are estimated at Rs. 14,00,000 a year; breakages in the course of collection, transport and distribution are estimated at Rs. 15,00,000 a year, and staling in the course of marketing is estimated to cost Rs. 28,00,000 a year.

In order to eliminate this wastage the provision of better housing and nesting, improved containers, more rapid and systematic collection of eggs and the provision of insulated and refrigerated transport facilities and more cold stores at rail-head in the larger consuming centres are stressed in the report. Apart from eliminating over Rs. 50,00,000 worth of loss due to wastage, experience has shown that proper

"Agmark" grading and marking of eggs brings in enhanced returns to the extent of 15 to 20 per cent. As there are, at least, 150 centres already in existence where anything up to 50,000 eggs are assembled daily, the rapid expansion of organised grading and marking stations would easily and readily be done by local marketing staffs and co-operative departments with much profit to poultry keepers.

India's Industrial Waste: Fusel Oil

S. DUTT

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FUSEL oil is a product of the fermentation of saccharine materials by yeast during manufacture of wines and spirits. It is formed in minute quantities and is the substance mainly responsible for the characteristic smell and taste of spirituous liquors. Most of the wines and spirits that are in the market nowadays contain from 2 to about 800 parts of fusel oil per 100,000 parts of the material, and some of the illicit drinks prepared in country stills may contain much more than this proportion. Fusel oil is a recognised poison to the human system, and most of the ill ecects of drinking alcoholic liquors have been attributed to the insidious poisoning by fusel oil contained in them. Hence many of the manufacturers of wines and of spirits, particularly the latter, try to remove much of the fusel oil from their products by fractional distillation or by chemical means, and the maturing of wines and spirits by aging in wooden casks or barrels is really intended to remove as much of the fusel oil as possible by a process of absorption. The following table will give an idea of the proportion of fusel oil present in various wines and spirits:

TABLE I. FUSEL OIL IN WINES AND SPIRITS.

Name of the wine or spirit	*Parts of fusel oil in 100,000 parts of the spirit or wine.*
1. Beer	1·7— 3
2. Sherry	3 — 5
3. Madeira	5 — 7
4. Port	8 — 10
5. Cider	3 — 5
6. Claret	3 — 5
7. White wine	2 — 4
8. Red wine	4 — 6
9. Gin	35 — 40
10. Jamaica rum	95 — 108
11. Dewar whisky (5 years)	189 — 224
12. House of Lords whisky (10 years)	217 — 265
13. Henessey brandy (2 years) ...	253
14. Martel brandy (10 years) ...	354
15. Bourbone whisky (new)	668
16. Country spirits (35 U.P.) Pot Still ...	923 —1254

The removal of fusel oil from spirits by fractional distillation is known as rectification, and the pure spirit thus obtained is known as "rectified spirit". But even the most highly rectified spirit contains 2-3 parts of fusel oil in 100,000 parts of the spirit, for all ordinary purposes, however, this is a negligible quantity. The rectification of wines or fermented liquors for the production of rectified spirit is carried out in a large distillation apparatus patented by Coffey in 1831, and which is on that account known as "Patent Still". In that apparatus which is divided into two parts known respectively as the 'analyser' and the 'rectifier', almost complete separation of the alcohol from the water and the fusel oil takes place, and the fusel oil being insoluble in water, now begins to float on the surface of the wash water as an oily layer with a strong characteristic odour. It can therefore be easily separated from the water and collected. But in India although there are quite a number of factories manufacturing rectified spirit from fermented molasses, yet in the vast majority of them, the fusel oil is never separated or collected. It is allowed to go to the drain with the waste water, and therefore a valuable industrial material is lost. India is a country of colossal wastes, and the loss of fusel oil in the alcohol factories in India is an example of these. For every 1000 gallons of rectified spirit produced, 3-5 gallons of fusel oil are also produced simultaneously, and if this is recovered and utilised as indicated furtheron, it may constitute an important source of national wealth. The present author has already indicated in a separate article * that India now produces in her sugar factories, over 200,000 tons of molasses, which when fermented and converted into rectified spirit can yield enough fuel to meet most of the motoring needs of India. Simultaneously there will also be produced

* "Rectified spirit as motor fuel" in SCIENCE AND CULTURE, *5*, 698, 1940.

nearly 50000 gallons (*i.e.*, approximately 230 tons) of fusel oil which can easily satisfy all the present technical and industrial demands for this material. On account of the large number of uses that have already been found for fusel oil and its derivatives, it is high time that the large-scale recovery and utilisation of fusel oil be started in India now, so as not only to partially prevent the flow of national wealth to foreign countries, but also to make use of a wealth that is literally going to the drains.

Fusel oil is a bright yellow oily liquid with a specific gravity of 0·83 to 0·85 and an intense and nauseating odour of old whisky or rum. It is insoluble in water, but easily soluble in 70 per cent alcohol. It dissolves waxes, resins and oils of various description, and on that account is ofen used in the preparation of furniture polishes, leather dressings, paints, varnishes and enamels, but its most important use consists in the preparation of butyl and amyl alcohols and their acetic esters, which are commonly used as industrial solvents.

The compositions of fusel oils differ very considerably from one another according to the source from which they are obtained and also according to the conditions of the fermentation. The following are recorded analyses in literature of fusel oils from: (i) beet, (ii) grapes, (iii) barley, (iv) potato and (v) maize:

TABLE II. ANALYSES OF FUSEL OILS.

(*Figures indicate percentage of various components*).

Components	Beet	Grapes	Barley	Potato	Maize
Ethyl alcohol Acetaldehyde	5·8	6·2	5·0	7·5	4·8
Acetal ...					
Water ...	8·2	9·5	6·5	12·5	6·0
Isopropyl alcohol ...	...	...	..	15·0	...
n-propyl alcohol ...	13·0	13·2	31 6	3·0	3·6
Isobutyl alcohol ...	12·4	6·5	5·0	24·3	15·7
n-butyl alcohol ...	6·2	7·5	5·2	3·5	7·5
Isoamyl alcohol ...	51·5	53·2	42·3	27·5	57·3
n-hexyl alcohol ...	0·3	0·3	0·8	...	1·2
n-hyptyl alcohol ...	trace	trace	trace	trace	trace
Free fatty acids ...	0·1	0·1	0·16	0·1	trace
Fatty acid esters ...	0·2	0·1	0·2	0·2	0·3
Furfurol and bases ...	trace	trace	trace	trace	trace
Terpenes	...	...	...	0·3	...

There has been no authentic record of the complete analysis of molasses fusel oil in literature, but the present author has carried out the following analyses of four samples of Indian molasses fusel oils collected from distilleries situated in different parts of India:

TABLE III. ANALYSES OF INDIAN MOLASSES FUSEL OILS.

(*Figures indicate percentages of various components*)

Components	From Rosa Distillery, Shahjehanpur (U.P.)	From Cawnpore Distillery (U.P.)	From Muree Brewery Co. Rawalpindi (Punjab)	From Mandya Distillery (Mysore)
Ethyl alcohol ...	1·2	5·57	0·55	trace
Butyric aldehyde ...	...	...	6·2	...
Isopropyl alcohol ...	17·6	2·2	2·1	18·4
n-Propyl alcohol ...	3·2	0·23	0·08	0·49
Water	5·7	5·1	6·0	5·1
Acetal	1·6	0·12	0·04	0·16
Isobutyl alcohol ...	1·8	0·22	0·02	0·16
Ethyl isobutyrate ...	0·7	0·16	0·04	0·18
n-Butyl alcohol ...	5·0	0·37	0·06	0·34
Isoamyl alcohol ...	60·9	85·2	72·9	66·2
n-Amyl alcohol ...	...	0·1	0·08	0·71
Ethyl valerianate ...	trace	0·03	0·02	0·02
n-Hexyl alcohol ...	0·2	0·04	0·08	0·07
n-Heptyl alcohol ...	0·2	0·52	0·03	0·32
n-Octyl alcohol ...	0·7	0·52	0·05	0·51
n-Nonyl alcohol ...	...	0·02	0·24	0·06
Higher esters ...	trace	3·2	2·1	2·3

From the above figures of analyses, it can be easily seen that there are two important constituents in Indian Patent Still molasses fusel oils which are present in large quantities, namely isopropyl alcohol and isoamyl alcohol. Both these substances can be easily recovered from molasses fusel oils by a process of fractional distillation. The following are the chief chemical and physical properties of these useful substances:

Isopropyl Alcohol—It is a colourless highly inflammable liquid with an agreeable spirituous smell and a specific gravity of 0·789 at 20°C. It is miscible with water in all proportions. It boils at 83°C, and has a high dissolving power for waxes and resins. It also dissolves to a fair extent the lower nitrates and acetates of cellulose. This together with its great volatility, makes it an excellent solvent for spray varnishes and enamels and also for shoe and furniture polishes, but unfortunately its comparative rarity and high price up till now have prevented its common use for these purposes. In case it is manufactured from molasses fusel oils in India, it can be easily made available for these purposes for which it is admirably suited. When oxidised, it is converted into acetone, which is another very important industrial solvent, indispensable for celluloid and explosive manufactures.

Isoamyl Alcohol—It is a colourless oily liquid, insoluble in water and boiling at 129-31°C. It is inflammable and has a peculiar and characteristic

empyreumatic smell, which is somewhat in disfavour of this otherwise excellent organic solvent. It has a specific gravity of 0·81 at 20°C. It is an excellent solvent for a wide variety of gums and resins and also waxes of various descriptions, and is on that account used in the manufacture of paints, varnishes, polishes and enamels. But the introduction of its acetic ester as an industrial solvent, has put amyl alcohol in the background on account of the fact that amyl acetate has a much more powerful solvent action than amyl alcohol. Besides that, amyl acetate dissolves many important synthetic plastics like pyroxylin, celluloid, xylonite and acetyl cellulose, on which amyl alcohol has hardly any action. As an additional advantage, amyl acetate has a pleasant banana-like smell as contrasted with the nauseating empyreumatic smell of amyl alcohol. On account of these interesting properties, amyl acetate is now a very important industrial solvent, and so a description of its method of preparation and properties would be quite appropriate before the conclusion of this article.

Amyl Acetate—On an industrial scale this compound, which is technically speaking the acetic ester of amyl alcohol, is manufactured by heating a mixture of amyl alcohol and glacial acetic acid with concentrated sulphuric acid or anhydrous calcium chloride. In actual practice, 20 kilos of amyl alcohol, 50 kilos of glacial acetic acid and 10 kilos of concentrated sulphuric acid or 18 kilos of anhydrous calcium chloride are heated together under a reflux condenser for 6 or 8 hours. With sulphuric acid the yield of amyl acetate is 20 kilos, and with calcium chloride, 25 kilos. The ester is washed with water, dried and purified by fractional distillation. On account of the greater cost of calcium chloride, sulphuric acid is generally used as the condensing agent, in spite of the diminished yield of the ester. The pre-war price of amyl acetate in India at ports was about Rs. 2/8/- per pound, but now the price has gone up considerably and it is only available with difficulty.

Amyl acetate is a colourless oily liquid, insoluble in water, with a very pleasant fruity smell resembling banana. It boils at 137-38°C and has a specific gravity of 0·872 at 25°C. In small quantities it is used in syrups, *sherbets*, aerated drinks, toffees, lozenges, jellies etc., as a banana essence. But its most important use nowadays is in the manufacture of nitro-cellulose paints and varnishes of the type of Duco, Dope, Nitro-valspar etc. It has a high dissolving power for celluloid and is extensively used in that industry and also in the preparation of celluloid varnishes like Glazo, Plastico, Cutex etc. It is also used in the manufacture of a special kind of artificial silk or rayon known as Celanese, and is also employed to an increasing extent in the explosive industry as a partial substitute for acetone in the manufacture of cordite. Amyl acetate is one of the most important industrial solvents of the present day, and any country possessing the necessary raw materials for its manufacture is likely to be at an advantage in the commercial world.

Fortunately India is in a very good position for the manufacture of amyl acetate. If all her molasses resources are converted into alcohol, there will be available in this country nearly 50000 gallons of fusel oil, from which about 6000 gallons of amyl acetate, valued at Rs. 16 lakhs can be easily prepared, which will not only satisfy the present need of India for this important material, but will also leave a substantial surplus for export. In the present stage of industrial development of India, she can hardly afford to overlook this important source of national wealth.

It will be interesting to note in this connection that the present author, who first started the chemical examination and analysis of Indian molasses fusel oils, has recently discovered a very interesting reaction by which the amyl alcohol contained in the Indian fusel oils can be quantitatively converted into amyl acetate with the help of a catalyst which is recovered unchanged at the end of the reaction. When applied on an industrial scale, this reaction will revolutionise the method of manufacture of amyl acetate and make it very easily and cheaply available to Indian manufacturers who are in need of that substance. This reaction or process is being made the subject of a patent by Allahabad University.

MEDICINE & PUBLIC HEALTH

Central Advisory Board of Health

AT a recent meeting of the Central Advisory Board of Health, consisting of the representatives of the central and provincial governments and of the governments of certain Indian States, reports of two special committees appointed to investigate the possibility of introducing compulsory inoculation of pilgrims against cholera and to study the complex questions associated with the prevention of food adulteration in India were considered, besides the questions of providing free laboratory service for diagnosis of infectious diseases, upkeep of the health of school children and of the lack of enforcement of bye-laws from hygienic view-point by the local bodies in the matter of building houses. The Board recommended that provincial governments should select suitable centres in their areas and try out a scheme of indirect compulsory inoculation on lines successfully pursued by the Government of Bombay for the past four years in connection with the Pandharpur festival. The committee on food adulteration has so far considered only the technical aspect of the probelm, including food standards and technique of food analysis, and it is expected that its reports on the legislative and administrative aspects will be made available for the Board at its next meeting. The committee emphasised the fact that the improvement of methods of food analysis and the prevention of food adulteration in India will have to be a continuous process and that the establishment of co-ordination between the provinces is a matter second to none in urgency. With this object in view the Board recommended the appointment of a standing committee to be called "The Central Committee for Food Standards" which would be in a position to advise the central, provincial and State governments on all aspects of food adulteration. All-India standards for 17 articles of food, have already been recommended and the standards for other articles will be investigated by the proposed Central Committee for Food Standards. The Central Committee would issue "instructions" incorporating the latest available information regarding methods of analysis for the use of the public analysts. The standardisation of methods is as important as the unification of standards of food purity.

The provision of a free laboratory service to medical practitioners is essential for a successful campaign against typhoid and many other infectious diseases. The value of such provision was demonstrated in Bombay during an epidemic of typhoid fever in 1938 when the Government of Bombay placed the services of the Haffkine Institute at the disposal of the medical practitioners of the city. The Board recommended a scheme for starting a provincial laboratory service which outlined a system of small district laboratories supported by regional laboratories for groups of districts and by a central laboratory for the province, which would co-ordinate the activities of the regional and district laboratories.

Vitamin C and Gold Therapy in Arthritis

NOWADAYS gold preparations are extensively used in the treatment of tuberculosis and joint diseases. Troublesome complications often met with in course of the gold therapy are diminution in the number of red blood cells and redness of the skin associated with some eruptions. These complications are considered to be due to poisoning of the body with the metal. Secher (*Lancet, i,* 735, 1940) determined the ascorbic acid content of the blood of these patients and no blood ascorbic acid was obtained in these cases. He therefore administered vitamin C to some of his patients suffering from arthritis along with sanocrysin (a gold preparation) injections. All the complications subsided and blood ascorbic acid rose to the normal level. He therefore suggests that the reactions or complications often met with after injections of gold preparations are due to the liberation of toxins from the site of infection and not due to the metal itself. When vitamin C is administered in increased amounts, it combines with or neutralises the toxins liberated after gold therapy and thereby prevents the resulting complications. He advocates vitamin C therapy before and during treatment with gold preparations.

S. B.

Sulphathiazole in Bubonic Plague

SULPHATHIAZOLE, a heterocyclic derivative of sulphanilamide, has been found to be superior to sulphapyridine in the treatment of bubonic plague in the hands of Sokhey and Dikshit (*Lancet, i,* 1040, 1940). They have cured 80% of plague-infected mice by injecting within twenty four hours of infection, 10 mg. of sulphathiazole, twice a day, for ten days. If the treatment is commenced within forty-eight to seventy-two hours after infection, a higher dose of 4 mg. twice a day for ten days is necessary to cure 80—90% of infected mice.

S. B.

Vitamin P and Purpura Haemorrhagica

JERSLID (*Lancet, i,* 1445, 1938) successfully treated cases of Henoch's purpura with vitamin P. Scarborough and Stewart (*Lancet, ii,* 610, 1938) treated two cases of purpura haemorrhagica, developed after arsenic therapy, with the vitamin. Recently Gorrie (*Lancet, i,* 1005, 1940) cured a similar case of purpura haemorrhagica with vitamin P. There was no deficiency of vitamin C in this case.

S. B.

Radium and Radon

RUSS and Scott (*Lancet, i,* 1048, 1940) compared the biological reactions of radium and radon on the rabbit's ovary. Similar effects were produced in each case. Radon is more easily available than radium, and in the place of radium therefore radon may be used with advantage in the treatment of cancer, tumours, and of skin and other diseases which are now subjected to radium therapy.

S. B.

Decurvon

BRAHN (*Lancet, i,* 1078, 1940) has described a preparation of insulin, Decurvon, in which a highly purified pectin, consisting of an ester of galacturonic acid, has been added to insulin. The action of this preparation of insulin is much more prolonged than that of ordinary insulin. The injection of this preparation is absolutely painless. No reactions are met with as are often obtained with zinc-insulin preparations and unlike the latter it can be injected intravenously in cases of diabetic coma.

S. B.

Use of Hypertonic Solution of Sucrose in the Treatment of Hypertension

FOR the reduction of increased intracranial pressure 20 to 25 per cent., solution of sucrose is being frequently used nowadays. Bullock *et al* (*Amer. Jour. Physiol., 112,* 82, 1935), Masserman *et al* (*Bull. Johns Hopkins Hosp., 57,* 12, 1935) and Jackson *et al* (*Ann. Surg., 106,* 161, 1937) obtained beautiful results after the intravenous administration of hypertonic solution of sucrose. The sugar was excreted by the kidneys and there was profuse diuresis. No serious toxic effects were obtained. Helmholtz (*Jour. Pediat., 3,* 144, 1933), however, observed that hypertonic sucrose given intravenously to rabbits produced swelling and degenerative changes in the renal convoluted tubules. This observation of Helmholtz was confirmed by Lindberg *et al* (*Arch. Int. Med., 63,* 907, 1939) in dogs. Anderson *et al* (*Jour. Amer. Med. Assoc., 114,* 1983, 1940) observed similar pathological changes in the renal tubules in six patients after post-mortem examination. These patients received intravenous injections of hypertonic solutions of sucrose. Hypertonic sucrose therefore should not be used in cases of hypertension.

S. B.

Indian Ephedra Research Creates Demand

ACCORDING to investigations carried out in the Forest Research Institute, Dehra Dun, the active principle in the Indian ephedra is in no way inferior to the Chinese ephedra, which till lately constituted the chief source of supply of this drug. This drug is a potent remedy for asthma and hay fever. Indian ephedra is now being exported to the United Kingdom, but till 1938, export to the United States of America was almost negligible. In 1937, China exported ephedra to the extent of over two million lbs., of which the United States of America alone took 1,196,000 lbs. But in 1938, when supplies from China and Spain were reduced by wars in those countries, India exported to the United States of America 446,300 lbs. of the drug worth about Rs. 88,000/-. If Indian ephedra is to establish herself in the American market—for which this is the right time—there must be a regular supply of the drug of uniformly high quality. This can only be ensured if the right species of the plant are collected from suitable localities and at the proper season. Failure to attend to these essentials in the past stood in the way of India's getting a permanent foothold for her produce in the world markets.

Delhi Urban Housing Scheme

A DEVELOPMENT of considerable importance is in progress in regard to housing conditions in the old city of Delhi. The principle has been accepted by Government that assistance should be given to persons dispossessed by slum clearance schemes to enable them to obtain not only alternative accommodation but also accommodation of suitable standard from the hygienic point of view. The minimum rent for houses fit for human habitation was assessed by the Delhi Improvement Trust at Rs. 5/- per month and the lowest income which could afford to pay this rent at Rs. 30/- per month. It has been accepted that a family with an income less than this amount cannot pay for a house fit for human habitation and that it, therefore, needs assistance for rehousing. Three types of houses have been proposed, one-roomed, two-roomed, and three-roomed. Not more than three adults (counting two children as one adult) are to be permitted to live in a single roomed house and not more than five adults in two-roomed houses, while larger families would be permitted to live only in three-roomed houses. Standard plans have been prepared for these types of houses, the approximate cost of which will be Rs. 450/-, Rs. 600/- and Rs. 750/- according to class.

The experiment proposed in Delhi will make it possible for the poor class families to own their own houses on the hire purchase system. The average capacity for rent of the families to be dispossessed is estimated at Rs. 2-13-0 per month while a return of Rs. 5-3-6 per month is stated to be necessary to meet the total cost on a non-profit basis, including the charges for equated instalment payments over a period of 20 years. Any dispossessed family which can pay the rent of Rs. 3-8-0 per month will be admitted to the benefit of ownership through the hire purchase system, the difference between this amount and the minimum rent for covering the cost of the scheme as indicated above, being met by grants from the proceeds of a special entertainment tax imposed by the Government.

Carotinoids and their Biological Importance

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CAROTINOIDS is the name given to a group of yellow to orange and red pigments which are very widely distributed in nature. They occur in all forms of living organisms ranging from the lowest bacteria to the highest forms of plant life. In the animal kingdom they are also present from the lowest to the highest animals, from protozoa to man. The name carotinoid is derived from one of the pigments of this class "carotin", so-called because it was obtained from carrots (*Daucus carota*), which was the first pigment of this class to be isolated in crystalline form. Carotene has not only lent its name, but has proved to be the most important pigment of this group.

Carotene was first described by Wachenroder (1826), who called it carotin. Arnaud (1886) proved the hydrocarbon nature of the pigment and it was Willstätter and Mieg (1907) who definitely settled the composition as $C_{40}H_{56}$, described its properties, its unsaturated nature, and developed methods of isolation and purification.

Willstätter's work gave a lot of stimulus to the study of the carotinoid pigments. It was discovered that these pigments were most universally present. They were present in all sorts of locations and under all sorts of circumstances. For example, besides carrots they were present in a number of other roots, in the chloroplastids, in the tissues of chlorophyllaceous plants, in leaves, particularly in all green leaves, in etiolated leaves, in naturally yellow leaves, in yellow autumn leaves, in the autumn and winter reddening of plant tissues, in flowers, in fruits, in seeds and grains, in a large number of red and green algae, in fungi, in brown and red seaweeds, in bacteria, in diatoms, in moulds, and yeasts, in the corpus luteum of mammals, in the blood serum, in the milk fat, in adipose tissue, internal organs, skin, nerves, in egg yolk, in the retina of the eye, in feathers of birds and in tissues of fishes, amphibians,

reptiles, insects, crustaceans, echinoderms, molluscs, worms and sponges etc. These are just some of the tissues quoted by way of example from which these pigments were isolated and studied. This universal occurrence of carotinoids in both plant and animal tissues raised the question, "Have they any function to fulfil?". In plants they should have a function since the plants synthesize them and they are almost always associated with active metabolism. The understanding of the functions of the carotinoids in the plants, however, has not progressed beyond the domain of conjecture. Without considering the various hypotheses advanced, let me at once proceed to the most interesting question, whether the carotinoids have any function in the life-process of animals.

Palmer was the strongest exponent of the view that carotinoids in the animals have no function at all. They are simply there by accident since they are so abundantly present in the food and they are there until the organism is able to excrete them or dispose of them in a suitable manner. On the other hand, some investigators were not inclined to the view put forward so strongly by Palmer. They considered that occurrence of carotinoids in tissues, of vital importance to the organism and in concentrations which bore no comparison to the rest of the body, offered a strong presumption that they were required there for some specific purpose. Take for example, the corpus luteum, or the yolk of an egg. Drummond, and Coward in a number of earlier papers dealing with vitamin A pointed out this phenomenon. The occurrence of carotene in a greater concentration in closterum than later milk might mean that it was required for the new-born calf.

The controversy between Palmer and Steenbock is too well known to be recounted in any detail. Steenbock (1919) put forward the suggestion that vitamin A activity was associated with yellow colour in most plant materials. During the course of three years that followed, Steenbock and collaborators published a series of papers showing a close relationship between vitamin A activity and the yellow colour of several roots, *e.g.*, yellow corn *vs.* white corn, green leaves *vs.* etiolated leaves, green peas *vs.* yellow peas and so on. And later in 1920 Steenbock and collaborators made a definite statement that carotene with a constant m.p. could induce growth in rats on vitamin A-deficient diets.

Palmer, who very strongly refuted the contention of Steenbock, stated that the mere fact that carotinoids are of wide spread occurrence is no evidence of the fact that they must play a role in metabolism. The more sensible view to take was that they are mere casual products in the animal organism derived from their food of plant origin. Palmer brought forward substantial evidence to prove his argument:

(*i*) Carotinoids are not present in the tissues of all animals *e.g.*, sheep, goat and swine. The cow can exclude xanthophyll and the hen carotene from its tissues. This meant that these animals have the power to destroy one or the other of the carotinoids more efficiently. If carotinoids had any function, they would be of general occurrence and would always be present in the tissues. This is not the case.

(*ii*) Even in such animals in which carotinoids naturally occur, they had no function because it could be experimentally shown that fowls could be raised from hatching to maturity on rations devoid of carotinoids. These fowls grew normally, lived healthily, showed normal fecundity and power of reproduction, produced eggs with white, carotinoid-free egg yolk and from those eggs normal chickens hatched.

(*iii*) Albino rats grew and reproduced normally on almost carotinoid-free Ewe milk fat and carotinoid-free egg yolk.

Such was the strong and convincing evidence brought forward by Palmer that for a time Palmer's view-point seemed to have triumphed.

Eight years later in 1928 Euler, Euler and Hellstrom again reopened the question and definitely stated that pure carotene was active as a source of vitamin A. They explained that the failure of the earlier tests was due to the fact that these diets were deficient in vitamin D. Vitamin D was then not differentiated from Vitamin A. Very soon this observation was confirmed in other laboratories.

After it was proved that carotinoid pigments were of biological importance there was added interest and activity in this field. During the years following the work of Willstätter and his school there had been little work undertaken in this field. But now the organic chemist with his modern equipment attacked the problem and in course of a few years tremendous advance was made. Many new carotinoids were discovered and the whole chemistry, structure and formulae of the more important carotinoids were established. Credit for these outstanding discoveries rests mainly with Professor Paul Karrer and his school at Zurich and Professor Richard Kuhn and his colleagues at Heidelberg. A brief outline of the more important features of this study is presented in the form of a table. (Table 1).

TABLE I.

Group.	Name.	Formula.	Double bonds.	Oxygen linkages.	Physical constants.	Remarks.
I. *Hydro-carbons*	Carotene	$C_{40}H_{56}$	11	—	—	Discovered by Wachenroder (1826); Formula settled by Willstätter and Meig (1907); Structure worked out by Karrer (1931).
	1. ,, *a*	,,	11	—	M.P. 172°C. Optically active. More soluble than *β*	Isomeric forms shown by Kuhn *et al*; Karrer *et al*; and Rosenheim and Starling in 1931; Formula worked out by Karrer and colleagues.
	2. ,, *β*	,,	11	—	M.P. 182°C. Optically inactive, less soluble than *α*.	Structural Formula worked out by Karrer (1932). *α* & *β* can be separated by fractional crystallisation or fractional adsorption on fibrous clay or Fuller's earth.
	3. ,, γ	,,	12	—		Discovered by Winterstein and Ehrenberg (1932); carrot pigments contain 1% of it. Marsh-dodder contains large amounts. Structure by Kuhn and Brockman.
	,,	—	—	—		Discovered by Winterstein (1933).
	4. Lycopene	$C_{40}H_{56}$	13	—		The red pigment of tomato contain conifers and red pepper. Existence in flowers shown by Zechmeister. Structure worked out by Kerrer.
II. *Alcohols*	5. Xanthophyll Lutein	$C_{40}H_{56}O_2$	11	2 OH	M.P. 192-193°C. $[\alpha]_{cd}^{18} = +138\text{-}152°$	Formula settled by Willstätter and Meig (1907); Tswett postulated 4 xanthophylls. *a*, *a' a''*, *β*. Kuhn got only a single one. However isomers likely. It is derived from optically active carotene, *i.e.*, *a*-carotene.
	6. Zea-xanthin	,,	11	2 OH	(Optically inactive?) Now found it is active when obtained from leaves. $[\alpha]_{6678\ CHCl_3}^{18} = -41°$	Pigment of yellow corn. Isomer of xanthophyll, discovered by Karrer. Lutein of egg yolk is 30% zea xanthin, 70% xanthophyll. This is derived from inactive *β* carotene.
	7. Krypto-xanthin	$C_{40}H_{56}O$	11	1 OH	Optically inactive.	Discovered by Kuhn and Grundman. Present in yellow corn with zea-xanthin. The pigment in papaya is mainly krypto-xanthin. The biological activity of yellow corn is due to this.
	8. Rubi-xanthin	,,	12	1 OH		Discovered by Kuhn and Grundman, xanthophyll derivative of γ-carotene. Formula and structure shown by Kuhn.

TABLE I—*Continued.*

Group.	Name.	Formula.	Double bonds.	Oxygen linkages.	Physical constants.	Remarks.
	9. Flavo-xanthin	$C_{40}H_{56}O_3$	11	3 OH	M.P. 184°C $[a]^{18}_{cd}$ = 190° C_6H_6	Isolated by Kuhn and Brockman (1932). This pigment yields intense blue colour with 25% Hcl.
	10. Viola-xanthin	$C_{40}H_{56}O_4$	10	3-4 OH	M.P. 207-208°C $[a]^{20}_{cd}$ = +35° $CHCl_3$	Discovered by Kuhn and Winterstein from pansies. Forms addition compounds of a salt type with intense blue colour.
	11. Tara-xanthin	$C_{40}H_{56}O_4$	—	4 OH	M.P. 184-185°C. $[a]^{20}_{cd}$ = +200°	Discovered by Kuhn and Lederer from dandellion flowers. Does not form salt with dilute acids and can be thus distinguished from viola-xanthin.
	12. Fuco-xanthin	$C_{40}H_{56}O_6$	10	4 OH	$[a]^{18}_{cd}$ = +72° $CHCl_3$	Pigment of the brown seeds. Formula settled by Willstätter and Meig (1914), and confirmed by Karrer and shown to be derivative of carotene.
	,,	$C_{40}H_{56}O_6$	11	4 OH 2 CO	M.P. 166-8°C. Optically inactive according to Helibron.	Helibron and Peiper show recently that the formula is $C_{40}H_{56}O_6$. Structural formula presented based on insufficient evidence.
III. *Ketones.*	13. Rhodo-xanthin	$C_{40}H_{52}O_2$	12	2 CO		A diketone. It readily gives a dihydro-derivative. Discovered by Kuhn and Brockmann. It has been changed to zea-xanthin by Karrer by hydrogenation.
	14. Capsanthin	$C_{40}H_{58}O_3$	10	2 OH 1 CO	M.P. 175-176°C	Pigment of Paprika. Often occurs in ester form with oleic, palmitic, myristic, stearic acids, etc.
	15. Capsorubin	$C_{40}H_{56}O_4$	9	2 OH 2 CO		Closely associated with capsanthin in nature. Formula worked out by Zechmeister and Cholonoky.
	16. Astacin	$C_{40}H_{44}O_4$	—	4 CO		Kuhn isolated it from eggs of sea spiders, and Karrer from star fish. Also occurs in the shells, eggs and epidermis of lobster.
IV. *Acids*	17. Azafrin	$C_{27}H_{36}O_4$	7	2 OH 1 COOH		First isolated by Lieberman (1911-15). Kuhn isolated it later and proposed the formula.
	18. Bixin	$C_{25}H_{30}O_4$	9	1 COOH 1 C(=O)OCH$_3$		Formula definitely established by Karrer by synthesis.
	19. Crocetin	$C_{20}H_{24}O_4$	7	2 COOH		Pigment of saffron. Formula definitely established by Karrer.

BIOLOGICAL IMPORTANCE OF CAROTINOIDS

After it was definitely established that carotene can act as vitamin A, it was soon discovered that vitamin A is formed by the breakdown of the carotene molecule in the animal organisms. Vitamin A activity was found to be characterised by the combination of a β-ionone ring with a carbon chain of 4-5 conjugated double bonds. Therefore only a few of the carotinoid pigments discovered could give rise to vitamin A in the animal organism. These were α-carotene, β-carotene, γ-carotene, and kryptoxanthin, together with some of the derivatives of carotinoids *e.g.*, semi-β-carotenone, semi-β-carotenone-oxime, β-oxy-carotene, and dehydro-β-semi-carotenone. All the other carotinoids given in the table have no vitamin A value.

It would be of some interest to point out that β-carotene is twice as active as α- or γ-carotene or kryptoxanthin, because it gives rise to two molecules of vitamin A while others only to one. The vitamin A activity of papaya and yellow maize is almost entirely due to kryptoxanthin. The yellow pigment of most green leaves is predominantly β-carotene but the pigment of carrots, red palm oil, mango etc., contains a high percentage of α-carotene. The pigment of tomato is lycopene which has no biological activity but it also contains some carotene to which its vitamin A action is due.

We come now to the most important question of the metabolism of carotene. There are two aspects of this question which have been the subject of numerous studies:

(*i*) Absorption of carotene from the intestinal tract. Carotene is a water insoluble pigment. In what form is it absorbed and what are the factors which control its absorption?

(*ii*) Transformation of carotene to vitamin A. In what organ and under what conditions does this change take place? What is the mechanism of this change? Can this change be imitated *in vitro*?

These problems have not been settled with the same degree of success which the organic chemist has attained in the elucidation of the chemical structure and the properties of the carotinoids. One fact however seems to be definitely established, that in the absence of fat in the diet carotene is not so well absorbed. This has been definitely proved by a number of our studies. With a normal amount of fat in the diet, 70-90% of the carotene might be absorbed, while if fat is excluded from the diet almost 70-80% of carotene given might be recovered from the faeces. There is no evidence that 10% fat will mean greater absorption than with 5%.

It has been suggested that bile acids might possibly form soluble and diffusible compounds with carotene and thus help in the absorption of carotene. Greaves and Schmidt have studied this question, and obtained some evidence in support of this view.

With respect to the question of the transformation of carotene into vitamin A in the animal organism attention has been focussed on two organs, (*i*) the intestinal tract and (*ii*) the liver.

With regard to the intestinal canal it was conjectured that the activity of intestinal bacteria might bring about the transformation. This however seems unlikely to be the normal mode of change in the organism since after ingestion of carotene quite a lot of the pigment is present in the blood serum, in the liver, and other organs of the body, which shows that carotene is absorbed as such and later on broken up into vitamin A.

Since liver is the chief storehouse of the vitamin in the body the general consensus of opinion is that transformation takes place in that organ. However any direct and conclusive evidence has not so far been obtained to that effect.

Some years ago liver perfusion studies were carried out by us. A colloidal solution of carotene was slowly perfused into the liver of anaesthetised animals through a canula attached to one of the splenic veins. A small piece of the liver was cut off before the perfusion to act as a control. The animals did not live very long after the operation. The longest that an animal lived was 18 hours and as much as 1-10 mg. carotene was perfused but no evidence of the transformation of carotene into vitamin A was obtained either chemically or spectroscopically. One most striking fact in these experiments was that carotene rapidly disappeared from the blood. Even within a few minutes after the perfusion was complete, no trace of carotene was to be discovered in the blood.

The animals used in these experiments were cats. Unfortunately it was later discovered that cat as a species lacks the power of transforming carotene into vitamin A. Young cats kept on skimmed milk and lean meat for long periods could be partially depleted of their reserves of vitamin A but the daily administration of even large doses of carotene, as much as 10 mg. daily for two or three months did not result in the formation of any vitamin A in the liver. On feeding cod liver oil considerable deposition of vitamin A in the liver took place.

When a colloidal solution of carotene was injected intravenously into an animal, the pigment rapidly disappeared from the blood and was localised chiefly in the liver, the spleen and the lungs. During the

course of the next few days the pigment tended to disappear from the liver but it could not be experimentally shown that the disappearance of the pigment was attended with the concomitant appearance of vitamin A. The rapid disappearance of the pigment from the blood suggested phagocytosis, its presence in Kupffer cells, and its localisation in the organs, which are the main seats of the reticulo-endothelial system, suggested that the reticulo-endothelial system might have something to do with the transformation, on the analogy of the mechanism of the formation of antibodies. Attempt were made to study this aspect by blocking the reticulo-endothelial system with Indian ink or dyes in vitamin A-deficient rats and then feeding them with carotene, taking the disappearance of the symptoms of deficiency or the storage of the vitamin in the liver to be a criterion of the ability to utilize carotene. The results were highly suggestive but inconclusive.

The problem was also studied in heptectomised rats. It was expected that rats from which the spleen was removed might have less ability to change carotene into vitamin A than normal rats, since removal of the spleen meant the removal of a part of the reticulo-endothelial system, although possibly removal of a part might also lead to the active proliferation of the reticulo-endothelial cells in other organs of the body. However the results were again inconclusive. Thus so far no direct and conclusive evidence has been possible to obtain to prove that the transformation of carotene into vitamin A takes place in the liver.

A few words might be said on the attempts to convert carotene into vitamin A *in vitro* with the help of liver tissue or other means. In 1931 attempts were made to see whether intestinal bacteria or minced liver tissue when incubated with colloidal suspension of carotene would lead to the formation of vitamin A. Experiments were repeated under a variety of conditions but without any marked success. But in certain experiments with certain strains of intestinal bacteria under anaerobic conditions a substance was produced which gave intense blue colour with a violet tinge with antimony trichloride reagent. However the substance was too labile for a spectrographic test to be made and the conditions under which it was formed could not be determined and could not always be reproduced.

Finally one more study may be described. Most of our earlier experiments were tried with liver extracts in minced liver tissue. It is possible that the change could take place only if the integrity of the cells is maintained.

A number of vitamin A-deficient rabbits were fed with carotene. After about 24 hours the livers were tseptically excised out and dropped into molten wax at 45-46°C which was rapidly cooled. These were kept at room temperature and allowed to autolyse. A piece of the liver was examined immediately for its content of carotene and vitamin A. The other pieces were examined after 15, 21, and 28 days. Carotene was estimated colorimetrically and vitamin A by the $SbCl_3$ reaction. It was observed that during the course of autolysis carotene disappeared while the vitamin A content of the tissues increased.

Research Notes

The Citric Acid Cycle and the Szent-Györgyi Cycle

H. A. KREBS (*Biochem. J., 34,* 775, 1940) puts forward new evidences supporting his "citric acid cycle" in respiration of tissues and also defines the relation between the "citric acid cycle" and the 'Szent-Györgyi Cycle" in pigeon breast muscle. He is of opinion that the oxidation of a "triose" equivalent involves one complete "citric acid cycle" and three repetitions of the "Szent-Györgyi Cycle" ; and that the "Szent-Györgyi Cycle" is concerned with the transport of (at least) 6 of the 12 H atoms released during the oxidation of one "triose" equivalent.

In support of his theory he describes another reaction in which oxaloacetate is reduced :

$$\text{Citrate} + \text{oxaloacetate} \longrightarrow \alpha\text{-Ketoglutarate} + CO_2 + \begin{cases} \text{fumarate} \\ l\,(-)\text{-malate} \end{cases} \quad . \quad . \quad . \quad (1)$$

From the above as well as the following two reactions known before

$$\left.\begin{matrix}\text{Oxaloacetate} \\ \text{pyruvate}\end{matrix}\right\} + \text{oxaloacetate} \longrightarrow \text{Citrate} + CO_2 + \begin{cases} \text{fumarate} \\ l\,(-)\text{-malate} \end{cases} \quad . \quad . \quad . \quad (2),$$

and "Triose" + oxaloacetate $\longrightarrow$ pyruvate +

$$\begin{cases} \text{fumarate} \\ l\,(-)\text{-malate} \end{cases} \quad . \quad . \quad . \quad (3),$$

he points out that the "Szent-Györgyi Cycle" acts as a hydrogen carrier in oxidation of citrate (1), in the formation of citrate (2) and in the oxidation of "Triose" to pyruvate (3).

A. R.

Synthesis and Breakdown of Starch in Plants

SYNTHESIS of starch in higher plants which primarily occurs as a result of photosynthesis is followed by its degradation into sugars for translocation and also for metabolic purposes. The reverse reaction also takes place simultaneously specially in the storage organs. The intermediary role of phosphorylated sugars in the breakdown of carbohydrate by yeast and certain animal tissues has been thoroughly elucidated. Naturally it is believed that a similar process takes place during the rapid interconversion of carbohydrates in higher plants. The isolation of Robison ester and Cori ester-like substances from plant materials by various workers has confirmed the idea that such interconversion also depends upon the formation of labile phosphorylated derivatives of sugars. Information regarding the types of enzymic mechanism responsible for the various aspects of this metabolic problem in the plant is still very meagre. C. S. Hanes (*Proc. Roy. Soc. B, 128,* 421, 1940) gives a preliminary report of his observation carried out with enzymes from mature pea seeds to elucidate the above phenomenon.

Finely powdered pea seeds (Laxton's Progress), freed from fat was extracted in distilled water for 40 hours in presence of toluene. This crude aqueous extract has been found to consist of an amylase, a phosphorylase and a phosphoglucose conversion system. The first recognisable step in the activity of the phosphorylase is the formation of non-reducing acid-labile glucose-*l*-phosphate which has been isolated in the form of the crystalline potassium salt. It is interesting that the conversion of starch to glucose-l-phosphate is a reversible reaction and is catalysed in both directions by the phosphorylase. Thus when glucose-l-phosphate is added to the pea extract it becomes partially converted into a polysaccharide resembling starch, and inorganic phosphate is liberated.

In an alternative reaction glucose-*l*-phosphate is converted into acid-resistant reducing hexose-monophosphates, of which a considerable proportion has been shown to consist of 6-phosphoric esters of glucose and fructose. This transformation is catalysed by two or more enzymes constituting the phosphoglucose conversion system.

Finally, when crude extracts of peas are allowed to act upon starch, in the presence of inorganic phosphate, fructofurnose—1 : 6-diphosphate is formed. The dialysed extract does not give this product. A dialysable co-enzyme is probably required by the mechanism concerned in this phosphorylation.

The results indicate that the phosphorylase is able to act upon a much wider range of carbohydrate substrates than is generally believed to be the case with the phosphorylases from muscle and yeast. It seems that almost any saccharide composed of l-glucopyranose units linked in positions 1 and 4 (as in maltose) may serve as substrate regardless of the length of the chain. There is indication to show that an endwise degradation occurs during the phosphorylation. These observations together with the fact that glucose is not esterified directly are in harmony with the hypothesis that l-glucose chains are degraded by the posphorolytic cleavage of terminal glucose units, these being liberated successively, from the non-aldehydic chain-ends, in the form of glucose-l-phosphate.

H. N. B.

Radioactive Iron as an Indicator in the Study of Iron Metabolism

IT is well known that iron deficiency is a primary factor in anæmia. Despite much conjecture, little definite knowledge is available about the mechanism of absorption and excretion, and mechanism for the transport and mobilisation of iron reserves of the organism. Radioactive isotopes have recently been very much available through the development of the cyclotron by Lawrence *et al* so that there has been very valuable and exhaustive researches in various laboratories on intermediary metabolism with the help of such "labelled" molecules.

Austoni, Rabinovitch and Greenberg (*Jour. Biol. Chem.*, *134*, 27, 1940) have studied the absorption, distribution and excretion of iron in normal and iron-deficient rats with radioactive iron as an indicator.

As data on the iron content of blood-free tissues and organs of rats in varying metabolic states are not available, these authors developed a technique of viviperfusion to free the tissues very thoroughly of their contained blood. In a preliminary experiment analysis was performed with tissues of normal rats, of rats made anæmic, and of iron-enriched rats.

The data, in general, showed a decrease in the iron content of most of the tissues of anæmic rats, the liver and spleen being most strongly depleted. Iron enrichment attained by feeding ferric chloride leads to an increase in the iron content of most of the tissues, the bone marrow showing the greatest gain.

Experiments were next carried out by administering radioactive iron to two groups of rats, normal and iron-deficient. Hemoglobin values for each animal were determined at weekly intervals. The radioactive iron, in solution as ferric chloride, was administered to the rats by stomach tube. The animals were then placed in individual metabolism cages over a device permitting separate collection of urine and faeces, and were fed the stock colony diet.

After the desired period had elapsed, the rat was anesthetised, a blood sample was drawn and the animal viviperfused. The blood and desired tissues were separated and analysed for their radioactive iron content either with a Lauritsen electroscope or with an ionisation electrometer.

It is found that a single dose of iron requires 12 hours to pass from the stomach and small intestine. Anæmic animals eliminate less of the administered iron in stool or urine. Where normal animals retain 30%, the anæmic animals retain 50% of the iron administered.

The specific accumulation of the absorbed iron per gram of tissue was greatest in the bone marrow, blood, spleen, liver and heart. Total accumulation was greatest in muscle and blood particularly in anæmic rats.

In normal rats, after 10 days, the radioactive iron nearly disappears from the muscle and blood but in case of anaemic animals it accumulates considerably.

The present investigation represents the first reported study of the passage of iron through the gastrointestinal tract with radioactive iron as a tracer.

H. N. B.

BOOK REVIEW

The Position of Women in Hindu Civilisation (from prehistoric times to the present day)—by DR A. S. ALTEKAR, M.A., LL.B., D.Litt., Manindrachandra Nandi Professor, Benares Hindu University. Published by Culture Publication House, Benares, 1938. *Pp. xi+468, with 8 plates. Price Rs. 6/-.*

In the work under review the author attempts to give an exhaustive account of the position and status of women in Hindu society from the earliest times down to the present day. The book is divided into twelve chapters. Chapter I deals with the childhood and education of Hindu girls in different ages, Chapter II with their position regarding marriage and divorce, and Chapter III with their married life. Chapters IV and V give an exposition of the status of widows, the former dealing with problems connected with the *Sati* and the latter with those of levirate and remarriage. Chapter VI discussing Hindu women in public life gives an account of the *Purda* system and also of women as rulers and administrative officers. Chapter VII discusses women's position in the Hindu religion, and Chapters VIII and IX their proprietary rights. Chapter X gives an account of the dress and ornaments popular with Hindu women in different ages. Chapter XI deals with the general attitude of the Hindu society towards women, and Chapter XII gives a retrospect together with some observations regarding the solution of several modern problems confronting Hindu women. There is a number of plates illustrating the dress, ornaments, etc., popular with the women of ancient India.

The vast Indian subcontinent is known to be equal to Europe with all its countries but Russia, and the Hindu population is made of numerous tribes belonging to different grades of civilisation and alien ethnic types. Even the earliest authorities on *Smriti* therefore had to recognise dissimilar customs for different parts and peoples of India (*cf.* Bodhayana on cross-cousin marriage amongst the peoples of the Deccan). The factor of local or tribal variation in the development of customs, the cross-currents of different culture and the lack of requisite data make a study of the evolution of Hindu society exceptionally difficult. Prof. Altekar however should be congratulated on his valuable work in spite of these limitations of the subject itself. He has tried to utilise all available materials and sources of information regarding Hindu women of all ages with reference to causes of the subsequent change in their position. He has also often attempted to indicate lines whereon the problems now facing Hindu girls may be tackled so as to get satisfactory solutions. His views are sympathetic and liberal, and his criticisms generally sober and impartial.

The nature of the subject and the sources of information, however, leave room for difference of opinion amongst scholars, and readers may not agree with the learned professor on all points. The reviewer does not agree with the author when he says that the *Purda* system was beginning to be popular with some royal families only about 300 A.D. (p. 200). The derivative meaning of the word *orodhana* (=*avarodhana*, *avarodha*, restraint) to indicate women's apartment in the houses of Asoka's brothers and sisters (Rock Edict V), Kautilya's description of the *antahpura*, and the *Mahabhashya's* references (1.1.6 ; 2.1.1 etc.) to *asuryampasyani mukhani* (faces not seen even by the sun) prove that *Purdas*, specially in royal families at least in some parts of India, is certainly much earlier. Book III of Chapters III-IV of the *Arthasastra* definitely proves the existence of strict *Purda* even in ordinary families.

Prof. Altekar is no doubt an able collector of materials. Since however they are scattered over a vast field, it is only natural that a few of them have escaped the learned scholar's notice. In the section dealing with queens reigning in their own right (p. 218 ff) some of the most important examples, those of the Kakatiya queen Rudhamba (*c.* 1260-91 A.D.) who succeeded her father Ganapati, and of Dandimahadevi (*c.* 886-93) and her mother both of whom succeeded king Subhakara of Orissa, have not been noted. Rudramba is no doubt the queen ruling over the Guntur district at the time of Marco Polo's visit to India (p. 224). In this connection, moreover, the administrative capacity of Bhavani of

Bengal and Jhunda (or Jhindan) of the Punjab can hardly be ignored. The learned professor again does not notice any early instance of *Sati* in the Deccan (p. 150 ff). According to many scholars, however, the Kavadi stone inscription (*Ep. Carn.*, VIII, p. 167) records the death of Kadamba Raviverman (C. 490-538 A.D.) and his queen "who probably became a *Sati*."

Similar other points may be cited, but they do not detract in any way from the value of Prof. Altekar's work. We are sure that students of Indian history, especially those interested in the study of Indian society, will be benefited by a perusal of his book.

Dines Chandra Sircar

Coal Carbonisation and Some of its By-products —by B. WILSON HAIGH. Reprinted from the *Transactions* of the Mining, Geological and Metallurgical Institute of India.

The paper on a highly interesting subject like coal carbonisation from Mr Wilson Haigh, the manager of Bararee Coke Company, Jharia, with over 30 years' experience in this line is quite welcome and a timely one when people are taking keen interest in the matter of industrial development of mineral resources of India. The author has dealt with the subject of medium-temperature and low-temperature carbonisation in brief but the subject of high-temperature carbonisation with a view to recover a number of useful by-products has been discussed in a more exhaustive manner. With regard to the question of immediate possibility of starting medium-temperature carbonisation (800°C) to manufacture smokeless patent domestic fuel the following remarks of the author are worthy of consideration ". . . . the time is near when coke-oven owners in India will need to turn their attention to producing a coke suitable for the domestic market as there are now in existence more by-product ovens than are required to produce all the coke that the metalliferous industries can absorb" . . . . "Such domestic coke would have to compete with the soft coke made from low grade coals in heaps or mounds at many collieries in the Jharia and Raniganj fields. This coke is sold at a very cheap rate as there is no capital expenditure involved in its manufacture. Speaking generally, it is a low-grade fuel, dirty and high in ash" . . . "If a demand for a clean, readily ignitable fuel at a higher price can be created and developed there must be a great potential market in northern India and in large cities like Calcutta. No doubt many difficulties have to be faced, one of which will be to educate the public to appreciate the advantages of such a fuel. A highly-developed marketing organisation would need to be established . . . . . ."

In face of these remarks it would be better if the Soft Coke Cess Committee instead of doing propaganda work for the sale of soft coke produced at present by crude methods directed their attention to encouraging the coke-oven owners to produce better domestic coke. The propaganda for this better commodity would meet with success.

With regard to the establishment and successful working of a well-planned and fully equipped low-temperature carbonisation plant in this country, the author has expressed sufficient doubts as the capital cost of such plants would be very high and as the other by-products might not be recovered with clear margin of profit under the existing conditions of market. Such statements from a practical man of sufficient experience cannot be ignored but on the other hand should be carefully scrutinised by those interested in this line. The Bihar Government in particular, who have already invested some money in starting series of experiments in connection with low temperature carbonisation, should give Haigh's comments a special consideration.

The subject of high-temperature carbonisation for the manufacture of metallurgical coke and for the recovery of many useful by-products such as coal-tar, ammonia, naphthalene, benzole etc., has been described in the paper.

The author has also dealt with in brief the subject of coal tar distillation for the manufacture of road tar, pitch, creosote oil, middle oil, disinfectants and antiseptics, coal tar colours, perfumes and flavours, plastics, medicinal and surgical substances, photographic chemicals, etc. Some of these common by-products such as tar, ammonium sulphate, naphthalene, creosote oil, road tar, coal tar pitch, disinfectants, carbolic acid, motor benzole, toluene, naphtha are already being recovered in the Bararee coke ovens, Jharia. Road tars Nos. 1, 2 and 3 to the British standard are now manufactured in India and it is gratifying to note that the use of road tar has quadrupled during the last quinquennium and it is expected to still further increase in near future with further expansion of tarred roads in this country.

The subject of recovery of benzole, the liquid fuel from coal gas is very important and has been dealt with in a comprehensive manner. The Bararee Coke Co., Ltd. were the pioneers in this direction (in 1920) and they were succeeded a few years later by the East India Railway plant at Giridih. The total annual output of the two plants does not exceed 2 lakhs of gallons whilst the potential output

of existing coke plants is about three to four million gallons. Some may think that the reason for India's low production is owing to the difficulties of recovery due to tropical conditions but the real reason, according to Mr Haigh, is to be found in the attitude of the Central Government, especially with regard to imposition of excess duty. This duty applies to petrol, benzole and alcohol alike. The cost of petrol at Indian ports is 3 annas per gallon whereas it costs, say, four times as much to produce a gallon of benzole and as they are both subjected to the same excise duty, benzole is automatically shut out of the motor-spirit market in competition with petrol. In other countries different conditions prevail. In Great Britain for instance benzole has always enjoyed a preference. The future development of the benzole industry in India, therefore, entirely depends on the drastic change in the policy of the Central Government.

The author remarks that it is manifestly impossible for any new companies in India to take up the manufacture of benzole or any motor-spirit from coal by any process without some form of Government assistance either by way of subsidy or remission of excise duty. This should, therefore, seriously engage the attention of the Government, who are responsible for the country's welfare. As Indian benzoles are rich in toluol there is every possibility of manufacturing high explosives (T.N.T.) from the toluol, provided the benzole industry develops under the care and protection of the India Government. The author's discussion of the subject of alcohol (derived from molasses) -petrol mixture as proposed by the U.P. and Bihar Governments is also worth a careful consideration before the proposal is actually made compulsory. According to him alcohol-petrol-benzol mixture would be a superior fuel to the alcohol-petrol mixture and both benzole and alcohol could be obtained from coal.

A large number of illustrations in the paper has made it highly interesting and instructive. Many of his suggestions seem to have practical bearing and the object with which the paper was probably written would be served if some interest is created in the minds of those who are seriously considering the question of industrial development of India.

N. N. Chatterjee

LETTERS TO THE EDITOR

Cashew Apple, a Rich Source of Vitamin C.

Before proper planning of the nutrition of the people is taken up in any country, it is essential that the approximate amounts of the protective principles present in the various foodstuffs grown locally should be known. This necessarily implies that foodstuffs specially rich in any particular dietary factor deserves serious notice in nutritional planning.

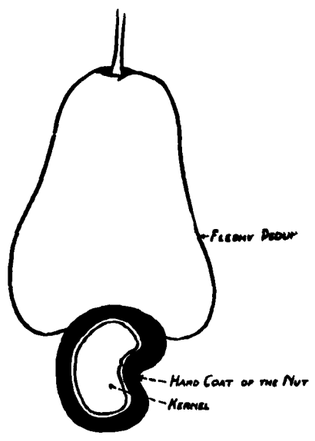
As far as the content of vitamin C in locally grown edibles is concerned, two kinds of fruits and one kind of vegetable have so far been described to be very rich (more than 200 mgs. per 100 gms. of the material) in this particular element. They are guava (*Psidium guayava*) described by Ghosh and Guha[1] and by Rangnathan,[2] Indian gooseberry (*Emblica officinalis*) described by Giri and Doctor[3], and *Kankrol* or *Kheksa* (*Momordica cochinchinensis*) described by Mitra *et al.*[4]

During routine examination of edibles for food value in the present author's laboratory it was found that cashew apple or the fleshy peduncle of cashew-nut or *Hijli badam* (*Anacardium occidentale*) is another rich source of vitamin C. This vitamin was assessed by the chemical method with 2:6 dichloro-phenolindophenol and carotene by colour matching as described in a previous communication by *Mitra et al.*[4] The other proximate principles were determined by the usual methods suggested by the Association of the Official Agricultural Chemists, America, with slight modifications.

Food value of Cashew apple per 100 gms. of the material.

Moisture	...	86.18 gm.
Protein	...	0.81 gm.
Ether extractives	...	0.60 gm.
Mineral matter	...	0.37 gm.
Carbohydrate	...	11.14 gm.
Calcium	...	4.0 mgm.
Phosphorus	...	20.0 mgm.
Carotene	...	0.09 mgm.
Ascorbic Acid	...	261.5 mgm.

Cashewnut belongs to the natural order Anacardiacea. The flowers are polygamous and each has one carpel yielding a kidney shaped nut with hard acrid coat. Under it the axis swells up into a pear like body, fleshy and edible. It is this fleshy



Cashew Nut (Anacardium occidentale).

peduncle which when ripe and yellow is known as cashew apple. Before subjecting the apples to analysis the parchment-like outer coat was removed.

The nut is grown extensively in South India. In Bombay, Bengal and Orissa a fair amount is also grown. The kidney-shaped nut is a popular article of diet over large parts of India. The fleshy peduncle when fully ripe is eaten either as fruit or cooked as vegetable. An alcoholic liquor is said to be fermented out of the cashew apple in South India (Mangalore). In Midnapur district (Bengal) the fresh juice of the apple is still used in the villages as a local antidote against snake venom. The nuts, when ripe, are roasted, shelled and kernel exported outside. Of total exports outside India a little more than 80% is shipped to the American countries.

The kernel of the nut was not analysed for its food value as this has already been done in Coonoor

*Production and export figures of the nuts.**

Province or State.	Production in tons.	Export in tons.
Bengal ...	1,200	not known
Bombay ...	4,500	850
Cochin ...	5,000	4,750
Madras ...	22,500	12,945
Orissa ...	560	380
Travancore ...	10,000	8,000

* Figures supplied by the respective marketing officers and are approximate.

laboratories and results published by Rangnathan *et al*[5].

The author is obliged to his friend Professor S. S. Chaudhury of the Prince of Wales Medical College, Patna, who has kindly procured the samples from Orissa for analysis and to his chief Lt.-Col. S. L. Mitra, I.M.S., for advice and encouragement.

Nutrition Scheme,
Public Health Laboratories, K. Mitra.
Bankipur, Patna, 4-8-1940.

[1] Ghosh and Guha, *Jour. Ind. Chem. Soc.*, *12*, 30, 1935.
[2] Rangnathan, S., *Ind. Jour. Med. Res.*, *23*, 241, 1935.
[3] Giri, K. V. and Doctor, N. S., *Ibid*, *26*, 167, 1938.
[4] Mitra, K. *et al*, *Jour. Ind. Chem. Soc.*, *17*, 250, 1940.
[5] Rangnathan, S. *et al*, *Ind. Jour. Med. Res.*, *24*, 699, 1937.

On New Diffraction Maxima in Laue Photographs

It has been reported recently by Sir C. V. Raman and Nilakantan [1] that a new type of diffraction maxima has been observed by them in the Laue photographs of diamond and crystals of sodium nitrate. The explanation offered by them regarding the origin of these maxima is that when X-ray quanta impinge on any set of planes of a crystal lattice, the characteristic vibration of the lattice is excited and if the glancing angle be other than a right angle, the phases of motion of different atoms of the plane are adjusted in such a way that the planes become slightly inclined to the original position during the vibration. Hence the monochromatic X-rays are reflected when the new orientation of the planes satisfies the Bragg relation even if, in their original position, the Bragg relation is not satisfied and the wavelength in question is not reflected by these planes. It has been pointed out later on by Knaggs *et al* [2] that such diffraction maxima have been observed by a large number of workers from time to time since 1913, and more experimental investigation is necessary before any theory can be accepted as essentially correct. A detailed mathematical theory has, however, been put forward by Zachariasen [3] and it is the purpose of this note to point out that this theory can explain the origin of the new diffraction maxima quite satisfactorily , while the observed facts are in disagreement with the hypothesis proposed by Sir C. V. Raman and Nilakantan.

The disagreement between the observed facts and the hypothesis mentioned above may be summarised as follows: First, the displacement of the atoms from their original positions required to give the new maxima in the observed direction is too large to occur actually in the crystal. Secondly, the intensity of the new maxima should not depend very much on the variation of the angle of incidence from the Bragg angle, but actually it depends very much on this variation. Thirdly, the direction of new diffraction maximum should make an angle $2\theta_B$ with the direction of the incident X-rays according to the proposed hypothesis, but actually the angle observed is sometimes less and sometimes greater than $2\theta_B$. Fourthly, in the case of diamond the frequency of the characteristic vibration is such that $h\nu \gg k\,T$ at temperatures below 1000°C and hence the thermal excitation of this vibration is not possible at any temperature below 1000°C, but actually it is observed that the intensity of the new diffraction maxima increases appreciably in the case of diamond when the crystal is heated to 500°C.

According to the theory put forward by Zachariasen, the diffuse scattering owing to thermal vibration of the lattice has a maximum in the direction making an angle $2\theta_m$ with the incident rays given by the relation,

$$2\theta_m = 2\theta_B + 2\Delta \sin^2\theta_B \qquad (1),$$

where θ_B is the Bragg angle and $\Delta = \theta_i - \theta_B$, θ_i being the glancing angle of incidence. In the following table the values of θ_m calculated for different glancing angles observed in the case of diamond are compared with those calculated according to (1). It is observed that there is fair agreement within experimental errors between the observed and the calculated values.

TABLE 1

Glancing Angle		$2\theta_B$	$\theta_i - \theta_B - \Delta$	$2\theta_B + 2\Delta \sin^2\theta_B$	$2\theta_m$
Incidence	Reflection				
17° 11′	24° 33′	43° 56′	− (4° 47′)	42° 36′	41° 44′
18° 41′	23° 50′	43° 56′	− (3° 17′)	43° 1′	42° 31′
20° 49′	22° 43′	43° 56′	− (1° 9′)	43° 37′	43° 32′
21° 4′	19° 6′	39° 30′	+ (1° 19′)	40° 58′	40° 10′

Thus the discrepancy between the Bragg angle and the observed angle of reflection for the new maxima is accounted for by Zachariasen's theory. According to this theory the intensity of the maxima diminishes very rapidly with the increase in the value of Δ and the intensity should also increase with the increase in the temperature of the crystal. The observed facts are quite in agreement with these conclusions. Thus the new maxima are probably parts of diffuse scattering owing to thermal vibration of the crystal and not a specular reflection as proposed by Sir C. C. Raman and Nilakantan. Details are given in a paper communicated to the *Proceedings of the National Institute of Sciences, India.*

The writers are indebted to Prof. M. N. Saha, F.R.S., for his kind interest in the work.

Palit Laboratory in Physics, University College of Science, Calcutta, 9-8-1940

S. C. SIRKAR.
J. GUPTA.

[1] Sir C. V. Raman and P. Nilakantan, *Proc. Ind. Acad. Sc., 11,* 379, 1940.
[2] Knaggs *et al, Nature, 145,* 820, 1940.
[3] W. H. Zachariasen. *Phys. Rev., 57,* 597, 1940.

Preservation of Cotton Fabrics

Formaldehyde (HCHO) fume is very effective for the preservation of cotton fabrics.

A Naga and a few Santal cloths including 'Sarees' were brushed very carefully. Some of them were starched. The specimens were subjected to the following treatment. 20 oz. of water and 2 oz. of formaldehyde solution (40%) were put in a tin canister (specially made for our laboratory purpose). The canister is open at its top and is 18″ × 9″ × 9″ in size. At a height of 6″ from the bottom 4 brackets are welded at the corners. A moveable plywood box with a hole at its bottom (diameter—5″) and with the opposite end completely open, is placed on the brackets. A fine sheet of wire-gauze is placed on this opening of the box so that no article may fall down. The fabrics were kept on it and the canister was placed over a Bunsen burner on a stand. A wooden lid made to fit the canister exactly was placed on the top.

The fabrics were fumigated for ten minutes, after which the burner was put out. The articles were taken out after 24 hours and the treatment appears to be very satisfactory. To dry up the little moisture they absorbed, the fabrics were kept in open air for several minutes (but not in the sun).

Afterwards the cotton fabrics were kept inside a Tarine moth-proof bag. A pound of napthalene was also put into it. The mouth of the bag was closed and it was hung on its hooks from the wall. The specimens were examined every two months.

EXPERIMENTAL DATA :— *PRESERVATION OF COTTON FABRICS*

Specimen.	Condition of specimen.	Reagent.	Date of treatment.	Period for which the specimen was under observation.	Result.
Naga waist cloth. C. 824	Old	Formaldehyde vapour	March 1938	2 Years, 4 Months	Good. No attack of Moths.
Santal Doal Saree. C. 517	New	Ditto	December 1938	1 Year, 7 Months	Ditto
Santal Saree. C. 530	Ditto	Ditto	February 1939	1 Year, 5 Months	Ditto
Santal cloth. C. 726	Ditto	Ditto	March 1940	4 Months	Ditto

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Ballygunge, 30-7-1940.

Minendra Nath Basu.

On Hierarchical Sampling, Hierarchical Variances and their connexion with other aspects of Statistical Theory

From a non-homogeneous univariate statistical population we can estimate the mean by a number of alternative methods one of which is a particular type of sampling recently proposed to be extensively used by P. C. Mahalanobis in crop-cutting experiments. Suppose the population in question is such that it could be cut up into a number of district zones (which let us call zones of the first order), each of these could be further cut up into a number of zones (which we call zones of the second order), each of the second order zones could be cut up further into a number of third order zones and so on till finally we get to zones of the $(k-1)$th order, each of which is a statistically homogeneous group. Suppose that the variance 'within' the $(k-1)$th order zones be σ_k^2, 'between' the $(k-1)$th order zones but 'within' the $(k-2)$th order zones be σ^2_{k-1}, 'between' the $(k-2)$th order zones but 'within' the $(k-3)$th order zones be σ^2_{k-2}, and so on till we come to the variance 'between' the 1st order zones which we denote by σ_1^2.

Our statistical population is said to be hierarchical if these variances $\sigma_1^2, \sigma_2^2, \ldots \sigma_k^2$ happen to be of entirely different orders. Now suppose further that from such a population we sample in the following manner: from the 1st order zones, we select at random n_1 zones, from each of these we select at random n_2 second order zones and so on and finally from each selected $(k-1)$th order zone, we pick out at random n_k individuals. We have altogether $n_1, n_2 \ldots n_k$ observations at our disposal; such a sampling has been called nested or hierarchical sampling by P. C. Mahalanobis. The mean of these observations is supposed to estimate the unknown population mean. The variance of the estimated mean could be easily shown (by the *Algebra of Mathematical Expectations*) to be given by

$$\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_1 n_2} + \ldots\ldots\ldots + \frac{\sigma_k^2}{n_1 n_2 \ldots n_k} \qquad (1)$$

If we call our variate x_k and introduce pseudo-variates $x_1, x_2, \ldots x_{k-1}$ such that x_1 numbers, as it were, the first order zones, x_2 the second order zones and so on and finally x_{k-1} numbers the $(k-1)$th order zones and if further we assume a multivariate normal distribution for the variates $(x_1, x_2, \ldots x_k)$, then we have shown that formula (1) could be derived in an elegant manner. This derivation of (1) involves certain restrictions no doubt and thereby robs (1) a little of its generality but at the same time this process of derivation gives a greater insight into certain aspects of the multivariate normal distribution and incidentally gives a neat statistical interpretation of the rectangular statistical co-ordinates introduced by one of us jointly with Mr R. C. Bose in a paper[1] entitled "Normalization of Statistical Variates and the use of Rectangular Co-ordinates in the Theory of Sampling Distributions" published in 1937 in *Sankhya (Indian Journal of Statistics)*.

For a fixed set of values of $(x_1, x_2 \ldots x_{k-1})$, x_k is normally distributed about a mean M_{k-1} which is a function of $(x_1, x_2, \ldots x_{k-1})$ but with a variance which is independent of the particular values of this set. This variance is σ_k^2; again M_{k-1} itself is distributed for a fixed set of values of $(x_1, x_2, \ldots x_{k-2})$ about a mean M_{k-2}, which is a function of $(x_1, x_2, \ldots x_{k-2})$ with a variance which is independent of the particular values of this set; this second variance is σ^2_{k-1}; and thus it goes on till we get to M_1 which is a function of x_1, and which is normally distributed about a constant M_0 with a variance which is σ_1^2.

It is of considerable interest to note that these variances $\sigma_1^2, \sigma_2^2 \ldots \sigma_k^2$ with their direct statistical import could be completely identified with the rectangular (statistical) co-ordinates for the (multivariate-normal) population introduced in the paper referred to above. This furnishes us, with a simple statistical interpretation for those co-ordinates which was lacking in 1936, when these co-ordinates were first introduced as fruitful auxiliaries for certain investigations in Mathematical Statistics.

Statistical Laboratory,
Presidency College,
Calcutta, 8-8-1940.

S. N. Roy.
Kalishankar Banerjee.

[1] *Sankhya, 3,* 1, 1937.

Generalised Boltzmann's formula and Planck's law

IN the usual Einstein's derivation of Planck's formula use is made of Boltzmann's law

$$\frac{n_2}{n_1} = e^{-(\epsilon_2 - \epsilon_1)/kT}, \qquad (1)$$

where n_1 is the number of systems in state 1 of energy ϵ_1 and n_2 the number of systems in state 2 of energy ϵ_2. This holds only when the systems obey the *classical* statistics. When this is not the case we have to use the generalised Boltzmann's law

$$\frac{A_2}{A_1} = e^{-(\epsilon_2 - \epsilon_1)/kT}, \qquad (2)$$

where A's are defined by

$$N_1(E)\,dE = \frac{a(E)\,dE}{\frac{1}{A_1}e^{E/kT}+\beta} \qquad (3)$$

and $$N_2(E)\,dE = \frac{a(E)\,dE}{\frac{1}{A_2}e^{E/kT}+\beta} \qquad (4)$$

$N_1(E)dE$ is the number of systems having their kinetic energy of translation lying in the range E to E+dE and their internal state of motion characterised by the energy value ϵ_1. $N_2(E)dE$ is the number of systems in the internal state ϵ_2 and with kinetic energies in the range E to E+dE. a(E)dE is the number of states for the energy range E to E+dE. For the case of Fermi-Dirac statistics $\beta=+1$ and $\beta=-1$ for Bose-Einstein's statistics.

In the present note Planck's formula is derived by using the generalised Boltzmann's law and not the special relation (1) which holds only in the case of a *classical* gas.*

The rate of spontaneous emission will be $A_{21}N_2\times(1-\beta\frac{N_1}{a})$ where A_{21} is the transition probability of spontaneous emission and the factor $(1-\beta\frac{N_1}{a})$ is introduced as usual in quantum statistics to take account of the "occupiedness of the levels"[1]. The rate of stimulated emission will be

$$U_\nu . N_2 B_{21}(1-\beta\frac{N_1}{a}),$$

where U_ν is the density of radiation of frequency ν and B_{21} is the transition probability of stimulated emission. Similarly the absorption rate will be $U_\nu N_1 B_{12}(1-\beta\frac{N_2}{a})$ where B_{12} is the transition probability of absorption. Equating the rates of emission and absorption, we get

$$N_2 A_{21}(1-\beta\frac{N_1}{a})+U_\nu N_2 B_{21}(1-\beta\frac{N_1}{a}) = U_\nu N_1 B_{12}(1-\beta\frac{N_2}{a})$$

which gives

$$U_\nu = \frac{A_{21}/B_{21}}{\frac{N_1}{N_2}\frac{B_{12}}{B_{21}}\frac{1-\beta\frac{N_2}{a}}{1-\beta\frac{N_1}{a}}-1} \qquad (5)$$

But from equations (3) and (4) we have

$$\frac{1-\beta\frac{N_2}{a}}{1-\beta\frac{N_1}{a}} = \frac{N_2}{a}\frac{1}{A_2}e^{E/kT} \Big/ \frac{N_1}{a}\frac{1}{A_1}e^{E/kT} = \frac{N_2}{N_1}\cdot\frac{A_1}{A_2}$$

Substituting this value in equation (5) and making use of relation (2), we obtain, since $\epsilon_2-\epsilon_1=h\nu$,

$$U_\nu = \frac{A_{21}/B_{21}}{\frac{B_{12}}{B_{12}}e^{h\nu/kT}-1} \qquad (6)$$

The constants in this equation are as usual, evaluated from the condition that for high temperatures equation (6) must reduce to the Rayleigh-Jeans formula, *viz.*,

$$U_\nu = \frac{8\pi\nu^2}{c^3}\cdot kT.$$

We have therefore

$$B_{12}=B_{21},$$

and consequently

$$U_\nu = \frac{8\pi h\nu^3}{c^3}\cdot\frac{1}{e^{h\nu/kT}-1}$$

which is the Planck's formula for black body radiation.

University of Delhi, Delhi, 26-7-1940.

Sukhdeo Behari Mathur
Badri Narayan Singh

* The frequency change in radiation due to Compton and Doppler effects is for simplicity not considered, *i.e.*, we assume that the kinetic energy of the systems is unchanged by acts of emission and absorption of radiation.

[1] Jordan, *Zeits. f. Physik.*, *41*, 711, 1927.

SCIENCE AND CULTURE

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On the Use of Science and Scientists

IN his anniversary address to the Royal Society Sir William Bragg, President of the Royal Society, makes the following remarks with respect to the use of science and scientists during times of peace as well as of war.

"There is indeed a widespread recognition of the general effectiveness of science. The ways of using science and scientific men are being slowly discovered. But the process is slow. It would, I think, be hastened, if certain fundamental truths were generally known and recognised. I venture to state them in the form of a few propositions:

1. Science, that is to say, the knowledge of Nature, is of fundamental importance to the successful prosecution of any enterprise.

For example, a nation is obliged to make all possible use of science in preparation for war, whether aggressive or defensive: and, again by way of example, in the maintenance of public health and social welfare. Of course, science is not alone in being a necessity in either case.

2. Science is of general application. There are not one science of chemistry, another of electricity, another of medicine and so on: there are not even distinct sciences of peace and war. There is only one natural world, and there is only one knowledge of it.

Experience shows that an advance in knowledge or technique or skill in any direction may be based on some item of knowledge acquired in a far distant field of research. For that reason, it is necessary to resist strongly a natural tendency for those who study science or apply it, to separate into groups without mutual communication.

3. Fruitful inventions are always due to a combination of knowledge and of experience on spot. Unless the man with knowledge is present at the place and the time when some experience reveals the problem to be solved he misses the fertilizing suggestion. Neither can the mastering idea suggest itself to the man who has the experience only but no knowledge by which to read the lesson that the experience teaches. The man with knowledge may be a temporary or special introduction, or, which is much better, he may be the man who meets with the experience.

4. There are difficulties peculiar to the application of science to war purposes. While the war proceeds scientists as a body are anxious to put all their knowledge at the service of their country: but when the time comes they are anxious to get away to their work on pure science or the applications of science to the problems of peace. Government may preserve and most fortunately has preserved a nucleus of able scientific effort during the last 20 years of peace, so that a certain connexion is maintained between these particular applications and the general body of science, but from the very nature of their respective occupations, and on account of a certain secrecy which one of the two bodies is forced to maintain, the connexion is not always strong. It can easily happen that the solution of a particular difficulty in the war service may lie in some piece of knowledge far away from the immediate science of the enterprise and unknown to those who need it."

The urgency of using science for times of peace as well as of war was discovered only during the last Great War, and almost all western countries and Japan set up organisations for this purpose, with varying amount of success. In this matter, this country as usual has been nearly 25 years backward. There have been, in other countries, many defects in the use of science and scientists, but if these mistakes be carefully noted by the Government and leaders of this country, our lost opportunities may, to some extent, be retrieved.

It is believed that statement No. (1) will be universally agreed to, but (2) is not so readily recognised by those who have not got a scientific education. When a Government organisation is set up, it is usually devoted to one particular object, say, researches on synthetic dyes or on fuel technology or on synthetic drugs, on jute, cotton and other commodities. The workers in such institutes tend to be segregated into water-tight compartments particularly in this country, where even technological committees are filled up with a motley collection of members of the Assembly and the Council of State, members of Chambers of Commerce, I.C.S. men etc., chosen for no particular knowledge of the subject and of scientific methods ; and inclusion of genuine men of science who can initiate fruitful lines of research and stimulate the investigators are not considered essential. It is not realised how much is lost because the workers in these institutions are thereby prevented from coming into contact with and under the influence of master minds in other sciences who may sometimes throw suggestions which may lead to solution of outstanding problems.

As regards (3) the principle has been recognised in the United Kingdom by the admission of scientists of a pure academic standing to such research associations as have been brought into existence for purely industrial work and the advantage of such associations has been illustrated in many cases in a very convincing manner. For example, the perfection of the recent methods of preservation of foodstuffs, cereals, and fruits (known as the refrigerated gas storage method) has revolutionised the whole technique, and it owes its success to the co-ordination between pure scientists and men who were acquainted with actual problems of food preservation in the Food Investigation Board created under the auspices of the Department of Scientific and Industrial Research. Many other examples may be given.

As regards No. (4), the problem is new to this country, because the Government, though it has been rather reluctantly forced to the view that scientific men should be mobilised at least for purposes of war, has not been able to take effective measures on account of inexperience, particularly in matters dealing with industry. But elsewhere, in England as well as in the enemy countries, science is being used very extensively and in a spectacular way for the prosecution of the war and in England the suggestion has been made that a Ministry of Science should form a part of every government.

Sir William Bragg does not like this idea because ministry would be too formal and rigid at any rate for immediate needs, and as far as our country is concerned, his remarks are all the more applicable because the Government departments in this country are not specially distinguished for promptness of decision or quickness of action. According to him the most successful way of using scientific knowledge should be personal and elastic. He thinks that the purpose will be served by attaching a central authority of science to the central authority of the country. This principle is to some extent followed in England in the Department of Scientific and Industrial Research, in the Medical Research Council and the Agricultural Research Council, but it does not suffice for the purpose as these organisations deal with a specific object, and are linked with the corresponding ministries. But for the application of science as a whole contact should be made between the rulers and eminent scientific men. He advocates the use of the Royal Society for this purpose. He suggests that a small group of Fellows selected for the purpose should be consulted by the Cabinet without hesitation whenever the need arose and it should be kept well informed by the members of the Government so that it might foresee occasions and needs.

Regarding the personnel of the new organisations which are being brought forward, Sir William Bragg is strongly of the opinion that even on the secretarial and administrative side, there should be men with a proper scientific training. The argument is reproduced in his own language :—

> "There are two subsidiary consequences of the present position of science which need to be remembered. We have not long passed the stage, if indeed we have quite gone past it, when our knowledge of Nature is used as a reference library is used. The knowledge is there, on the shelves, to be taken down when anyone wants information on a particular point and happens to remember where possibly it may be obtained.
>
> Anyone who wants to use a library effectively must already have some knowledge of the same nature as that which he hopes to find there. If not, he does not know where or how to look ; nor can he grasp fully what he finds, even if he happens to hit upon the right book."

The importance of this suggestion can hardly be overestimated, particularly in this country. It is often found that many of the newer scientific organisations which are meant to put science and scientific men to the country's work are manned by members of the Civil Service or Audit Service having

absolutely no background of scientific knowledge, or, if they had any such knowledge while they were students, all vestige of that has been washed away in the dull routine of office work. As a glaring illustration we may point out that the posts of Director of Industries in most of the provinces have generally been reserved for such members of the Indian Civil Service for whom, for some mysterious reason, a berth has to be found somewhere outside the pale of administration, justice, or secretariat. While talking with such men about the scientific research needed for a particular line, it has been our experience that we were talking to a vacant mind, which has not been able to grasp the problems at all, and instead of coming to relevant points, finds pleasure in taking refuge behind vague and diffuse propositions. Such a man is just in the position of a candidate for an examination in some science subjects who has not previous training in science, and cannot therefore find out the proper answer even when the best textbook is put in his hand. A good deal of inefficiency of the scientific departments of the Government of India is due to the continuance of this practice.

The Government of India has, as a result of the situation created by the war, brought out a new baby for the development of India's industries, namely, the Board of Scientific and Industrial Research. They hope to nurse the baby with the time-worn methods with which alone they have been familiar. We can only say that if these methods are rigidly followed, the baby will be found to be still-born. We therefore recommend for their serious consideration the advice given by the octogenarian president of the most famous scientific society in the world.

X-RAYS INTO FOSSIL REMAINS

A five-ton dinosaur that roamed the western part of the United States 80 million years or so ago has just had his teeth X-rayed. His jaw was removed from the American Museum of Natural History, New York, where it is normally on exhibition, to the works of the Westinghouse X-ray Company. There it was photographed by means of X-ray apparatus that is used in industrial work, and it was then discovered that there were four rows of uncut teeth inside the jawbone, in addition to the 36 that were visible to the eye. Altogether this dinosaur must have possessed over 500 teeth some of which had decayed. It is scarcely likely that he suffered from toothache, however, for in spite of his great size his brain was only the size of a man's fist and nervous system was poorly organised.

The dinosaur jawbone that was X-rayed in these experiments came from the lower left side of the mouth of a creature to which the formidable name of Triceratops Serratus has been given. It was dug from soft sand in Montana, a position suggesting that the creature had wandered into a quicksand and died when unable to struggle free. He is estimated to have been 50 years old when he came to this untimely end, and had then completed only a quarter of the average life of his kind. He stood 8 ft. high, and a tremendous shield stretching backwards from his head helped to protect his neck from his mortal enemy, a carnivorous dinosaur. He had two horns, each about 3 ft. in length, that projected forward over his little eyes, and a much smaller horn between his nostrils.

X-rays are proving particularly useful for examining rare fossil remains of this kind. Previously what was inside them could only be discovered by sawing 'windows' out of the bone. Now they can be examined without injury, and arrangements have been made for fossil finds of explorers on behalf of the American Museum of Natural History to be X-rayed by the Westinghouse X-ray Company.

—*Meccano Magazine*

Indian Scientists and the Present War

I shall refer first* to the creation of the Board of Scientific and Industrial Research. This Board has been created to bring the scientists in contact with industries, so that the vital problems of production and manufacture may engage the attention of all of us. As the Secretary pointed out in his report, your Association can legitimately claim its share in the creation of this Board. There is no doubt that the brilliant advocacy of this idea by your official organ "SCIENCE AND CULTURE" has borne fruit. This brings me immediately to the second important thing in which we are all interested namely our journal, "SCIENCE AND CULTURE". This journal and the *Current Science* have done yeoman's service to the cause of science in India. The Indian Science News Association has a very important function and part to play in the present times. Our learned President has remarked in his speech that the task of mobilising an army of scientific men is easy when compared with the task of educating public opinion in things scientific, and that the latter task is to be taken up in more earnest at the present time. I am glad that both these subjects are the Association's concern. I must confess that even our Government of which I am also a part now is not agile enough to appreciate the impacts of science on society. We are steeped in the bureaucratic methods of the old I.C.S. While the I.C.S. is still an efficient prime mover in the Government, it must be acknowledged that the present civilisation is largely based on applied sciences and a change in the angle of vision of the Government and the public is therefore clearly indicated.

It is not possible now to allow this laziness to resist the onward march of science. An interesting story of such laziness I heard when I was a student. It was reported that once a forest caught fire, and the officer on the spot sent a telegram to the authorities concerned asking for the necessary relief. The telegram had to pass through proper official channels before the necessary action could be taken but meanwhile the forest was ruined. When, however, the telegram had passed through the proper channels and reached the hands of the official concerned, after a month's lapse of time, the officer was quite active and replied by wire, "Fire-brigade is ordered to extinguish the fire".

The war has certainly made some change for the better and things are moving a little more rapidly. It must be said to the credit of the Hon'ble the Commerce Member that he brought into being the Board of Scientific and Industrial Research as quickly and without as little delay as possible with the result that our third meeting is going to take place on the 9th of September at Bombay. One or two things are already being manufactured on a large scale as a result of impetus given by some members of this Board. Different research committees have met, and the Technical Secretary is busy day and night toiling at the reports submitted by them. Over 80 workers are shortly going to be engaged on the research programme to be carried out under the auspices of the Board. This is a good augury and we hope the Board in which your Association has taken so much interest will score further successes, and that the present enthusiasm will continue and some real and tangible result will come out of all this.

I now refer to your task of educating public opinion. The interest of the public in science can be aroused only if the scientist comes down from his heaven of wisdom to the earth of the common man. I must confess that although we have scientists who can solve the most difficult mathematical problems and enunciate theories which will require days for even a man of science to understand, yet there are rather few amongst us who are able to do things which inspire the interest of the common man. When I was a young lad, the thing that made me most interested in science was the railway engine which I saw running up and down everyday from the residence of my uncle, who was

*Adapted from the speech delivered by Dr S. S. Bhatnagar as the guest-of-honour on the occasion of the fifth annual meeting of the Indian Science News Association held on the 27th August, 1940, last at the University College of Science, Calcutta.

an officer in the railway department. My mother, my sisters, and my young relations knew of science not from discourses of learned men or from academic journals, but from the rapidly moving engines running to and fro and carrying heavy loads. The wonderful inventions of science such as radio, telephone, telegraph, railway engine and motor car have done more to arouse the interest of the common man in science than all the wisdom poured out by our men of science. Applied sciences have been rather neglected by our universities, and it is only during the last few years that interest in applied science has acquired the importance it deserves. The result has been that while we have a number of very distinguished scientific men, there are comparatively few scientific processes named after Indians, comparatively few machines which we can claim as our inventions and still less number of articles of utility which are in use which can be said to have been manufactured by us. That is why the common man calls us by the name of mere philosophers, mathematical dreamers and armchair workers etc. It is interesting to note however that this distinction between the pure and applied sciences is fast disappearing. Prof. Saha, who is well-known as a mathematical physicist, is now thinking of manufacturing compressor and vacuum pumps in his laboratory. We know that other scientific workers who were formerly more interested in producing theses and papers are devoting at least a part of their attention to the things that matter to the common man. If this attitude continues, I have no doubt that the common man will be able to take more interest in us, and the apathy of the man of wealth to science will shortly disappear.

You are lucky in having Dr Law as the President of your Association. He represents a rare combination of culture, science and industry. If you wish to make your Association a living force, and if you wish to be of real service to the public you shall have to cater for the public, produce scientific work which will help in the amelioration of the miseries of the poor people, which will do something to save our civilisation. It should help in providing better houses, better food, better living conditions, so that the legislators might be able to say that it is good that the scientific men are also engaging themselves in doing the task which so far constituted only their responsibility. The Indian Science News Association has done much good by focussing public attention on scientific problems. Besides the advocacy for the establishment of the Board of Scientific and Industrial Research, I have seen "SCIENCE AND CULTURE" advocating the creation of the River Physics Laboratory in this province, the creation of a National Physical and Chemical Laboratory and an Institute for Fuel Technology, a Jute Research Institute and so forth.

This organ has fought hard for all that is good for us. This journal has been no respector of persons or departments and has fought its battles independently and courageously. When the Board of Scientific and Industrial Research was created, the inadequacy of the measure and the vagueness of description regarding my own duties in the Government Communiqué excited the attention of the editors. When, however, it came to be known that I had already postulated with the Government that my duties will not be only advisory, but that I shall be actually in a laboratory connected with research, a letter of congratulations was promptly sent to the Government on this decision. It is this frankness and justness of criticism which I admire. I hope this spirit will continue and that the criticism of national affairs in the columns of SCIENCE AND CULTURE will be just and fearless.

Returning to the question of service which we can render to society, we must help the businessman in this country to bring about the industrialisation of our land. Although businessmen in this country like those in other countries are interested in gambling at the stock exchange, they do not like to take the risk on a gamble with the applied scientist. If they risk even one tenth of their wealth on experiments with industries, they will not only enrich themselves but will also bring untold wealth to their country and thus help the cause of humanity and science. It is to be hoped that the efforts of the Indian Science News Association will bring about this very important liaison between the industrialists and the workers in the scientific fields.

Before I sit down, I wish to say something which may look superfluous and even common place. As there is need for unity amongst the politicians, so is the need for unity amongst the scientific men. There is no organisation that is set up in this country which is not immediately criticised by a set of people. I am not referring to the old controversy of the Academies, of the *Current Science* or the *Science and Culture*. I am referring to the task before the

country, namely the industrial development of the country, particularly at the time when the scientific men are being given an opportunity to come to the aid of our industries. We should sink our differences of caste, creed and provinces and face the task with wisdom and courage so characteristic of the scientific man.

I have spoken enough on the working of the B. S. I. R. and the duties of this Association. The B. S. I. R. has been created during this period of stress and strife created by the European war and I must emphasise that the scientific men have to play a very important part. Supplies of trained experts will have to be more and more the concern of the universities. In the speeches delivered by Mr Churchill and Lord Linlithgow it has been clearly indicated that India is going to be the centre of supplies for Europe and the Middle East. It is announced this morning that Sir Alexander Roger is coming out on a mission to organise the supplies and munition production capacities of our country. This is a step in the right direction. I am sure the scientific men present here and the readers of the journal will have opportunities to be able to contribute to the progress of this country. Let me hope that Indian sicence will not miss the opportunity and prove equal to the great task imposed upon it by the war.

SPIDER IS WORLD'S CHAMPION DIVER

The world's champion diver, according to an article in the magazine *Natural History*, is the water spider, the female of which can stay under water for hours and days and even sleeps and raises her young below water.

She accomplishes this almost unbelievable feat by spinning a broad airproof web or sac which she fastens between the stems of under-water plants. Then stretching the credulity of man even further, she fills it with fresh air by carrying down air bubbles from the surface and releasing them in her submarine chamber. And in this hideaway she lives a leisurely life secure from intruders, travelling to the surface for more air when the need arises. This remarkable water spider has even figured out a way to hang the eggs of her young conveniently from the filmy ceiling of her magic diving web.

—*Science Digest.*

The Work Before Indian Scientists

OUR thoughts* today are centred on the war and the international situation. The entire world is now passing through the throes of a new birth, and our lives, institutions, and destinies, to all appearance, have been thrown into the melting pot. Whether we are scientists, literary men, political workers, or just common men, we cannot leave this fact out of the reckoning.

So far as the scientists of Europe are concerned, the war has seen the most thoroughgoing harnessing of all their activities to the war machine. In India, however, their lives and activities have not yet been visibly affected by it, although signs are fast appearing that they will be. In the process of mobilisation of the resources of the British Empire for the prosecution of the war, demands are being made on an ever-increasing scale on the resources of India, both material and human, actual and potential. It seems as if the present war is going to stimulate the industrial revolution in India to a far greater degree than even the last one. Industries and lines of manufacture which in ordinary circumstances would not have had an immediate start in this country are being contemplated. There is already a scheme to establish an aeroplane factory and a ship-building yard in India, while heavy industries which were not making very great headway are being expanded and remodelled. Indians are also being recruited to the technical branches of the defence services, for work on the ground, on the sea and in the air. There is every likelihood that if the war lasts a few years more, it will see the industrialization of India taken to a point far in advance of the stage at which it stood at its commencement.

This is a development which is bound to affect Indian scientists and science. The trend is already in operation. Indian scientists are being requisitioned by the Government for giving the benefit of their experience and knowledge to the schemes designed to secure the expansion of Indian industries. The Government of India has constituted a Board of Scientific and Industrial Research, whose functions are to advise the Government as to the lines on which industrial research should be conducted and the channels into which it should be guided in order to ensure the co-ordinated development of India's industries, as also to recommend specific problems for investigation to the staff under the Board and to the various scientific institutions of this country. This Board counts among its members some members of our Association, and its Director is Dr Bhatnagar, our honoured guest today. I have no doubt that this Board will pave the way for an intimate co-operation between our scientists and our industries. The development which it foreshadows is bound to grow and have a profound influence on our industrial future.

The scientists of India, and more particularly the members of our Association, on their part, have no reason but to welcome this development. If the articles and discussions which are being published in the organ of our Association furnish any indication, the industrialization of India is a cause very near to their heart and one in whose promotion they and the Association are actively engaged and interested. Almost every aspect of the industrialization of India, particularly in its scientific bearings, has received attention in our journal. The journal has touched upon problems connected with electrification, irrigation, health, agriculture and a host of other subjects. By so doing it has served to awaken its readers to the importance of these problems, and has brought the relevant facts and arguments before their minds ; furthermore, it will, as I hope, make a valuable contribution to their solution on scientific lines.

There can be no doubt that this work is vitally related to the purpose for which our Association exists, inasmuch as the popularization of science as a technique of living and its presentation as a philosophy of life are complementary aspects of the great object of our Association. Obviously, the practical importance of science as an instrument of

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* Adapted from the Presidential Address delivered by Dr S. C. Law at the fifth annual meeting of the Indian Science News Association held on the 27th August, 1940, last at the University College of Science, Calcutta.

industrialization and economic reconstruction requires far less stressing than its more intangible values. The proof of the pudding is in the eating, and the best advertisement of science is the actual demonstration of the power of science that people see in the numerous scientific devices which touch their lives at every point. Yet it may be doubted whether, for all the popularity of motorcars and radios, and all the new enthusiasm of Indian business men for new plants and machines, there is full comprehension of the real implications of these contrivances which are being used to a greater and greater extent by us. We seem as yet to have an imperfect realization of the sweep and meaning of modern science and of the revolution it is going to bring about in our social, economic, and political existence. We are even now too prone to misunderstand modern science as it has been developing since the end of the 18th century.

This misunderstanding must be removed. Modern science is not just an additional gloss on the existing and traditional scheme of things, it is a new phenomenon such as has not been seen in human society since the discovery of agriculture thousands of years ago. It has brought to man a new and vast power over nature, and is bringing into existence a new technique of living whose full shape we have yet to see. But already science has given sufficient proof to us that it is not a thing whose acceptance or rejection admits of a choice or a thing of which we can accept one feature and leave aside others. We have to take it as a whole, just as it is, on its own terms.

I am emphasizing the all-embracing and revolutionary character of modern science and urging a more positive approach to it for the simple reason that without realizing the one and adopting the other, there can be no planned scientific economy for India. It is of course true that science and the industrial revolution are making steady inroads into every walk of our national life and bringing about a dissolution of our old social and economic structure. But the whole movement is still uncontrolled and piecemeal. Too much is being left to chance and to individual likes and dislikes. We are not yet the master of the movement, which we must be, if we want to reap its full benefit. We must be more deliberate in our acceptance of science ; we must plan its application as a whole and on a co-ordinated plan. Only this will enable us to complete the industralization of India and the modernization of its means of production in the most effective way and in the shortest possible time. It will also spare us the disturbance of equilibrium and lop-sidedness inseparably connected with haphazard processes. By accepting a conscious plan, based on a scientific outlook and scientific knowledge, we shall be able to bring about the transition from old to the new order with the least disturbance of our social equilibrium.

This means that the scientists of India must become ever-increasingly conscious of the part they must play in the economic transformation of India and be ready to undertake the burden in an ever-increasing measure. In this process the role of an association like ours is also clearly chalked out, and that role will be no minor one. I would say that the hopes of establishing a scientific economic order in India rests equally on actual scientific work, and on the dissemination of scientific information and ideas among the mass of the people. If the scientists will furnish the knowledge and technique which will make national planning on an adequate scale possible, the popularizers will create the fulcrum of public opinion without which the knowledge and technique of the scientists must be largely unavailing. As yet we suffer from insufficient co-ordination between these two wings. There is not perhaps in these days in India any serious dearth of competent scientists who could be set to the task of national planning, and such dearth which might still exist is likely to be removed in the near future. But the other half of the job, *viz.*, the mobilization of public opinion on behalf of a planned scientific economy, remains unaccomplished. This task must be shouldered by us.

Our Association exists for facilitating this work and is in fact giving more and more attention to this subject. This good work must be kept up. I have every confidence that Indian scientists as a class will never allow their enthusiasm in this matter to flag. There are among them men who are not only distinguished specialists in their own subjects but who are also patriots. They are awake to the wider social background of their work and to their duty to society. The thoughts and activities of these men have turned towards the problem of applying science on the widest possible basis for the national regeneration of India, and of awakening the public to its importance. Their example is inspiring. Let us also pray that their teachings and work may achieve their true and ultimate purpose by bringing into existence at no distant date a new oder in India.

Long-Distance Radio Communication—Application of Records kept at Ionospheric Observatories

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INTRODUCTION

RADIO listeners are now so used to short waves, when tuning their sets to foreign stations, that they can hardly be persuaded to believe that, about a couple of decades ago, the use of such waves was quite unknown for long distance radio communication. The remarkable property of short waves for reaching long distances was accidentally discovered by amateurs, and attracted the attention of radio engineers only at the beginning of the last decade. Before that date, long-distance radio communication was synonymous with the use of enormously long waves. Wavelengths as long as 20 kilometres were in common use. Such long waves required, for their efficient radiation, the erection of huge aerial systems and employment of enormous power. The advent of short waves changed the situation completely. The aerials of a modern trans-continental short wave station would seem amateurish if compared to the elaborate aerial system of the old days. The power employed also is only a mere fraction of that necessary for long wave stations. Besides, short waves provide "room" for an immensely greater number of communication channels than the long waves. For these reasons, short wave has gradually supplanted long waves though it has also certain disadvantages. Firstly, short wave signal is subject to very strong fading. This, however, is not a very serious drawback and can be remedied by the use of devices like automatic volume control or by suitable disposition of the receiving aerial system as is employed in the so-called 'diversity reception'. It has another drawback which is more serious. Short wave signal strength is greatly dependent on the particular wavelength used and on the hour of the day and on the season of the year. In fact, for the maintenance of communications, different wave-lengths have to be used at different hours of the day, in different seasons and also in different epochs of the sunspot cycle. Still as mentioned above, the difference in cost of erection and maintenance between a short wave and a long wave station is so great that in spite of these disadvantages and also because short wave provides greater number of communication channels, it is now universely used for long-distance radio communications.

It is obvious that to make the best use of short waves, the right wavelength has to be chosen at the right time. Here, the radio engineer is faced with a problem which he had hitherto been solving only by clever guess work based on long experience. It is the purpose of this article to describe a method by which it has been possible in recent years, to determine the most effective wavelength in a scientific way by utlising the collected data of the electrical properties of the upper atmosphere.

RÔLE OF THE IONOSPHERE IN LONG-DISTANCE TRANSMISSION

The different ionospheric regions which guide radio waves round the curved surface of the earth are represented in Fig. 1 which is for a typical summer daytime condition. For simplicity, the three regions, E, F_1 and F_2 are shown as three mere lines. Actually the regions have a certain thickness and the distribution of ionization density with height is roughly illustrated at the right of the diagram. The dotted lines show two of the many possible paths along which radio waves sent out from the transmitter T travel to the receivers at R_1 and R_2 by being reflected from the ionosphere at I_1 and I_2 respectively. The third dotted line indicates that waves sent out in this direction are not reflected and thus escape to the high atmosphere. This picture, simple as it is,

represents the basic mechanism of radio wave transmission over long distances. In actual practice the phenomenon is more complicated since the density of ionization and the heights of the ionized regions vary with time and geographical location of the place under consideration.

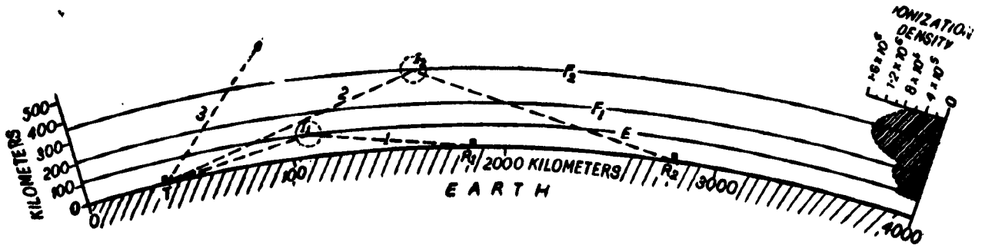


FIG. 1. Illustrating the mechanism of long-distance radio transmission *via* the ionosphere.

It is easy to see that the characteristics of the ionosphere at I_1 controls the propagation of radio waves from T to R_1. These characteristics are the "height" and the ionization density of the region concerned. Before proceeding further, it is necessary to define the sense in which the term "height" is used. The actual path followed by a radio wave returned from the ionosphere is shown in Fig. 2. The usual method of ionospheric measurements gives the height z_v of the apex E from the ground. This height, as may be seen from the figure, is greater than the true height attained by the radio wave and is called the *virtual* or *equivalent* height of the region.

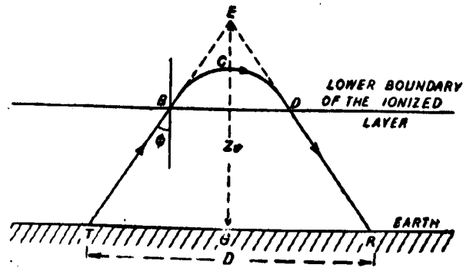


FIG. 2. Illustrating the actual path followed by a radio wave from the transmitter T to the receiver R. The virtual height of reflection EG is greater than the true height CG.

Now, the ionospheric observatories distributed in different parts of the world, keep records of ionospheric characteristics corresponding only to the case of *vertical* propagation *i.e.*, for radio waves which are incident on the ionized strata *normally* and are returned so by reflection. In the case of long-distance transmission however, the wave is incident *obliquely* on the ionized strata and it is extremely difficult and tedious to obtain transmission characteristics at oblique incidence from experimental observations. The problem therefore is how to utilize the observatory data obtained with *normal* incidence for computing transmission characteristics at *oblique* incidence.

CHARACTERISTICS FOR VERTICAL PROPAGATION

Records kept at ionospheric observatories supply the following data: (*i*) the virtual heights of reflection (z_v) at normal incidence for waves of frequencies that may be reflected and (*ii*) the critical frequencies f_E, f_{F1} and f_{F2} *i.e.*, the maximum frequencies beyond which at normal incidence, waves cease to be reflected from the ionized regions E, F_1 and F_2 respectively. Fig. 3 depicts a typical record for a summer day, showing the variation of virtual

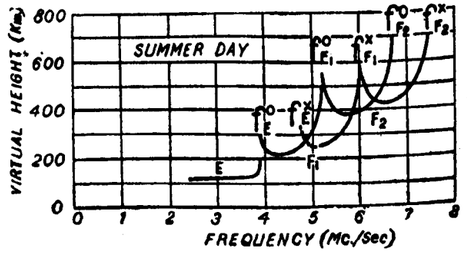


FIG. 3. Depicting a typical (P'—*f*) record made at ionospheric observatories.

height with the exploring wave-frequency. It will be noticed that there are a number of discontinuities in the curves. These discontinuities mark the *critical frequencies i.e.*, the frequencies just above which the wave penetrates a particular ionospheric

stratum and begins to be reflected from the higher one. It will also be noticed that just before penetration, the virtual height of the stratum concerned increases enormously and more or less suddenly with the increase of wave-frequency. The increase is due to the fact that for frequencies near the critical one, the waves travel in the ionized region with a velocity much smaller than their normal velocity, which, of course, is the velocity of light. The waves therefore take much longer time to reach the receiver and appear to have been reflected from a very much higher level. It will be further seen from the curves that for a particular region, Region E say, there are two critical frequencies marked as f_E^o and f_E^x. This indicates that due to the earth's magnetic field, the ionosphere becomes a doubly-refracting medium and consequently, a radio wave, on entering into such a medium is split up into component waves which are reflected from different levels. One component marked 'O' is called the ordinary wave and the other marked 'X', the extraordinary. It should be noted here that the critical frequency is a measure of the maximum ionization density of the region concerned and of these two, any one may be used for calculating it with the help of the corresponding formula.

CHARACTERISTICS FOR OBLIQUE PROPAGATION

We have already seen that long-distance transmission corresponds to the case of oblique propagation through the ionosphere (Fig. 1). It can be shown that for a particular frequency, a wave, incident obliquely, is reflected from a lower level (that is, a level of smaller ionization density) than the same wave incident normally. Again the larger the angle of incidence (angle of wave path with the vertical), *i.e.*, the greater the transmission distance, the higher is the upper limit of frequency of waves that can be reflected from a region of given ionization density. This upper limit of frequency for transmission over a given distance and time is called the *maximum usable frequency*. It is easily seen that the distance for which a given frequency is the maximum usable frequency is also the minimum distance over which signals of that frequency can be received. This minimum distance for any frequency is called the *Skip distance*; at any smaller distance, reception is impossible on that or any higher frequency.

CALCULATION OF THE MAXIMUM USABLE FREQUENCY

Data for normal incidence as kept at the ionospheric observatories can be utilised for computing the characteristics for oblique propagation in the following way.

It can be shown that if the earth be assumed to be flat, the maximum usable frequency f' for transmission over a distance D is given by

$$f' = f \sec. \phi,$$

where f is the critical frequency of the region concerned, and ϕ, the angle of incidence, is given by $\tan \phi = D/2z_v$. The above simple relation is found to hold good for transmission over distances up to about 500 kilometres. For long distances the curvature of the earth has to be taken into account and the analysis then becomes complicated. Without going into the details of the analysis, we may state here that the effect of the earth's curvature is to cause the radio wave to be reflected from a region of smaller electron density than would be necessary if the earth were flat.

For rapid analysis it has been found possible to determine approximate conversion factors. The maximum usable frequency is obtained by muliplying the critical frequency by the appropriate factor for the given distance and time. These factors depend upon the time of the day and the season of the year, and their values for transmission via different ionospheric regions and over different distances are given in the table below. The values are for single-hop transmission.

TYPICAL AVERAGE VALUES OF THE MAXIMUM USABLE FREQUENCY FACTORS

	TRANSMISSION DISTANCE (IN KILOMETRES)				
	500	1000	1500	2500	3500
Winter					
Midnight F ...	1·2	1·5	1·8	2·8	2·9
Noon F_2 ...	1·2	1·6	2·1	2·9	3·4
Summer					
Midnight F ...	1·2	1·4	1·7	2·4	2·8
Noon F_2 ...	1·2	1·5	1·8	2·5	2·9
Noon F_1 ...	1·3	2·0	2·7	3·6	...
Noon E ...	2·0	3·4	4·4	...	...

It will be seen that there are some blanks in the table. This is due to the fact that for the larger distances single-hop transmission is not possible.

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The above conversion factors are for the latitude of Washington. These, together with similar factors for stations situated at other latitudes, may be used for determining the factors for places where there is no ionospheric observatory. It should be mentioned that in the tropical and sub-tropical regions, the factors do not vary appreciably for small changes in latitude. Finally, for a particular latitude the ionospheric characteristics are essentially the same throughout at the same local time.

Curves in Fig. 4 (b) and 4 (*c*) show the relations between the three variables—maximum usable frequency, distance of transmission and time of the day—necessary in communication problems. Curves in Fig. 4 (*a*) depict the corresponding monthly average critical frequencies for Washington, D.C. at different hours of the day during June, 1937.

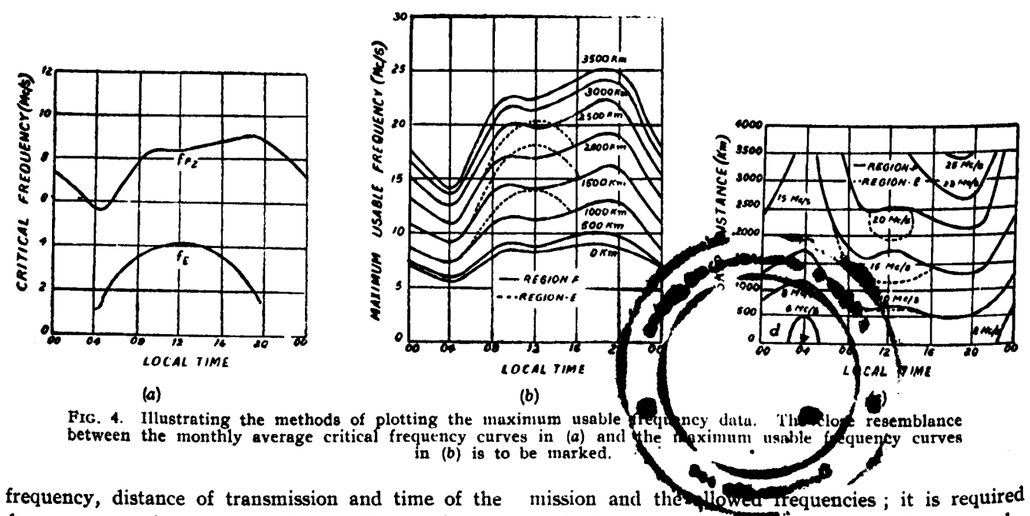


FIG. 4. Illustrating the methods of plotting the maximum usable frequency data. The close resemblance between the monthly average critical frequency curves in (*a*) and the maximum usable frequency curves in (*b*) is to be marked.

Of the two sets of curves shown in the figures, the one depicting the variation of the maximum usable frequency with local time for different distances as in Fig. 4 (*b*) contains the available data most concisely and completely and is in a form for ready use. Now, in the case of fixed stations the distance of transmission is fixed and only a certain number of frequencies is licensed for use. The optimum frequencies from amongst these to be used during different hours, or the optimum hours for any of these frequencies can be easily determined with the help of these curves.

The set of curves in Fig. 4 (*c*), showing the skip distance-time curves, is particularly useful for mobile radio service where the distance varies continuously and it is desired to determine the optimum frequency for communicating with a mobile unit at a given time.

PRACTICAL APPLICATION OF MAXIMUM USABLE FREQUENCY DATA IN RADIO COMMUNICATION

We may now discuss the method of utilising the above data for practical purposes. The problem with which a radio engineer is concernd is this: Given the two points between which communication is to be maintained, the approximate hours of transmission and the allowed frequencies; it is required to find out the optimum frequency which may be employed for maintaining the communication.

The first information which is necessary is that regarding the nature of the transmission path, *i.e.*, whether the path is single-hop or multi-hop. The maximum range for single-hop transmission is obtained when the angle of departure above the horizontal is zero. The distance covered by such a hop is about 2400 km. for transmission via Region E and about 3500 to 4500 km. for that via Region F. In practice, it is found that transmissions at angles of departure less than 3½° do not result in efficient communication due to ground absorption of the high frequencies used. Corresponding to this angle of departure, the maximum range is less, being 1700 km. for transmission via Region E and 3000 to 3500 km. for that via Region F. It is obvious that for distances greater than these ranges the transmission path should be multi-hop. In the case of

single-hop transmission, the part of the ionosphere which controls the transmission lies half-way between the transmitter and the receiver. For the case of multi-hop transmission, the corresponding controlling regions are easily determined. For the latter however the different controlling regions might be in different latitudes and in different conditions of daylight or darkness. There will thus be different maximum usable frequencies for different hops.

Knowing the nature of the transmission path, curves of the type given in Fig. 4 can be employed for determining the maximum usable frequency for a given transmission path and time. For the case of multi-hop transmission the maximum usable frequency which is the lowest will have to be taken.

OPTIMUM FREQUENCY—DELHI-CALCUTTA SERVICE

The optimum frequency, which must be below the maximum usable frequencies, is now chosen from the available frequency range. For this, two facts have to be considered. Firstly, the absorption of radio waves in their passage through the ionosphere increases *i.e.*, the signal strength becomes less, as the transmission frequency is lowered below the maximum usable frequency. Secondly, for maintenance of communication, it is necessary in practice to allow for the day to day variation of critical frequency from the monthly average value. Experimental results over long periods show that this variation is within 15% of the monthly average value.

Now, it is not ordinarily possible to change the transmission frequency frequently and hence a small limited number of frequencies is so chosen that a fairly efficient communication at all hours of the day may be provided. The general rule is to select a frequency lying between 50% and 85% of the monthly average maximum usable frequency for a given distance and time. Because, below 50%, the received signal may be weakened by absorption and above 85%, the frequency may, on some days, be beyond the maximum usable frequency on account of the day to day variation of ionospheric conditions.

In order to understand the procedure adopted for calculating the working frequencies for a given transmission distance let us for example, take the case of transmission between Calcutta and Delhi. The distance between these two places is 1295 kilometres and hence the transmission will be a single-hop one. The midpoint of the path, where reflection takes place, is near Jaunpur (Lat. 25° 40′ N; Long. 82° 57′38″ E) in the United Provinces. The properties of the ionosphere at this place determines the transmission characteristics between Calcutta and Delhi. Since the latitude of the place is only little different from that of Calcutta, the ionospheric characteristics at the mid-point may be taken to be the same as those at Calcutta. Fig. 5 depicts the

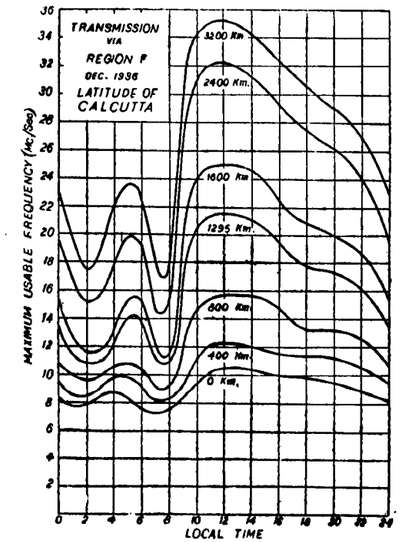


FIG. 5. Depicting the maximum usable frequency *versus* local time curves for Calcutta for December, 1936.

variation of maximum usable frequency with local time for different transmission distances. The curve corresponding to zero kilometre gives the monthly average critical frequency for Region F obtained at Calcutta in December, 1936. Now, since the local time at the point of reflection is only 2 minutes in advance of Indian standard time, the abscissa of Fig. 5 though plotted as local time, gives practically the I.S.T. Fig. 6 shows such a curve for the given transmission distance of 1295 km. Two auxiliary curves (dashed ones) have been drawn on the same graph, one 15% and the other 50% below the maximum usable frequency curve. The frequencies chosen for transmission should lie between these two curves and should also be such as to involve as few

changes of frequency as possible during a day. The dotted lines show one possible set of frequencies which may be used for transmission between Calcutta and Delhi. The vertical dot-dashed lines mark the hours at which the transmission frequency is to be changed.

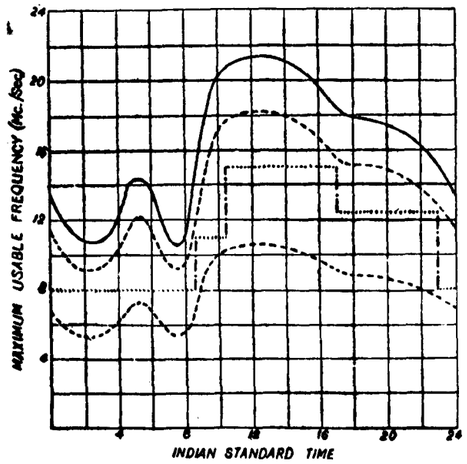


FIG. 6. Illustrating the method of determining the optimum frequencies to be used for transmission over a given distance. The curves are for transmission between Delhi and Calcutta.

The National Bureau of Standards of the U. S. A. is using this method with considerable success, for computing the optimum frequency and publishes monthly charts depicting the frequencies to be used at different hours of the day and for different ranges, based on ionospheric data recorded at Washington. The importance of such publications is evident and a preliminary attempt has therefore been made in this article to prepare similar charts for the sub-tropical latitude of India (Fig. 5). Unfortunately, though the equipments necessary for keeping 24-hourly records are available at the laboratory in which the author works, it is not possible to keep such records over long periods for lack of funds.*

* The author has much pleasure in acknowledging with thanks the help he received from Prof. S. K. Mitra in the preparation of the article.

BEETLES AS BONE CLEANERS

An army of beetles has been mustered into the service of cleaning bones of small animals that are to be mounted, because the beetles do the job better and quicker than humans. Skeletons and skulls of animals are shipped to the American Museum of Natural History from points as far distant as Persia and Australia, and invariably there are scraps of dried meat clinging to them which must be removed before mounting. The collection of bones is placed in a metal-lined "arena", where they are attacked by hundreds of beetle cleaners. The insects are of a variety propagated from stock received from Africa and Asia.

—*Armchair Science.*

The Santal Tree-Press and Plank-Press

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IN an earlier paper I have described the tree-press of Nicobar and of Assam ; and in a post-script to that paper, I mentioned that the Santals are stated to have formerly used a similar press for oil making.[1] My enquiries in Santal Parganas proper regarding a tree-press did not lead to the discovery of any actual specimen. I was however informed in some of the villages that tree-presses had been known to have existed formerly. Thus Babulal, the head man of Amui, in Jamtara subdivision of the Santal Parganas, a man about 35 years of age said that he had heard of this press but never seen a specimen. His uncle (a step brother of his deceased father) Kandon, an old man over 60 years of age (computed on the basis of age of grand-children, and other statements) stated that he had seen the tree-press when he was a young lad. There was then a tree-press in Amui, and another in a village on the other side of the Ajoy river. He said that a stone was placed at the base of a *Mohua* tree, a hollow was made in its trunk and a thick plank about a foot and a half long (he said a cubit, which is of this size) was placed on the bundles of crushed and steamed mohul seed. Another plank, a little longer, was placed on the stone but under the bundles. A log was then inserted into the hollow, and pressure applied by means of a thong or rope tied to the log, and the lower plank. He gave a demonstration of how he had seen the press worked. He could not say who introduced the plank-press (*Sunum pāta*). But he stated that people found it safer to work the plank-press and therefore abandoned the tree-press. In the Jhargram subdivision of Midnapore I was informed that the tree-press had been in use about a generation ago. A Santal young man of age not more than 25 years, of the village Kalabuni, about three miles from Jhargram railway station showed me in this village where there was now the usual *Sunum pāta* or horizontal plank-press. There was a *Mohua* (*Bassia latifolia*) tree which had formerly been used for a tree-press. He said he had seen it worked when a boy. There had been a big hole (now a hollow) in the side of the tree and a block of wood or stone used to be put at the base. Baskets of steamed and crushed *Mohua* seed were placed on the block and pressure was applied on these by a log thrust into the hole in the tree. His statements were confirmed by the village elders independently. In village Kasia, I was shown a *terel* or *keond* (*Diospyros melanoxylon*) tree formerly used for a press. It is now known as the *cunruj pāta terel, i.e.*, the *terel* tree used for an oil press. There is now a *sunum pāta* here ; the tree-press disappeared over a generation ago. Only old men remembered having seen it in operation.

In Mayurbhanj, where I went during Christmas holidays in 1938 for field work, enquiries made of the Santals at a weekly fair led to the discovery of a tree-press in the village Rokoni, in Muruda Pargana. The village is about 22 miles to the east of Baripada, the capital of Mayurbhanj. The village has several hamlets, one of which Patiasahi is inhabited entirely by the Santals. In this hamlet I came across a plank-press of the usual type and also found the tree-press. The plank-press was found in several other villages near by, and not always in Santal houses. In Rokoni itself, in the main village, which is inhabited by potters mostly, I found a plank-press in the house of Judhisthir Behara, a potter by caste. The Oriyas call it the *Jānta* or press. The tree-press was subsequently found in almost every Santal village in this part of the country.

The plank-press is invariably owned by an individual ; but he allows his neighbours (co-villagers) to use it, for a consideration. Generally, one *poa* (quarter seer) of oil is made over to the owner for every five seers of oil pressed out. The tree-press in most villages was however stated to be the

[1] Indian oil presses and oil extraction : *Journal of the Indian Anthropological Institute*, Vol. I, 1938, Calcutta.

There is a short note on the Santal tree-press in *A Santal Dictionary* by P. O. Bodding besides the mention of it in the footnote to the folk tales.

property of the entire Santal hamlet. The press in Rokoni (fig. 1 & fig. 2) consists of the following parts :—

(1) The main tree trunk, of a thick living *Mohua* tree, with a hole in it, two feet from the ground level.
(2) The block of wood fixed to the ground before the hole, and just below it. It is roughly shaped and flat on top. Size—4′-3″ long, 1′-10″ wide and 1′ high. It has a circular groove on the outer half of the top surface about two inches wide and a foot in diameter. It ends in a lip at the edge of the block. In this lip is inserted a bamboo channel made by splitting into two a hollow bamboo a few inches long. The groove is known as *cando* and the channel of bamboo as *luta*. The *luta* may also be of palm leaf.
(3) The top plank. It is only a short oblong piece with two projecting handles. There are several such oblong planks about a foot long and ten inches wide. They are all termed *āphrā*.
(4) The presser. It is a long pole, being a slightly dressed trunk of a tree. One end is inserted into the hole of the big *Mohua* tree. Length, 13 feet. Diameter, 7 inches. Generally the length varies from 12′ to 14′ and the diameter from 6″ to 7″.
(5) The press-lever. In this particular type of tree-press, the pressure is not applied directly but by means of a lever, which is another similar pole (trunk of a tree) fixed in a hole in another big tree in a direction at right angles to the presser described in the previous paragraph. Both the poles are known as *jānta tārā*.



FIG. 1.



FIG. 2.

The tree-presses in the villages of Ajan, Sanniasi, Bahresahi and Camardonr (shown on survey maps as Bhaduasahi and Camardahani), while resembling this type in general outline varies in certain details.

In Bahresahi, Camardonr and Sanniasi, the fixed block at the base of the tree is of stone, with the usual groove and lip ; at Ajan, the block is of wood as in Rokoni. In Bahresahi, the presser "p" (fig. 3) rests on a forked upright "t" known as *Thesa Khunti* fixed in the ground near the end of the long pole, almost in a line with the hole and the stone. There is another upright log "k" known as *Khunti*, about two feet away to the side of this line (to the left, facing the tree). It has a pin, "h" *Khila*, at about a foot from the ground. The end of the press-lever is tied to the upright log (*Khunti*) and pin (*Khila*) and pressure is applied on the presser log, after taking the latter off the fork of the supporting log (*Thesa Khunti*). Three or four men sit on the presser to apply the necessary force.

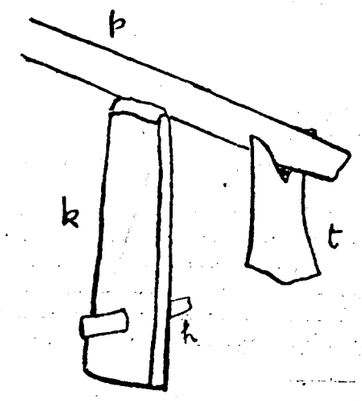


FIG. 3.

In the three other villages, two press-levers are employed. In Sanniasi there are two tree-presses at two ends of the hamlet, and both are of this type. In one of these there are two upright logs for tying the ends of the press-levers with fibres or thongs, one on each side of the middle line, *i.e.*, the presser and a couple of feet away from it. (fig. 4).

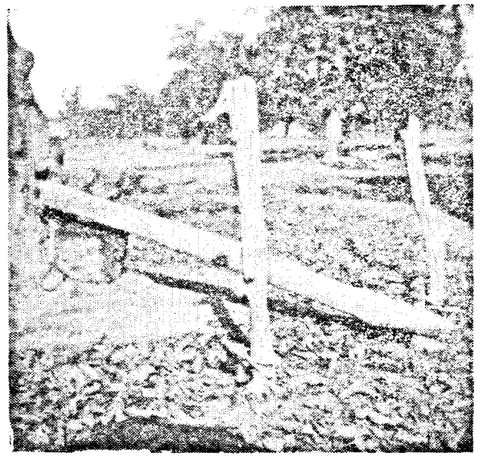


FIG. 4.

In the other tree-press, in Sanniasi, a thick root of the main tree of the press is used to tie one of the press-levers, instead of fixing an upright log in the ground. In Camardonr and Ajan slots are cut in the uprights and (fig. 5) the press lever ends inserted into them. Pressure is applied at the other ends of these levers by one or two men forcing them downwards.

The fork comes in handy for resting the presser in an elevated position, necessary for placing the bundles of seeds below its end near the tree. A tamarind tree was used for one of the presses in Sanniasi, and a banian tree was so utilised in the main hamlet of Ajan. Elsewhere *Mohua* trees were utilised. None of these villages, except Rokoni had a plank-press.

The tree-press has also been reported from Singhbhum among the Santals. It is also stated to have been in use until recently in a village in the Noakhali district of Eastern Bengal among the Hindus living near the border of Hill Tipperah. It has also been noted in my previous paper that the tree-press is found in upper Assam. A photograph showing its use in the Darrang district among Koches, was reproduced in that paper. A description was also given of the tree-press used by the Nicobarese who speak a language of the Austric group, intermediate in position to the languages of the Mundari and Monkh-Mer sub-groups.

The *Mohua* kernel, which seed alone is pressed by the Santals in these machines, is first of all crushed and then steamed. It is then packed in bundles of straw or in baskets termed *topa*, made in Mayurbhanj, of a creeper called by the local Santals *jāmlār*. The fibre is soft and strong ; and woven into round flat baskets of a check pattern, of diameter 7½ inches. The packed baskets are placed on the block of wood, on the *cando*, generally putting four to six baskets together one on top of the other. The top āphṛā is now put on the baskets and the presser adjusted to the middle of the top plank. Where there is only one press-lever, it is now brought over the presser, and three or four men sit on this last pole. Elsewhere the press-levers are fixed and pushed downwards. The oil dribbles out by the channel and is caught in a pot placed in position. After the oil has come out as far as possible under such pressure,

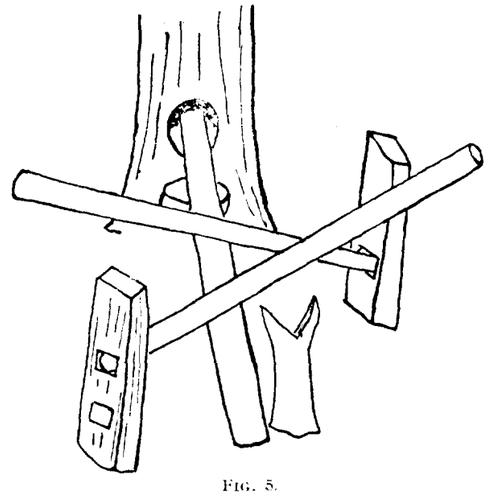


FIG. 5.

the presser and press-levers are raised, and two or more āphṛā planks inserted between the top plank and the baskets. Pressure is then again applied and further oil drained out. The cake that remains over is used as fuel. The tree-press is termed *cunruj pata* to distinguish it from the ordinary plank-press, termed *sarpa pata*, in Mayurbhanj.

Mohua oil is used in cooking in this part of the country and is also used to lubricate cart wheels. The plank-press in the house of Mangat Manjhi, a Santal

of Patiasahi in Rokoni was being used to press out *Mohua* oil on a commercial basis when I with my students visited the village in 1938. The owner had engaged three other Santals to help him in this work. At that season, *Mohua* oil was being sold at five annas per seer. The hired men were getting as daily wages five seers of paddy, worth about an anna and a half. We could not find out how much time or labour was spent on collecting the kernels. But we were told that Mangat and his three men would press daily ten to fifteen seers of oil, worth from rupees three to rupees four nearly. If only two persons worked at it, apparently five seers or a little more of oil would be pressed out in a day. This would be the number that would usually work if a family wanted to press oil out of kernels collected by it, with occasional help from other members of the family. I saw a (Santal) husband and wife, helped by another member of the family working a plank-press of a non-Santal in the village of Baldia to press out oil for domestic use. They stated five seers to be the amount obtained in a day and this was confirmed by the owner of the press. For lending the oil-press for a day, the owner would therefore get oil worth one anna and a quarter or perhaps a little more—practically half a day's wage for an adult. The daily rate of the wages varies from two to three annas a day for an adult in this area.

The tree-press of the Santals in Mayurbhanj differs from the single lever tree-press of Assam and Nicobar in respect of the arrangement for applying pressure. As noted before, an additional lever is employed. In other words it is a double lever tree-press. A reference to my earlier paper will show that I suggested that the double lever plank-press had evolved from the single lever tree-press. The Santal double lever tree-press furnishes evidence of the correctness of this view by preserving an intermediate type. We may try to reconstruct the possible line of evolution from the Santal tree-press to the full-fledged plank-press. The second tree, for the insertion of the press-lever as found at Rokoni, is replaced in the type used at Bahresahi by an upright log. There are slots cut in the uprights at Camardonr and Ajan, comparable to the hole in the second tree, for insertion of the press-lever. The slots however have given way elsewhere to tying with thongs or ropes. We may therefore presume that in later types, the living tree into which the main lever (here termed presser) was thrust, was replaced by a fixed upright. The presser had its lower surface dressed to prevent slipping and was tied to the fixed upright. The fixed lower wooden block (in place of stone) was extended and became the lower plank or log of the improved press, the *cando* remaining in the middle, and the channel for draining the oil naturally going to the side. The two uprights on the two sides would help to keep the two planks or logs of the press proper in position. The press-lever or levers would just be tied at one end, at the side and the force applied. The Seraikella oil press of first type (text figure 1, page 45 of my paper quoted) is an example of this kind of plank-press, with the planks vertical. It would be more likely that the forked upright which serves as a rest for the presser as noted before, will be used for tying the two planks together to keep them in position. This would make it more convenient to fit the press-levers in the loop of the thongs (or ropes) on the same side as each of the levers. I may add here that in Santal plank-presses two levers, one on each side of the planks, is also quite common.

The final improvement consisted in fitting the uprights at each end into the two planks or dressed logs, of the press instead of tying them. The press-lever continued to be tied to the upright, but the fulcrum of the lever was obtained by placing that end against the press as a whole for convenience.

The plank-press, as noted before, is not found in the purely Santal villages in Muruda Pargana. It is common in the villages where there is a hamlet of the Hindus, and is found also in the houses of the Hindus. It is found also among other people, as noted in my earlier paper. The Santals themselves admit that the plank-press has replaced the tree-press among them. In some villages in Jamtara, this happened two generations ago ; in Jhargram it occurred in some areas a generation or two ago. But it has survived in other parts of the Santal country, like Singhbhum, and notably in Mayurbhanj. It shows that the plank-press had assumed its present form among non-Santals before it spread to the Santals although the tree-press furnished the basis of it. The geographical distribution of the tree-press itself is limited within the bounds of the area to which the Austric speaking tribes spread in India, (including Nicobar Islands) although in two of the places (in Assam and Bengal) where the tree-press is found, such tribes have now disappeared. There is however an island of Austric speaking people near by, in the Khasi hills. Language may have changed and racial absorption even may have occurred in both these places while leaving the particular element of material culture to survive because of its simplicity and utility.

Octane Number and Super-Fuel

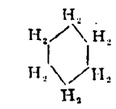
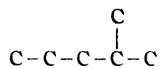
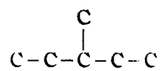
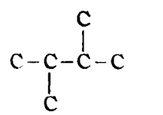
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SINCE the outbreak of the present war American scientific journals are writing ceaselessly that Germany has a very low stock of high-octane fuel, which is essential for aviation, and consequently is not in a position to continue the war for a long time. In the present article an attempt is made to explain what this high-octane fuel is and what bearing it has got on aviation.

In the early part of this century the naptha stripped from crude oil ("straight run") and recovered from natural gas was the only source of motor fuel. But it was discovered that the tendency of the fuel to "knock" restricted the power of the spark-ignition engines to convert the energy of the fuel into power. The thermal efficiency of an internal combustion engine is increased with increasing compression ratio, *i.e.*, for the same amount of fuel more energy is converted to power. Typical compression ratios of ordinary gasoline engines are near about 6 : 1. This means that the mixture of gasoline and air that is charged in the cylinder of the engine is compressed to one-sixth its volume before it is ignited by an electric spark. The products of combustion, being heated up to a high temperature by the heat of combustion of the fuel, develops a high pressure which forces the piston out and thereby converts the heat energy of the fuel to mechanical energy. With the "straight run" gasoline, if the compression ratio exceeds the value mentioned above the mixture of gasoline and air will not require a spark, but the heat generated due to compression only will raise the temperature so high that the mixture would start burning in the cylinder long before it should. The mixture would start burning while the piston is still compressing and thus cause a violent 'knock' or even force the piston back down the cylinder and cause the engine to start running backwards.

In order to have therefore more power from the fuel, the compression ratio of the engine should be high and the fuels with higher anti-knock properties must be used. The anti-knocking property of the fuel is measured in terms of octane number. The octane number of a fuel is expressed as the per cent of iso-öctane in a blend with *n*-heptane, which produces the same tendency as the fuel to knock in an internal combustion engine run under specified conditions. The octane-number of iso-öctane (2,2,4-trimethylpentane) is 100 and that of *n*-heptane 0 by definition. How octane number varies with chemical structure for a given number of carbon atoms is brought out by the following tabulations :

	Approximate Octane Number		Approximate Octane Number
C–C–C–C–C–C–C	40		
C–C–C–C–C=C	80		80
	70		
	80		
	120		100

Several years ago, the General Motors Corporation of U. S. A. carried out researches to find out the relation between the octane number and compression ratio. The fuels used in each case were just capable of avoiding a knock. A car was run both on the dynamometer and on the road. It was found that 69 octane-fuel was required for standard 5·25 compression ratio, about 95 octane-number for 8·0 compression ratio, and something better than 100 octane-number for 10·3 compression ratio. At a speed of 40 miles per hour, the miles per gallon im-

proved from 12·5 at 5·25 compression ratio to 18 at 8·0 and 21 at 10·3. The average increase in economy, between 10 and 60 miles per hour, is about 45 per cent in going from 5·25 to 8·0 compression ratio under these conditions of constant performance.

The importance of high octane fuel in aviation lies in more mileage with less fuel. Figuratively an increase from 87 to 100 in octane-number allows a plane to carry 1200 lb. less fuel on a 1400 miles flight. Seven more passengers or an equivalent weight of mail or freight may also be carried instead. Present 100 octane-number aviation fuels have made possible a 15 to 30 per cent increase in power for take-off and climbing, or a 20 per cent reduction in fuel consumption during flight, when compared to a previously available fuel of 87 octane-number. 100-octane fuels have increased both power per cubic inch of displacement and power per gallon of fuel.

Before a gasoline is to be used in an internal combustion engine, two important properties—high lead susceptibility and high volatility—are to be ensured to approach an ideal condition. Lead susceptibility is the property of a hydrocarbon which may be measured by the increase in octane-number obtained by the addition of a given amount of tetraethyl lead [$Pb(C_2H_5)_4$] ; therefore lead-susceptibility is the ability of a fuel to respond to "leading". This unique ability of tetraethyl lead to improve octane-number was discovered about 17 years ago. Addition of as small a quantity as 3 c.c. of tetraethyl lead per U. S. gallon increases the octane-number of iso-öctane itself to about 114. In all cases the first addition of lead produces the most marked effect. Gasoline containing tetraethyl lead was first put on public sale in a single service station in U. S. A. in the year 1923, under the now familiar name of "ethyl" gasoline. Fourteen years later, in 1937 about 66 million pounds of tetraethyl lead were marketed, sufficient to increase the octane-number of 20 billion gallons of gasoline by some 6 or 7 points. In the aviation field almost all gasoline of 80 octane-number or better contains tetraethyl lead. In fact, the performance of the modern military and the transport planes is due in large part to the development of high octane gasoline, a development in which tetraethyl lead has played an important role.

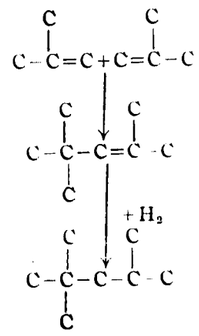
When the octane-number is so important in preventing the knocking in high-compression engines then question may be asked why iso-öctane itself or other high-octane ingredients are not used. Here the factor of volatility comes in. Gasoline must boil within a certain range of temperature, which varies somewhat with the grade of gasoline, its use, and the season of the year. Conventional aviation gasoline has an average boiling range of 180-210°F. Most desirable high-octane ingredients have a boiling point much higher than that (iso-öctane—200-240°F.) and so must be diluted with more volatile, less knock-resistant hydrocarbons. This reduces the octane-number of the blend. The decrease in the octane-number of the blend is increased by tetraethyl lead.

Side by side with the development of tetraethyl lead, the petroleum refiners are also striving hard to produce gasoline having high volatility as well as high octane-number. Thermal cracking of crude petroleum was originally introduced to satisfy the rapidly increasing demand for gasoline without using up all available resources. But the cracking operation, whereby higher boiling petroleum fractions are broken down into materials boiling within the gasoline range, did more than increasing the gasoline volume. It has given the refiner considerably better control over his product, by which the branchiness, the unsaturation, and the aromacity of gasoline can be increased, all of which make for higher octane number.

Next the process of destructive hydrogenation filled up the gap between the aromatic and aliphatic hydrocarbons and it has now become possible to go from one to the other. Operations at moderate temperatures in the presence of hydrogen, maintained at a pressure of several hundred atmospheres produces more gasoline from the crude than mere thermal cracking, and also removes the undesirable sulphur quantitatively. By means of operations at higher temperatures, extending for a longer time of contact than that of straight thermal cracking, it is possible to produce a material of high aromatic content. This type of hydrogenation has the additional advantage of producing high octane-number fuel in the higher boiling range.

The gasoline industry is now entering its fourth phase with the production of synthetic fuels. Gaseous hydrocarbons are also produced along with more gasoline from the process of thermal cracking. In addition to methane, these gases, include the two-, three-, and four-carbon hydrocarbons, and by suitable processes they are now being recombined to produce synthetic products having higher octane number and higher volatility. Polymerization of isobutylene in the liquid phase with sulphuric acid

produces 2,2,4-trimethyl pentenes which, on hydrogenation yield 2,2,4-trimethylpentane or iso-öctane :



The above is the iso-öctane used as a reference fuel for anti-knock evaluation. A few years ago the petroleum refiner had to buy it for evaluation purpose from the chemical manufacturer at about 70 rupees per gallon. Today it is being produced at a rate of million gallons per year for use in commercial aviation fuel. As will be recalled the octane-number of this product is 100 by definition.

Branched chains are also formed by direct additions of olefins to paraffins. This type of alkylation takes place with the aid of a modified Friedel-Crafts catalyst and even, in the absence of catalyst, at high temperature and pressure. Very recently a new compound called neohexane with a boiling point of 121°F. and with an octane number of 94 has been announced. The commercial process by which neohexane is being made is called "thermal alkylation". This is an alkylation reaction—the combination of an olefine with a paraffin. It is carried out at high temperature and high pressure in the presence of an excess of iso-butane. Neohexane has more lead susceptibility than iso-öctane so that on "leading" it has an octane rating of 115-120. Even a blend of 50-50 iso-öctane and neohexane has more lead susceptibility. Therefore neohexane and iso-öctane can be blended with other hydrocarbons to yield a blend in the right boiling range and with much higher octane-number than heretofore attainable.

This art of synthetic gasoline manufacture is being so much perfected that the petroleum chemists are thinking now of producing such hydrocarbons as tetramethylbutane and 2,2,3-trimethylbutane, which have octane ratings of at least 125. But is there any limit to this increasing trend towards higher and higher octane number and higher compression ratio? There appears to be a feeling in certain quarters that the ordinary automobile engine cannot utilize efficiently the fuels that will be appreciably higher in anti-knock value than those available today. In fact, testimony was recently presented to the Temporary National Economy Committee in Washington to the effect that the motor of today has reached the top in high compression ratio and therefore there is no need for further improving the quality of gasoline. But in the development of aviation, where power per cubic inch of displacement is usually more important than thermal efficiency, the situation is different. It has been demonstrated that a supercharged engine can utilize fuel of as high an anti-knock value as may be available. With the increase of intake manifold pressure for supercharging, the octane number of the fuel must also increase, if the knocking is to be prevented. An important advantage of supercharging is that for the same engine supercharged to 10 inches of mercury above atmospheric pressure, the horse-power ordinarily available in an unsupercharged condition rises to twice the original value. It may therefore be said that no limit can be now set as to the octane number of the fuel. The designers of the automobile engines of the future will alone decide whether they will be capable of utilizing the superfuel to be produced in days to come.

The Late Sir Joseph Thomson

WE regret to announce the passing away of Sir J. J. Thomson, O.M., F.R.S., Master of Trinity College, Cambridge and formerly Cavendish professor of experimental physics. His earthly remains have been interred in the Westminster Abbey by the side of his most brilliant pupil Lord Rutherford. He was the last of the line of British physicists like Kelvin, Stokes, Maxwell and Rayleigh, who received their early training in mathematical physics but later took up experimental research and who gave a characteristically British stamp to the development of physics in the latter half of the nineteenth century. We give below an account of his life and activities.

Joseph John Thomson was born on December 18, 1856 in Cheetham, a suburb of Manchester. He was intended to be apprenticed to an engineering firm. While on the waiting list a friend advised his father to have the boy, who was then only 14 years of age, admitted to the Owens College—which subsequently became the University of Manchester—for a course in engineering. His teachers were Osborne Reynolds in engineering, Balfour Stewart in physics, William Roscoe in chemistry, and Thomas Barker, a senior wrangler from Trinity College, Cambridge in mathematics. Amongst the friends he made at that time were Arthur Schuster and J. H. Poynting; the friendship with the latter, Thomson records to be one of the greatest joys of his life.

His father died soon after his admission to the Owens College, and as the family could not pay the heavy premium necessary for joining an engineering firm, it was decided to allow him to continue his studies in the Owens College, where he stayed for five years. Had it not been for the sacrifices made by his mother and the scholarships he won, it would not have been possible for him to continue his studies in Manchester and later in Cambridge. On the advice of his professor of mathematics, Professor Barker, he decided to appear at an entrance scholarship examination tenable at Trinity College, Cambridge. He was awarded a minor scholarship of value £75/- a year and a subsizarship at Trinity College which he joined in October, 1876.

He began to read for the Mathematical Tripos, and as was the custom he attended the classes of the famous Cambridge coach Dr Routh, of whom he has given a very interesting account in his *Recollections*. He attended the lectures of Cayley, Adams and Stokes, also N. D. Niven's lectures on Maxwell's *Electricity and Magnetism*. He sat for the Mathematical Tripos in January, 1880, and came out as second wrangler, the senior wrangler of the year was Sir Joseph Larmor. It is interesting to record that Prof. Homersham Cox of Muir College, Allahabad was the fourth wrangler the same year. Thomson used to visit the Cavendish Laboratory during this period, but somehow he never met Maxwell who died in 1879. Later on Thomson edited the second edition of Maxwell's *Treatise on Electricity and Magnetism*, to which he added a supplementary volume entitled *Recent Researches in Electricity and Magnetism*.

Thomson had done a certain amount of experimental research work in Manchester, one of which ended in an explosion which injured his eye, and for sometime it was doubtful whether his eye could be saved. After taking his B.A. degree in 1880, till his obtaining the Cavendish professorship, his time was fully occupied with both theoretical and experimental investigations. For his Fellowship examination, for which a dissertation had to be submitted, he took up a subject the suggestion for which came to him in Manchester while attending Balfour Stewart's lectures on the Conservation of Energy. Owing to the difficulty which he found in conceiving how one kind of energy was transformed into another, he made the assumption that all kinds of energy were kinetic in nature, the physical effects produced by it depended upon the nature of the system in which the energy found its home. He made use of, Langrange's and Hamilton's equations, which gave very general methods for dealing with systems possessing only kinetic energies, to problems in physics and chemistry. His dissertation was subsequently expanded into a book called

Applications of Dynamics to Physics and Chemistry. He was awarded the Adams Prize in 1882, the dissertation for which was subsequently published as *A Treatise on Vortex Motion*. The results and ideas obtained during the course of this investigation came useful to him later when dealing with the structure of atoms, and the nature of the electric field.

Another problem he took up at this period was the investigation of the behaviour of moving charged particles in light of Maxwell's theory, to determine the magnetic force due to the charged moving particle, and also the mechanical force acting on the latter in a magnetic field. The results were published in the *Philosophical Magazine* in 1881. One of the important conclusions drawn was, that a sphere of radius a with charge e appeared to have an extra mass $\frac{2}{3}\frac{e^2}{a}$, corresponding to the fact that when it was set in motion energy had to be put in the electromagnetic field surrounding it. It was Sutherland who pointed out that if the radius a was taken sufficiently small, *viz.*, about 2×10^{-13} cm., there was no need to suppose that the electron had any ordinary mass at all. This fundamental research of J. J. Thomson was the starting point of a number of important investigations by Abraham, Heaviside and Searle on the variation of the effective mass of an electron with velocity, with parallel experimental investigations by Kaufmann, Bucherer and Naumann, culminating in the Lorentz-Einstein transformations of the restricted theory of relativity and the principle of the equivalence of mass and energy. Another consequence of these investigations was the formulation of the electromagnetic theory of matter, *viz.*, the masses of all kinds of matter and the forces between them are of electromagnetic origin. Later investigations have shown the untenability of this theory.

The experiments undertaken during this period by J. J. Thomson were chiefly on the suggestion of Lord Rayleigh who had succeeded Maxwell in 1879. They were on problems arising as consequences of Maxwell's theory, the most important of which was the determination of the ratio of the electrostatic to the electromagnetic systems of units, which according to the theory ought to be equal to the velocity of light.

In 1882 Thomson applied for the chair of applied mathematics at Owens College, but he was passed over in favour of Schuster. He was elected a Fellow of the Royal Society in 1884, and in the same year he was chosen to succeed Lord Rayleigh as Cavendish professor of experimental physics, much to his and to everybody else's surprise as he states in his *Recollections*.

His tenure of the Cavendish Chair lasted from 1884-1918, when he was made Master of Trinity College. This period can be divided into two parts, the first from 1884-1895 was spent in organising the lecture and laboratory work for an increasing number of students, for which he had the able assistance of men like Glazebrook, Shaw, Fitzpatrick, Wetham, Searle. The beginning of the second period coincides with the new interest created in physics by the discoveries by Röntgen of X-rays, of a similar penerating radiation from uranium compounds by Becquerel and the isolation of radium by the Curies. The time was ripe for a mass attack on such problems by a group of research students working under the guidance of a master investigator. This facility was provided by the Cambridge University introducing regulations by which graduates of other universities were admitted to Cambridge as research students, and were eligible to the award of the Master's degree after two years, on the submission of a thesis which was considered to be of distinction as a record of original research. The reputation which the Cavendish Laboratory had acquired as a home of research attracted a large number of able students from all over the world, and the first batch had included men like Rutherford, Townsend and McClelland.

The investigations carried on by J. J. Thomson during the years 1884-95 dealt with the phenomena of the discharge of electricity through gases. The theory of electrolytic dissociation, proposed in 1887 by Arrhenius and Vant Hoff, had attracted the attention of J. J. Thomson and he wanted to find out whether a similar splitting up of the gas molecule took place under the influence of the electric field present in the discharge tubes resulting in oppositely charged atomic ions. In 1897 he was able to convince himself that the gaseous dissociation was of quite a different type. As he states in his *Recollections* he was very clumsy with his fingers, and throughout his series of important investigations on gaseous discharge he had the technical assistance of others; the first of his collaborators being his old friend R. Threlfall, who subsequently became professor of physics in the University of Sydney. In later period he had an assistant named Everett, a very skilful

glass blower, from whom all the research students took lessons in the art. In recognition of the services rendered by him, Everett was awarded the honorary M.A. degree of Cambridge University, a few years before he died. Other important investigations undertaken in this period were the classical investigations of Callendar on the temperature variation of metallic resistance, and the investigations by C. T. R. Wilson on the formation of clouds, which found very important applications later.

Since the introduction of the new regulations in 1895 the number of research students increased rapidly, and there were at one time or another students from almost every important university in Europe, Asia, Africa and America. Amongst them may be mentioned the names of the present Lord Rayleigh, H. A. Wilson, Barkla, O. W. Richardson, J. C. McLennan, F. W. Aston, E. V. Appleton, G. P. Thomson, P. Langevin, Max Born, Pringsheim, Bumpstead, K. Przibram, Smoluchowski and Vegard. With the increase in the number of advanced students, a Cavendish Physical Society was started in 1893, the primary object of which was to discuss recently published papers in physics. Opportunity was also given to research students to give accounts of their own investigations. Such meetings were preceded by tea presided over usually by Lady Thomson. Besides this there was the daily institution of afternoon tea in the Professor's room, where the research workers daily met. All topics except physics were discussed at such gatherings, from American politics to golf and football, in all of which J. J. Thomson took a lively interest. In 1898 was instituted the annual dinner of the Cavendish Physical Society, which was attended by many past students. A notable feature of these gatherings was the songs composed for these occasions by research students, the most prominent of whom was A. A. Robb. They were sung to the tune of popular music hall songs. Even the intricate Maxwell's equations did not escape the attention of the versifiers. The writer remembers attending the annual dinner in 1909, the year Rutherford was awarded the Nobel Prize. The latter attended the dinner prior to his journey to Stockholm. Robb composed a special song for the occasion enumerating all the benefits which α-particles has conferred on Rutherford.

J. J. Thomson was a shy man, the essential kindness of whose nature was hidden under a gruff exterior and a booming voice. He possessed a dry sense of humour which used to come out in his speeches and conversation. His experimental lectures were interpersed with many 'hoary annuals'. It is probably recounted of him that before beginning one of his stories he used to remark that 'those who attended my lectures last year need not laugh this time'. The affectionate regard of the research students towards 'J. J.' found expression in many stories about him, some of which were true and the others belonged to the category of 'ought to have been true'. His little eccentricities, and his occasional attempts to improve upon the experimental arrangement set up by his assistant Everett, some of which led to disaster were the subject of many amused comments. The existence of the positive electron was an article of belief with him, just as that of the neutron with Rutherford. While experimenting with positive rays one day J. J. Thomson obtained a photographic record which he thought was due to a positive particle of electron mass ; further investigation showed that it to be due to a spurious effect.

The experimental researches carried out by him during the period 1895-1914 were concerned with the nature of the cathode ray, the phenomena of gaseous ionisation and conduction, and the properties of the positive rays. For two terms in the year he used to give a course of advanced lectures on these topics, which later appeared in book form under the title *Conduction of Electricity through Gases*, and became at once a classic in the subject.

He was the first to show that cathode rays could be deflected by electric as well as by magnetic fields, and his researches contributed mainly to the establishment of the view that they consisted of negatively charged particles, which were named corpuscles by Thomson, but later on the suggestion of Stoney the name electron was adopted. These electrons were shown by him to be an universal constituent of matter, and whether emitted by radioactive or incandescent bodies, or by photo electric emission, they gave the same value for e/m. Some of the earliest determinations of the latter were due to him. The first determinations of the electron charge were undertaken in his laboratory by Thomson, by Townsend and by H. A. Wilson. It was left to Millikan to improve on Wilson's method, which led to the famous oil drop method of determining *'e'*.

His theoretical investigations during this period dealt with the structure of the atom, for which he proposed the model of a spherical volume distribution

of positive charge in whose atmosphere Z electrons were to be found, such that the total positive and negative charges were equal in amount. In such a model the electrons were subject to a quasi-elastic force. For this model he gave a formula for the multiple scattering of electrons and also of X-rays by thin layers of matter. The formula deduced for the last named effect, showed that the scattering per atom was proportional to Z, the number of electrons in it, and Barkla found that for some light gases with the exception of hydrogen, Z was about half the atomic weight—the first evidence of the fundamental role of nuclear charge in the theory of atomic and nuclear structure. He speculated deeply on the stability of electronic configurations in his atomic model and he showed how his model could explain the periodic law. But the key to the mystery of the atomic structure could only be found by the application of quantum theory by Bohr. Study of ionisation by X-rays and of the energy of electrons in photoelectric emission convinced J. J. Thomson as early as 1903, that the energy of electro-magnetic radiation was not continuously spread over the whole wave front but was concentrated in specks on the wave surface, *i.e.*, the energy was propagated in separate bundles. He could never accept wholeheartedly the implications of the Quantum Theory ; probably the difficulty of forming a model of the 'quantum of action' prevented him from considering the theory seriously. He belonged to the school of Maxwell, Kelvin and Rayleigh, who had definite views on the importance of using models as an aid to physical discoveries. His own attitude is shown in his most successful text book *Elements of Electricity and Magnetism* in which all the properties of the electro-magnetic field are expressed in terms of Faraday's tubes of force.

Towards the end of the period under review Thomson took to the study of positive rays ; he devised the parabolic method of focussing charged particles with the same e/m. The most important result obtained by him was the separation of the two isotopes of neon—the possibility of the existence of such isotopes had just been suggested by Soddy, from a study of the transformation of radioactive elements. Later Aston working in Thomson's laboratory considerably improved the focussing of the apparatus and made it into a precision method of determining atomic masses.

The work in the Cavendish Laboratory suffered from the outbreak of the last War, most of the workers were diverted to war work. Thomson was made a member of the Central Committee of the Board of Invention and Research. During this period he was also elected President of the Royal Society. In 1918 he was appointed Master of Trinity College, Cambridge, upon which he resigned his Cavendish professorship. Rutherford was elected to succeed him ; but he continued to work in the Cavendish Laboratory with his assistant and a couple of research students.

With the retirement of Thomson, a great change in the technique of the research work carried out in the Cavendish Laboratory took place. During his regime the equipment of most of the research scholars consisted of a Töpler pump, with charcoal and liquid air for producing high vacuum. Each student had to build up his own apparatus which was made chiefly of glass, and the ionisation currents were measured chiefly with the help of Wilson's tilted electroscope. Rutherford also did all his fundamental investigations with the aid of simple apparatus like the alpha-ray electroscope and the scintillation microscope, but he recognized the change that was coming in the technique of physical investigations. He gave facilities to Kapitza to build up an arrangement for producing intense magnetic fields, and started the Mond Laboratory for low temperature work. Cockcroft and Walton were given facility for setting up high voltage generators for nuclear disintegration work, and one of Rutherford's last acts was to obtain a donation of £250,000/- from Sir Herbert Austin for erecting a cyclotron.

Compared to the present scale of expenditure in the Cavendish Laboratory, it is interesting to note that in 1912-13 the extra amount spent on research by 40 students came up to about £550/-. In his *Recollections* Thomson makes the following confession 'It is not the first discovery of some new physical phenomena that is costly, *e.g.*, the discovery of X-rays by Röntgen, or radium by the Curies, of the long continued experiments of C. T. R. Wilson (leading to the visualisation of tracks of ionising particles) cost quite insignificant sums. Discoveries such as those were due to what cannot be bought, to keen power of observation, to physical insight, to an enthusiasm that does not falter until the difficulties and discrepancies which attend pioneering work is overcome'. He continues 'that when the first discovery is made, the effect observed is generally small and require a succession of lengthy

experiments to obtain trustworthy results. It is the attempt to get larger results that is so expensive . . such money is however well spent for it enables us to obtain them more quickly and with greater certainty". As will be evident from the account given above, his own investigations were of the pioneer type. He was interested more in the discovery of new phenomena rather than in the complete and accurate survey of a limited region.

After his retirement he paid his last visit to America in 1923, when he delivered a course of lectures on *Electrons in Chemistry*, which showed his interest in the nature of the chemical bond. In 1936 he published his *Recollections and Reflections*. Those who are familiar with pre-war Cambridge will find his reminiscences of men and events very delightful and entertaining. Of wider interest is his recollections and estimates of his teachers and great contemporaries.

He married the daughter of Sir George Paget, a well-known Cambridge physician. He is survived by a daughter and a son Prof. G. P. Thomson.

D. M. Bose.

ENERGY IN PETROL TANK

When we drive up to a gasoline filling station in our car and say calmly "ten gallons please", we are getting comfortably contained within a volume of about one and one-third cubic feet in our tank, the power equivalent, if expressed in terms of water in a reservoir elevated 100 feet, of 1,800 tons of water occupying nearly 600,000 cubic feet of volume.

—*Sigma Xi Quarterly.*

The Late Sir Oliver Lodge

WITH the death of Sir Oliver Lodge is removed from our midst one of those few physicists who, though brought up in the mechanistic school of rigid determinism, lived to see the advent of new physics in which determinism had hardly any place. Lodge belonged to the school of Kelvin, Poynting, Hertz, Crookes and Rayleigh to whom Newtonian mechanics and classical electrodynamics founded by Faraday, Maxwell, Lorentz represented all in physics. The few of that generation who lived down to the present time could hardly adapt themselves to the strange ideas of modern physics in which laws of mechanics are flagrantly violated, the distinction between matter and energy is fast disappearing and determinism giving place to uncertainty. Sir Oliver was no exception to this. It therefore seems strange that in spite of an essentially mechanistic outlook of the universe, Sir Oliver could, at the same time, be a staunch believer in psychical research and apply with characteristic energy and zeal his critical faculties for studying mysteries like the survival of human personality after death.

Oliver Joseph Lodge was born at Penkhull in Staffordshire on 12th June, 1851. He was the eldest son of Oliver Lodge, who owned a prosperous business of supplying blue-clay to potters. He began his education in Grammar School at Newport. At the early age of 14, Lodge left the school and was admitted into his father's business. At this time the boy chanced to come across a few old copies of *English Mechanics* which he read with great interest. The natural inclination of the boy towards science, which lay dormant, was thereby kindled. He grew restless, but, it was not until seven years had elapsed that he managed with great difficulty to obtain permission from his father to leave the business and step into the path of science.

At the age of 21, Lodge joined the University College at London where he took his D.Sc. degree in 1881 and was appointed assistant professor of physics. Sixteen years later he was elected professor of physics in the University of Liverpool, and was at the same time made a fellow of the Royal Society. In 1900, he was appointed the first principal of Birmingham University through the influence of Joseph Chamberlain. He obtained knighthood in 1902. During the last great war he served as a member of the Central Committee, which was the Governing Body of the Board of Invention and Research instituted in July 1915 with a view to giving expert advice to the Admiralty for organizing scientific efforts to meet the requirements of the Naval Service. Lodge resigned the principalship of the Birmingham University in 1919 and went to live in retirement near Salisbury where he breathed his last on August 22, 1940.

While at the University College, London, Lodge was attracted by the theoretical work of Clerk Maxwell which predicted the existence of electromagnetic waves. He naturally commenced his first experiments on electrical phenomena and related subjects. The nature of the discharge of Leyden jars was studied by him in great detail and in this connection he carried out illustrative experiments on the performance of lightning conductors. He was the first to call attention to the fact that the self-inductance of lightning conductors is of much more importance than the direct current conductivity. Even if the conductivity is adequate, lightning conductors may prove to be dangerous instead of being of any protective value, if the self-inductance is not low. In 1889, he delivered a lecture before the Royal Institution on the oscillatory discharge of a Leyden jar where he performed experiments to demonstrate the effects of the discharge on wires as well as in free space. He was no doubt working with electro-magnetic waves the existence of which had been established a year ago by himself and more satisfactorily by Heinrich Hertz. Like Sir J. C. Bose he repeated all the experiments of Hertz on electric waves using as detector a Branly's coherer modified by himself to increase its efficiency. He demonstrated beautifully the reception of the waves at a distance of a few hundred yards from the emitter—the waves being made perceptible by the deflection of a spot of light or by the impression of the signals on tape with the help of a siphon recorder. By this time he had also devised a new type of coherer which consisted of a greasy steel wheel maintained in constant rotation with its edge

dipping in a pool of mercury. Normally the pool is divided into two distinct portions having no conducting connection between them. When electric waves are incident the two portions coalesce and a conducting link is established.

Though Lodge performed his experiments on electric waves with great success, the idea that these waves could be made use of for wireless communication escaped his notice. In this respect he shared the lot of a number of physicists like Hertz, Dolbear, Righi and Hughes who had within their grasp the secret of an achievement of outstanding importance but, strangely enough, failed to realize it. This failure of so many brilliant workers to apply the results of a first class scientific discovery was due to a cause which is unfortunately only too common in the scientific world. A scientist, cloistered as he is in his research laboratory investigating the laws of nature and engrossed in the work of imparting knowledge to his pupils, finds little time and also frequently has little inclination to exploit the discoveries by applying them to satisfy some daily need of mankind. In this connection Lodge's own words may be quoted: "I was too busy with teaching work to take up telegraphic or any other development. Nor had I the foresight to perceive, what was turned out to be, its extraordinary importance to the Navy, the merchant service, and, indeed, land and war service, too." Speaking on the work of Lodge, Professor J. H. Poynting has said, "Whatever developments and changes may be made in the system of wireless telegraphy, there can be no doubt that Sir Oliver Lodge will always be recognised as one of the founders of the system, as a pioneer in researches on which others have built." Even after Marconi had succeeded in inventing his own system of wireless telegraphy, Lodge introduced certain improvements without which the practical applications of any system of wireless would have been seriously limited. In 1897, Lodge called attention to the fact that by tuning the transmitter and the receiver,—which he described as *syntonic telegraphy*—privacy of the messages transmitted and freedom from interference could be ensured. This invention was no doubt an invaluable and essential step towards the progress of wireless communication.

Lodge carried out successfully a very important experiment on the relative motion of matter and ether before the advent of the theory of relativity, at a time when the perplexing question of the reality or otherwise of the ether of space was agitating the mind of the scientific world. With great ingenuity Lodge devised his famous ether-drift experiment which showed that the velocity of light just outside moving matter is not influenced by the motion of the matter.

Although an experimental physicist, Lodge was a man of no small literary ability. He is the author of a large number of books on varied topics. His style is simple and vivid and unrivalled for clear exposition. This is particularly evident in his admirable work, *Pioneers of Science*, which, though written half a century ago, is still read with profit and pleasure by many. We cannot help quoting here from this book his striking description of the true man of science. He says—They are men "who seem of another age and country, who look upon the bustle and feverish activity and are not infected by it, who watch others achieving prizes of riches and pleasure and are not disturbed, who look on the world and the universe they are born in with quite other eyes." They are distinct from men "using the name of science but working for their own ends, jostling and scrambling just as they would jostle and scramble in any other trade or profession. These may be workers, they may and do advance knowledge, but they are never pioneers."

While engaged in purely scientific pursuits, Sir Oliver also devoted his time to psychical researches. In the early eighties there was a great vogue of experimenting with the so-called *spiritualistic medium*, not only amongst the laymen but also amongst distinguished scientists to whom the laymen looked for opinion and guidance. There were individuals, men and women, who claimed that while falling into a trance they could be in communion with spirits of the other world. Seances used to be held in celebrated centres of learning in which famous scientific men participated to find out the truth of such claims. We find Sir Oliver also drawn into the whirl of occult research at this time. But, while in course of the last sixty years there has been a general tendency amongst scientists to dissociate themselves from these investigations or, at any rate, not to commit themselves to any definite view regarding the nature of these phenomena, Lodge continued in his investigations and remained all along his life a staunch spiritualist. We find however, at times, his critical scientific mind asking pertinent questions and trying to interpret his experiences and observations in terms of the laws of the physical world. Thus, when a *medium* is found

to be detected in fraud he says that it does not necessarily follow that the medium has no psychic power. He would rather believe that when the control is lax and the medium finds that it is easier to produce the expected effects by fraud than by his psychical power he is tempted to take recourse to dubious methods. Again, when he tested the powers of the well-known medium Usapia Palladino, an Italian peasant woman, at the place of Professor Richet, he was satisfied about the genuineness of the phenomenon produced, namely, bulging out of curtains without any apparent connection with Usapia. He explained the phenomenon by saying that the medium had the power of thrusting out a sort of extra arm having mechanical qualities. To Lodge the spirit-world was a matter of intense faith. This undoubtedly led him to publish the famous work, *My Son Raymond—Life and Death*, embodying his experiences of the spiritual sittings in which he believed that the spirit of Raymond, a young son of his who had lost his life in the last great war, appeared and made his presence felt. We are not in a position here to give any opinion on this aspect of the activities of Sir Oliver. Be it said, however, that his writings on this subject, coming as they were from a man of his scientific eminence, found eager readers amongst the most intellectual persons and, what is more, had been a source of solace and comfort to thousands who had lost their near and dear ones.

S. K. Mitra.

HEALTHIER PLANTS

From the Horticultural Department of the American Chemical Paint Company comes news of the commercial production of a vitamin-hormone stimulant, Transplantone, for plants, that not only invigorates old roots but also multiplies the production of new ones, reduces the loss which frequently occurs with transplanting operations, and reduces wilting. It is applied to rooted plants to add to existing root growth and to force their general growth.

Transplantone is a water-soluble powder impregnated with vitamin B_1 and other parts of vitamin B_1 fraction, plus root—promoting hormones. The hormone initiates root growth and plant physiologists assert that the Vitamin B chemicals are necessary for the maintenance of their growth. That it is quite concentrated is obvious for it requires only one level teaspoonful to a gallon of water to make a stock solution which is then further diluted. Seedlings may be lightly sprinkled weekly, or it may be applied to plants set out in the soil, whether they be trees, shrubs, vines, annuals, or perennials. In the case of plants which are set out without a ball of earth, the manufacturer recommends that the roots be soaked in the stock solution for an hour. Treatment usually results in vigorous and extensive root growth and this, in turn, requires more frequent watering than is ordinarily necessary.

The manufacturer further claims that, owing to frequent clipping, grass is unable to produce enough vitamin and hormone naturally for the roots and that watering with an ounce of stock solution to three quarts of water will improve turf quality. Sods similarly treated before being set in place will also readily form new roots.

—*Scientific American.*

Notes and News

Ageing of Populations and its Consequence

In his presidential address at the centenary celebrations of the American Statistical Association Prof. Raymond Pearl pointed out how in many civilized countries there is a marked tendency for populations to age with time and how this has an important bearing upon the aggregate behaviour of those populations and upon the probable course and outcome of enterprises upon which the people embark as a whole.

Biologically the life cycle of man falls into three stages—pre-reproductive, reproductive and post-reproductive. People in the reproductive phase have to do the work not only to get their own livings but also the livings of the young and the major part of the livings of the old persons in the post-reproductive phase. From these considerations arises a three-fold age classification of 0-14 years, 15-49 years, and 50 and above. About 50 p.c. of all populations generally fall into 15-49 class but in the other two classes it varies largely. The population of India in 1931 had 39·9 p.c. in the pre-reproductive phase, 50·4 p.c. in the reproductive phase and only 9·7 p.c. in the post-reproductive phase, whereas in the same year the population of France had only 22·9 p.c. in the pre-reproductive phase, 51·4 p.c. in the reproductive phase, and 25·7 p.c. in the post-reproductive phase. This shows how the two populations are deeply differentiated biologically.

War is one of the significant forms of aggregate behaviour of a population, and a study of the populations of the chief protagonists in World War I of 1914 and World War II of 1939 yields useful information. On the figures of 1910-11, Germany and Austria had resources of upwards of 64 million persons of whom 33·5 p.c. were in the pre-reproductive phase, 50·8 p.c. in the reproductive phase, upon whom naturally fell the burden of fighting and producing goods for the troops and civil population, and 15·7 p.c. were over 50 years of age. Among the allies (France, England, and Belgium) the corresponding figures were a total population of 87·5 millions, of whom 52·2 p.c. fell in the fighter-worker class, in the under-15 phase were 28·5 p.c. and over 50 years about 19·3 p.c. At the outbreak of World War II the allies had total population resources of 87 millions of whom more than 25 p.c. (as against 19 p.c. in 1914) were of post-reproductive age. The fighter-workers show a decrease from 52·2 to 51·3 p.c. and instead of 28·5 p.c. of youngsters coming of age there are only 23·6 p.c. The population resources controlled by Germany has a total of 90 millions of which 53·7 p.c. (an increase over the 1914 figure) are in the fighter-worker phase while there are 22·4 p.c. in the older group and 23·8 p.c. in the group of youngsters. So far as population aspects of war are concerned the advantages and disadvantages accruing from that source have become reversed in the quarter of a century. Falling birth rates on one side and rising birth rates on the other have been in the main responsible. Analysing the white population statistics in the United States in 1840 and 1930 Prof. Pearl shows that while in 1840 each 1,000 worker had 1,984 persons, younger and older, to take care of, in 1930 each 1,000 supported only 880. The ever-increasing use of such devices as contraception as adaptive procedures to ease the burden of ageing populations may make life easier for the present generation but there is the fear that in future there will be none to live.

Improvements in the Electron Microscope

Drs L. Marton and V. K. Zworykin of the RCA Manufacturing Co., Camden, N. J., U. S. A. have developed a new electron microscope giving a total useful magnification of 100,000 diameters. The instrument employs three magnetic lenses, the optical equivalents of a condenser, objective and projector. The first stage or intermediate image is produced by the objective at a magnification of 100 diameters. This image is subjected to a further magnification of 250 by the projector lens which throws the final image at a magnification of 25,000 on to a fluorescent screen for direct observation or on a photographic plate. The photographic record

produces a further enlargement of 4 diameters giving a total useful magnification of 100,000 diameters. The technique of preparing specimens for examination has also been carried to a stage where the instrument is ready for use in a research laboratory. Such object as diatoms, viruses and bacteria which were far beyond the resolving power of optical microscopes have been brought under direct visual observation. The use of the instrument promises to yield much new knowledge about particles of colloidal dimensions.

Index of Body Build

Since Kretschmer emphatically and persistently directed attention to the correlations between habit of body and psychological and temperamental characteristics, the need for seeking a formula for an index of body build has been strongly felt by workers in the field. Various proposals have been made from time to time but none were found suitable as the human body from the geometrical point of view is a solid of extremely complex shape and is difficult to express adequately by a simple numerical statement or formula. The difficulty lies in the fact that changes in the size of the body occur in all three of the fundamental reference planes of the body, *viz.*, length, breadth, and thickness. After surveying the proposals Prof. R. Pearl suggests that the formula, Habitus Index $= \frac{100\ (\text{chest girth} + \text{abdominal girth})}{\text{Stature}}$, would meet fairly most of the requirements. Evidently the value of the index would increase as we pass from tall and skinny persons to short and stout persons, who will have the highest indexes. Another advantage is that the index involves only linear measurements. Moreover, all the three dimensions are definitely located and biologically significant. By actual trial this index has proved to reflect in a sensitive manner the differences between individuals in body build, and those in the same individual consequent upon changes in his body build with advancing age.

Automatic Distress Signals

The International Marine Radio Co., Ltd., has devised a new type of safety flashing light 'Raft-o-lite', which has been approved by the British Ministry of Shipping. The arrangement comprises a battery and light in a watertight case, provided with a float. When floating it will always assume a vertical position and the light is automatically switched on. When placed in an inverted or horizontal position the light is not in use. A flasher is incorporated and this is designed to emit automatically the international distress signal, 'S.O.S.' The flashing light after being automatically switched on will continue for at least fortyeight hours. These lights will be particularly suitable for oil-burning ships or oil tankers, where oil floating on the surface of water makes it dangerous to use open flames.

Coloured Photographs of the Inside of Human Body

Surgeons often use instruments to examine visually the interior of different parts of the human body. Three American surgeons have now devised an arrangement to take photographs in natural colours of the interior of the human body by adapting a miniature colour camera to the exploring instruments used by surgeons. They have actually taken photographs of the interior of the bladder by adapting the camera to a cystoscope. With the help of exploring instruments like the cystoscope it is possible to see inside the body cavities through a series of lenses arranged in a flexible tube with a tiny electrical bulb at its end. It is also possible to perform delicate operations with instruments which are thrust through the tube and manipulated with the help of the light. But with these only the operating surgeons could watch the operation. The new photographic method will make it possible to photograph the various stages of the operation and demonstrate it to others. Another great advantage is that the various kinds of cancerous and other growths, injuries and stones etc., can be photographed in their natural colours and these may be of aid to physicians in identifying and treating them.

New High Speed X-ray

Dr Charles M. Slack, research physicist of the Westinghouse Lamp Division, New Jersey, has developed a new ultra-high speed X-ray tube that would make it possible to take photographs of the inner structure of rapidly moving opaque objects or of objects reacting to a sudden external force or blow. High speed photography enables taking photos of bullets in air but the new device will make it possible to see what is happening to the bullet in its course through wood or other hard opaque substances. Engineers hope that the new device will enable machine and motor builders to study internal strains in rapidly moving parts. Even rifle makers will be able to determine any slight deflection of the bullet in its passage through the gun barrel. High speed X-ray tubes in use at

present permit exposure times of nearly 1/100 of a second which is fast enough for taking pictures of objects at rest. But an exposure of even 1/1000 of a second would be far too long for high speed work. The new tube is designed to receive a heavy surge of current only momentarily, from a series of condensers. The current flows for only about 1/1,000,000 of a second, creating X-rays, and the film also is exposed only during this extremely short interval.

Power From Uranium

ABOUT 35 years ago Einstein established the fact that mass and energy are quantitatively related. If a suitable method could be found to annihilate one pound of matter it would be possible to obtain from it 10^{10} kilowatt-hours of energy. The possibility was there and since then the search for a suitable process for this annihilation of matter or atom-smashing business or scientifically speaking transmutation of elements has been attempted by scientists all over the world. But the economic utilisation of the energy released was out of question.

This situation has recently changed due to the discovery of the peculiar behaviour of the nature's heaviest metal uranium (in the isotope 235) under neutron bombardment. When uranium is hit by a neutron that enters its nucleus, the atomic weight becomes 236 and it turns into a non-stable exploding atom which splits into two lighter atoms and the binding energy of the uranium atom to the extent of 200,000,000 electron volts is liberated. Recent experiments have definitely established that only one low-energy neutron, slowed down by water, would behave like a trigger setting off the energy liberation from uranium-235. This neutron also need not be supplied by any apparatus, but any neutron liberated from air by constant bombardment of Cosmic rays, and slowed down by passage through ordinary water will serve the purpose. All that is necessary to start Uranium-235 liberate its energy is to place it in an environment of ordinary water. A neutron liberated by Cosmic rays will be slowed down by water before it can hit the uranium atom. The atom will be split into two parts, liberating 200,000,000 volts of atomic binding energy and in the process other neutrons will be liberated from the U-235 atom. These neutrons slowed down by the water will split other U-235 atoms. The process continues as long as there are atoms left and there are 2500 billion atoms per gram.

The energy liberated from the atoms heats up the water so that it turns into steam which can then be put to work. Very small energy is required to bombard uranium-235. But the problem of obtaining uranium-235 in commercial quantities and at an economic cost must be solved first. Commercial uranium is a mixture of three isotopes of uranium—0·006% of the atomic weight 234, 0·7% of 235, and over 99% of 238. Attempts are however already being made to separate U-235 on a large scale. Prof. Wilhelm Krasny-Ergen of Stockholm have set up 30 ft. thermal diffusion tubes which have made possible an yield of 1·3 mgm. of U-235 per day. This would require about 3 years to get one gram of the substance.

An idea of the tremendous amount of heat released by uranium-235 can be had from the following facts: one pound of uranium-235 will give up 37 billion (37,000,000,000) B.t.u. on disintegration. This heat is equivalent to 1650 tons of Bengal coal (calorific value—10,000 B.t.u. per lb.). Assuming the present heat efficiency of 25% in modern steam power plants, this amount of heat will generate 2,700,000 kilowatt-hour by the existing methods. This would be enough to operate a 100 horse power motor continuously at full load for three years.

The best uranium ore is "pitch blende" in which it is in the form of its oxide U_3O_8, which is being used for many years as the commercial source of radium. At present there are pitch blende mines in Western Canada, in Australia, in Belgian Congo, and in Germany. There is some pitch blende deposits in India in the province of Behar. The present price of uranium oxide is about Rs. 20/- per pound, and that of commercial uranium metal about Rs. 160/- per pound.

It is very likely that the present central power plants will not be so much affected but considering its extreme concentration of energy, uranium-235 has an immense possibility as the future fuel for the powering of the aeroplanes, automobiles, ships, etc. With no improvements in the present conversion efficiency a car that runs 15 miles on one gallon of petrol would run about four million miles on one pound of uranium-235. But the technique is yet to be developed.

N. K. S. G.

Announcement

MR M. SWAMINATHAN, M.Sc., chemist, Nutrition Research Laboratories, Indian Research Fund Association, Coonor, has been awarded the D.Sc., degree in chemistry of Madras University, for his thesis "Nicotinic Acid and its rôle in Nutrition".

SCIENCE IN INDUSTRY

Mixtures of Staple Fibres with Indian Cottons

WITH the comparatively recent development of staple fibre—cut filaments of specified length, diameter and denier—leading to its being spun pure or blended with cotton, wool, etc., on the existing machinery, the textile industry has been offered an excellent material for producing an almost unlimited variety of yarns with novel characteristics. It has, for instance, been used in the manufacture of fancy plyed or crepe yarn, in hosiery goods, in union fabrics in which contrast effects have been produced, in imitation of light worsteds etc. The demand for these fibres has been increasing so fast that within the last decade their world consumption has risen from a bare 9 million to 1,000 million pounds. The Indian mills are evincing considerable interest in this new material and in the wide possibilities it may open up for producing novel and attractive fabrics when mixed with cotton. At the Technological Laboratory of the Indian Central Cotton Committee experiments have been undertaken to study the spinning quality of mixtures of Indian cottons with suitable staple fibres. Some preliminary work done at the Laboratory gave interesting results which were published in a bulletin. Recently more detailed study have been made, especially of the optimum conditions for spinning mixtures of staple fibre, 1·00" and 1·5 denier, with three Indian cottons, Jayawant, Cambodia Co.2 and Surat 1027 A.L.F., in which the proportions of staple fibre were 10, 15, 20 and 30 per cents. The pure staple fibre, the cottons and their mixtures were spun with different twist multipliers and drafts in order to investigate the effect of these important factors on the spinning behaviour of the material and the quality of the yarns.

It has been found that higher twists and larger proportions of staple fibre tend to reduce the dry yarn strength, while with lower twists the addition of staple fibre up to 20% improve the yarn strength. The wet strength decreases progressively with increase in the proportion of staple fibre in the mixtures, while the elasticity of the yarn increases. For the lower proportions of staple fibre the dry strength is very nearly equal to the wet strength, while the wet count work product is always higher than the dry count work product. Full details of this work will be published in a bulletin.

Jute Research and Universities

REALISING the importance of carrying out research on jute in the closest touch with other branches of scientific research, the Indian Central Jute Committee have decided on the policy of collaboration with the Universities of Calcutta and Dacca and to co-opt some professors of these universities on its Technological and Agricultural Research Sub-Committee. It is interesting to note here that in course of our review of the Report of the Imperial Council of Agricultural Research in the July, 1940 issue of this journal entitled "Agricultural Research in India" we commented on the lack of co-operation between the Jute Committee and the Universities at Dacca and Calcutta. We are glad now that steps are being taken to utilise the university laboratories for industrial researches. The immediate objects of collaboration are primarily two-fold. First, the Committee thought that the university scientists, many of whom were perhaps working on similar lines, might offer valuable advice on the work that was being done in the Committee's Research Sections. Even if their immediate work might be different from the investigations undertaken by the different technical sections of the Committee they felt that their familiarity with the basic scientific methods and processes might be of considerable help and value to the Committee's research workers. Secondly, the Committee were inclined to think that the universities, on their part, could also further their aims and objects by undertaking fundamental research on a number of subjects for which there was not, and indeed could not be, any room in the programmes of work laid down for the different sections of the Committee. Such fundamental investigations might lead to results of far-reaching consequence which might be of abiding benefit to the jute industry of this country.

Indian Material for a Harmless Dye

KAMALA, an orange-red powder consisting of minute red glands and hair of the fruit of an evergreen tree Mallotus, may have a synthetic dye industry of her own, following investigations at the Forest Research Institute, Dehra Dun. As a dye, it is used for imparting to silk and wool a bright orange or flame colour. The tree is common in the United Provinces and occurs in profusion in Bengal, Bombay and Orissa. The ripe capsules are gathered in February or March and the powder is collected either dry, by shaking the capsules in a bag, or wet, by stirring them in water and collecting the sediment in the form of cakes. Kamala has been used as a dye and an anthelmintic in India for centuries and has been exported to Europe and America for the same purpose for a long time. Lately owing to high adulteration there has been a setback in the export of this product.

The experiments at the Institute show that Kamala, when properly prepared, should not only find favour with the foreign importers once again, but it can also be profitably utilised in this country for a variety of purposes. The colouring matter, being soluble in oils and fats, could be employed for colouring hair oils, butter and its substitutes and in the form of its water-soluble sodium or ammonium salt, for colouring aerated waters.

In India foodstuffs are often deliberately coloured, but India is not yet producing synthetic dyes, all of which have to be imported, and therefore any suitable vegetable raw material for the extraction of an edible dye would find a ready market. In the United Provinces alone about 1,000 maunds of Kamala is collected annually, and the whole of it could be converted into dye and made available for colouring silk, wool, oils, fats, food materials, etc.

Marketing of Jute

THE first report of the Marketing Department of the Indian Central Jute Committee has just been issued. It confirms the general opinion that the present jute forecasts have proved of little practical value in providing for correct estimates of acreage and outturn.

The report is the result of intensive enquiry in 26 jute growing districts. Starting with a concise, but complete, description of the present system of crop forecasting, the report proceeds to examine at length the various stages through which the fibre passes from the grower to manufacturer or shipper as well as the details of the marketing organisation and the methods of buying and selling that are followed at all these stages.

The enquiry has also established that, during the season, 1937-38, growers sold 75 per cent of their jute in villages, 20 per cent. in *hats* and only 5 per cent. in baling centres. The early sales and the disposal of threefourths of the crop in villages are attributed mainly to the lack of growers' holding power, as well as to the prevalence of various market allowances and deductions, difficulties of rural transport, and dearth of storage facilities for growers in the markets. With a view to establish direct contact between producers and consumers, it is recommended that regulated markets, licensed warehouses, and co-operative Jute Sales Societies should be started (first as experimental measures) in villages, assembling centres and in Calcutta. The abolition by legislation of the existing market allowances has also been recommended. As the sale of jute in a completely unassorted condition, at all marketing stages up country, has led to the underestimation of quality by buyers, the universal adoption of sales by assortment and the introduction of grading in villages has been recommended. A price structure, which is an analysis of the various costs incurred on the movement of jute from villages to Calcutta, reveals the interesting fact that the growers, on an average, received a little less than 81 per cent. of the Calcutta landed price of jute in October, 1937. And out of the remaining 19 per cent., 10·1 per cent. was spent on handling and transportation, 3 per cent. was paid as market allowances and 6 per cent. was absorbed as standing charges of *kutcha* balers. It is also recommended that the classification and grade of jute should be fixed on scientific basis and experiments should be undertaken for the determination of the natural moisture in jute.

Industrial Researches at Forest Institute.

NEARLY five tons of a wide variety of papers—writing, printing, typing, wrapping, newsprint, drying, cover and brown papers—and mounting boards were made in the experimental factory of the Paper Pulp Section at the Forest Research Institute, Dehra Dun. Of these about three tons were supplied to various Government institutions, besides 1,100 lbs. of pulp supplied to the Archaeological Survey of India for use in the preservation of monuments. On paper made at the Institute was printed the latest annual report on forest research, about which a note was published in the last issue of this journal (p. 163).

Researches are being continued on the manufacture of wrapping paper from raw materials available in India's forests. Paper has been made both in the laboratory and at the factory from *ulla* sulphate pulp alone, and from mixtures of *ulla* sulphate pulp with *chir* sulphate and *chir* mechanical pulp. By grinding *chir* (*Pinus longifolia*) and *bendi* (*Kydia calycina*), attempts are being made to prepare mechanical pulp for the production of cheap wrapping papers and newsprint quality of papers. A fairly satisfactory quality of newsprint has been made from a mixture of *bendi* mechanical pulp and bamboo chemical pulp, and studies are being continued on the production of mechanical pulp from *bendi* and other soft woods.

With a grant made by the Govenment of the United Provinces, studies have been made of the possibilities of improving paper making processes, so that hand paper-making can be carried on as a cottage industry. Writing papers and envelopes (white and coloured), drawing papers, blotting papers, cover papers, wall papers, greeting cards, etc., have been made out of raw materials such as tailors' cuttings, paper cuttings, bamboo and grass pulp, etc. Other raw materials available in or near the villages will also be tried.

Another interesting investigation now being carried on is that for finding suitable Indian timbers for the construction and repairs of aircraft. Cypress from Garhwal in the green condition, gave encouraging results, but the timber seems to become brashy during seasoning. In a timber structure the joint forms the weakest link, and an investigation was started to develop proper methods of making joints. It has now been found that the incorporation of a small piece of bamboo ring, costing practically nothing, in the joint more than doubles its load-carrying capacity. Further tests are proceeding.

Identificatons of timbers form a routine work at the Institute and the total number of timbers identified during 1938-39 was about 400. Among those who benefited from the assistance given by the Institute were the different railways, the Defence Department, museums, the Meteorological Department, jute mills and various industries which use timbers in some form or other. On an enquiry from the Meteorologist, Upper Air Observatory, Agra, a sample of imported wood reported to be a good thermal insulator, has been identified as balsa (*Ochroma* sp.) of Central America. Sujit (*Cryptomeria japonica*) from Bengal and pangra (*Erythrina suberosa*) from the United Provinces were recommended for trial as Indian substitutes.

Leather Industry in Bengal

B. M. DAS

Superintendent, Bengal Tanning Institute, Calcutta.

LEATHER industry consists of making leather from hides and skins and manufacturing useful articles of leather. It has four main branches, *viz.*, collection of hides and skins, tanning, shoe making, and manufacture of other leather goods besides shoes. Each of these is sufficiently big in scope to form an industry or trade by itself.

HIDE AND SKIN TRADE

Bengal produces chiefly cattle hides and goat skins. Buffalo hides and sheep skins are available to a lesser extent. Besides the hides and skins of these domestic animals, there is quite a large supply of skins of such reptiles as lizards, snakes, pythons and crocodiles. The estimated annual value of raw hides and skins produced in Bengal is about one and a half crore of rupees approximately made up as follows:—

	Number of pieces.	*Value in rupees.*
Cattle hides ...	60·50 lakhs.	120 lakhs.
Buffalo hides ...	1·81 ,,	10 ,,
Goat skins ...	15·10 ,,	15 ,,
Sheep skins ...	2·20 ,,	1 ,,
Reptile skins ...	...	8 ,,
Total ..		154 lakhs of rupees.

Besides these indigenous hides and skins of Bengal, large quantities are sent to Calcutta from the Punjab, U. P., Bihar, C. P., and Assam.

Calcutta is the biggest market for raw hides and skins where purchases are made by tanners of Calcutta, Madras, Cawnpore and by hide and skin exporting firms which have their offices in Calcutta. So although Bengal's own production of hides and skins is worth a little over 1½ crores of rupees the total trade in hides and skins in Bengal is valued at about Rs. 4¼ crores annually. The total trade is tabuated below ; the figures are for 1937-38.

Export to foreign countries	...	Rs. 270	lakhs.
Madras	...	,, 96·5	,,
Cawnpore	...	,, 1·5	,,
Tanned in Calcutta ...	...	,, 53·7	,,

It will be seen from the above figures that of the total raw hides and skins disposed of in Calcutta 12 per cent only are locally tanned.

Good deal of work is involved in the hide and skin trade and a large number of people are engaged in it. The work consists of flaying, curing and preservation, collection from producing centres, despatching to principal markets, grading and selling to customers. In case of hides and skins exported to foreign countries further work has to be done, such as cleaning, trimming, grading according to exporter's standards of assortment, baling and shipping. Most of these works are technical in which considerable skill and experience are necessary to carry them out efficiently.

Flaying is the first operation. About 80 per cent of the cattle and buffalo hides of Bengal are derived from animals that die a natural death from old age or disease. The carcases are usually flayed by village *chamars* and the hides are, in many instances, their perquisites in return of the labour involved in the disposal of the dead body and its flaying. The *chamars* are on the whole skilful flayers and the hides from dead animals are usually taken off without being damaged by cuts and scores. In cities like Calcutta and Dacca a number of cattle are killed in slaughter houses for meat. These hides are flayed by professional butchers. They pay more attention to the meat than to the hide and in doing so invariably damage the hides by cuts and deep knife marks. The Indian Marketing Board is trying to improve flaying at slaughter houses by paying bonuses to butchers for good work.

If hides and skins cannot be put to tanning process within 12 to 24 hours of flaying they must be preserved from rotting and decay until they can be tanned. In most cases it is not possible to tan hides and skins so soon after flaying as tanneries are far away from centres of collection of hides and skins and are often in foreign countries and consequently several months usually elapse before they can be put to the tanning process. The process of preservation is technically called curing of which there are different methods. In the dry up-country centres of collection the hides and skins are simply dried out in the air. Cattle and buffalo hides of better quality are stretched lengthwise on wooden or bamboo frames and dried out in the stretched condition. These are called "Framed hides" in the trade. The inferior hides mostly derived from dead cattle are dried out simply by spreading them on the ground. On drying these hides shrink and crumple up and therefore they are known in the trade as "crumpled". On account of the long rainy season and the usual humid climate of Bengal curing by air drying is not possible in this province. In Bengal, hides and skins which have to be preserved long are cured by a special process called "Dry salting". This consists in spreading the hides and skins on the ground flesh side up and applying a solution of a saline earth, khari salt, 3 or 4 times with intermittent drying. When the hides and skins are suffused with this saline preservative, they are finally dried out. These are known in the trade as "dry-salted stocks". Goods of both the above two cures (air-dried and dry-salted) are meant for export overseas. The air-dried hides which are also called "Flints" are arsenicated (dipped in a solution of white arsenic) before shipment to prevent ravages by moths and insects during transit. Goat and sheep skins for export are mostly dry-salted and to a very small extent air dried.

For local tanning green hides and skins, *i.e.*, the hides and skins just after flaying are preferred. But if there be delay in sending them to tanneries they are preserved by the application of common salt on the flesh side but are kept in wet condition. These are known as "Wet salted" hides and skins. They keep sound only for a short time (from 6 to 8 weeks) and therefore this process of curing is followed only in the case of goods meant for tanning in India.

TANNING INDUSTRY

The main function of tanning is to convert the perishable raw hides and skins into a non-perishable substance which is called leather and to dress up this leather in a number of ways to make it suitable for the various uses to which leather is put.

Each variety of hide or skin is adapted to the manufacture of a particular variety or a number of varieties of leather depending on its basic

characteristics. For instance, a thick hard leather required for soles of shoes can only be made in this country from a buffalo hide which is naturally thick while a thin and soft leather for a wallet or money purse has to be made from a sheep skin which is thin and pliable by nature. Between these two extremes there are several varieties of leather which are commercially required and there are also raw hides and skins of suitable basic qualities for making them. In Bengal we have got the full range of raw hides and skins from the thick buffalo hide to the thin sheep skin which may be provided for nearly all varieties of leather in use.

TANNING MATERIALS

Commercial leathers in Bengal are manufactured mainly by two different processes of tanning, the vegetable and chrome. For the former, vegetable substances, *e.g.*, barks, fruits, wood, leaves etc., containing an astringent material known as "Tannin" are employed. These are called the vegetable tanstuffs. In Bengal, barks of *babul* and *goran* and myrobalan nuts are principally used. Barks of *sonali*, avaram and wattle are also occasionally taken recourse to.

Babul bark (*Acacia arabica*) produces a good leather which satisfies not only popular taste but also the specification for leather required by the military department of Government of India. Buffalo hides for sole leather, and harness and saddlery leather for military and civilian use, cow hides for suit cases, straps etc., are tanned in large quantities with this bark in Northern India, in the up to date as well as in the small cottage tanneries. The total annual consumption of this bark in Calcutta alone is more than one lakh maunds. Out of this only twenty three thousand maunds are produced in Bengal while the balance is imported from the Punjab. This import could be stopped if the bark were collected in Bengal.

Goran bark (*Ceriops roxburghiana*) is exclusively a Bengal product. *Goran* belongs to the species of plants collectively known as mangroves and grows extensively in the swamps of the Sundarbans. Large quantities of *goran* logs are felled every year in the forest and are brought to Calcutta with bark on. These logs are stacked in the open timber yards along the Belliaghata Canal in Calcutta exposed to rain and sun. The rain dissolves and washes off an appreciable proportion of tannin of the bark, and the tannin of the rain-soaked bark also ferments whereby it is partially decomposed and discoloured. This bark stripped from the logs is sold to Calcutta tanners. About two lakh maunds of it are annually consumed by the local tanneries. Carefully collected samples of *goran* bark have been found to contain about 35 per cent tannin whereas bazar samples do not give more than 20 per cent. It will thus be seen that for the faulty method of collection and stacking of *goran* logs in Calcutta the bark loses much of its tannin content and tanning properties.

Although singly *goran* bark does not produce good leather, it may be used with other tanstuffs such as *babul* bark and myrobalans with advantage. This material is not only rich in tannin but is also very cheap. It is sold from 0-8-0 to 0-12-0 annas per maund (1 maund =82 lbs.) whereas the price of *babul* bark is from 1-8-0 to 3-8-0 a maund. Besides, the *goran* tannin penetrating the pelt quickly shortens the period of tannage.

Myrobalans (*Terminalia chebula*) is purely an Indian product and used by tanners all over the world. India enjoys a monopoly of this material. The value of its annual export amounts to about 50 lakhs of rupees. The quality of myrobalans differs greatly according to the place of origin. The best grade myrobalans are obtained from the Madras Presidency and are known in the trade as "Salem" myrobalans. Central provinces produce large quantities, which are distinguished as "Jubbulpores". Madras myrobalans are wholly consumed in the tanneries of that province while bulk of the C. P. product is exported. Myrobalans are produced in Bengal but the quantity is small and the quality not very high. Besides the local products, myrobalans are imported from Mayurbhanj, Giridhi and C. P. to Calcutta. The local tanners consume about 90 thousand maunds of myrobalans valued at 1,25,000 rupees annually.

Used singly myrobalans do not produce good leather but they are invaluable as a material for mixing with other vegetable tanstuffs on account of certain characteristics they possess.

Avaram bark (*Cassia auriculata*) is an important tan stuff of India. It grows wild in South India and Rajputana. *Avaram* bark is at present used by tanners in the Madras Presidency in the half tanning of goat and sheep skins for export but in the Bombay Presidency cow hides as well as sheep and goat skins for export are tanned with it. In the half tanning of cow hides and buffalo calf skins for export the Madras tanners now use wattle bark imported from South Africa although at one time *avaram* bark was in use for this purpose.

Wattle bark (*Acacia mollissima*) contains tannin from 30 to 45 per cent averaging about 34 per cent. The cultivation of this species of wattle for the sake

of its bark is one of the principal industries of South Africa. It is an excellent tanning material which is now used practically by all leading tanning countries of the world. Recently the War Supply Board of Government of India has purchased 7½ thousand tons of this bark worth about Rs. 10 lakhs to keep a reserved stock as a safeguard against interruption of or delay in importing the bark due to the present war conditions. Cultivation of wattle trees in India for its bark deserves special consideration. *Acacia mollissima* has been found to grow on the Nilgiri Hills at an altitude of about 7000 ft. from the sea level. The forest department of Madras tried its cultivation near Kodaikanal. Wattle trees also occur in Travancore. The bark from these trees was found to contain 35 to 46 per cent tannin which compares favourably with the average tannin content of the South African bark. Commercial plantation of wattle should, therefore, be vigorously pursued in Madras where it has been proved that the trees can grow. The possibility of its plantation in Bengal may be investigated.

Sonali bark (*Cassia fistula*) contains 10 to 12 per cent tannin and used in Bengal to a certain extent. *Sonali* trees grow in a few places in the province but the bark is not collected on a large scale. When required commercial supplies are obtained from South India where it is known as konam. In Calcutta it was once used to a fairly large extent in tanning lizard skins for export but with the decline of this trade consumption of *sonali* bark was considerably reduced. Its use appears to be reviving again since the outbreak of the present war.

Minor Tanstuffs

Besides the above, a number of minor tanstuffs are used in the villages in crude small scale tanning. Some of these are barks of *ashan*, mango, sal, guava, *dahua*, *jam* and *amlaki* leaves etc. Use of these materials does not extend beyond local areas and they cannot be exploited on a commercial scale as their supply is not adequate and regular and leathers produced by them are not of the approved commercial standard. Besides the above certain tanning materials occurring in the Sunderban forests have been examined at the Bengal Tanning Institute and found to contain such percentages of tannin as would make them suitable for use as tanstuffs. Although these unexploited tanning materials are not yet really wanted by the tanning industry they are nevertheless potential resources of the province and may prove valuable in emergency.

Other Tanning Materials

In modern tanning practice, tanning extracts are being used in increasing quantities because they offer several advantages. In Bengal their use has commenced. At present mimosa extract imported from South Africa, quebracho extract imported from South America and locally manufactured myrobalan extract are used. Myrobalan extract manufactured at the Raneegunge factory is also exported to foreign countries.

A large number of chemicals, dyestuffs, mordants, fat an oil preparations, leather finishing materials such as gums, mucilagenous substances, waxes, gelatine, albumin, pigments, polishes and lacquers are used in the tanning industry. A few of them are locally produced but the majority are imported. The principal chemical used in chrome tanning is bichromate of soda. It may be produced locally from chromite found in Singhbhum district and other places in India. Among other things necessary, sodium sulphide and coal tar dyes deserve special mention. Manufacture of these chemicals and dyes in India is of national importance Although they require investment of a large amount of capital and big organisations it is essential that these industries are started in the country as early as possible.

Modern Tanning in Bengal

The Western processes of tanning to manufacture those types of leather which satisfy modern tastes and requirements, have been introduced in Bengal both by private enterprise and through Government help. The Bengal Tanning Institute under the Industries Department, has contributed a lot to foster the growth and development of the tanning industry in Bengal on modern lines. The principal chrome tanning centres in India are Calcutta, Cawnpore and Madras producing annually under normal trade conditions 15¾, 13½ and 11 million square feet respectively of chrome shoe upper leathers. It will thus be seen that Calcutta is the largest centre of chrome tanning in India. The principal varieties of chrome leather manufactured in India are the following:—

A. Chrome shoe upper leathers.

(*i*) Box and willow sides made from cow hides.
(*ii*) Box and willow calf from calf skins.
(*iii*) Chrome Patent leather from cow hides.
(*iv*) Glazed kid from goat skins.
(*v*) Glazed sheep skins.

B. Shoe lining leather.

(*vi*) Natural chrome sheep skins.

C. Chrome sole leather from buffalo hides.

(*vii*) White chrome sole leather.
(*viii*) Waxed or proofed sole leather.

D. Industrial leather.

(*ix*) Chrome picking bands from buffalo hides.
(*x*) Chrome lace leather from light buffalo or heavy cow hides.

Among these the first named, *i.e.*, box and willow sides, represent bulk of the production both in volume and value. About 3 years ago the total average annual output of this leather in India was about 32¾ million square feet valued at about Rs. 90¼ lakhs. The development of the manufacture of this chrome leather in Calcutta during the last 25 years has been phenomenal. About the year 1914 not more than 1½ lakh square feet of this were yearly manufactured in Calcutta. The present output is about 15 million square feet annually, an increase of 100 times. At present on account of the improvement of quality, Calcutta's box sides and box calf are being freely sold in large quantities not only all over India and in the export markets of Burma, Strait Settlements, Iraq, Cyprus, Africa but also in the United Kingdom, in competition with similar leather produced in Europe and America.

Since the Ottawa Agreement of 1932 an export trade in Indian chrome upper leather, chiefly box sides and box calf, has developed. The peak of this export trade was reached in 1937 when 11·714 million sq. ft. of these leathers valued at Rs. 54,13,500 were exported to England from India. The chrome tanneries in Calcutta had considerable share in this trade. At present a number of these tanneries are engaged in this export business. The Bengal Tanning Institute by its researches and training has contributed considerably to this development.

The Bengal Tanning Institute has also worked out a process for the manufacture of a superior type of sole leather from buffalo hides by pit tanning. Besides this leather no other varieties of improved vegetable tanning are as yet manufactured in this province.

The manufacture of chamois leather from goat skins by formaldehyde and oil tannage was introduced in Calcutta chiefly through the experiments conducted at the Bengal Tanning Institute. A passed student of this Institute is now manufacturing this leather on a commercial scale. The quality of the leather is good and it commands a ready sale.

Alum dressing is used in the dressing of skins of such wild animals as tiger, leopard, deer etc. sent to the taxidermists by *shikaries* and others. Taxidermy is fairly well done in Calcutta.

Marketing of Leather

As already stated, leathers produced in Bengal are sold in India and also exported abroad. For the Indian market as well as for markets in the overseas countries like Burma, Strait Settlements and Iraq, the distribution is done through Punjabi leather dealers. They purchase from the tanners and sell the leather in the markets. A very small proportion of the leather is sold by the tanners directly to the shoe makers and other consumers of leather.

Some of the large tanneries have their own sales organisations, and those who have middlemen as their selling agents can manage to control them so that they may not go against their interest. The real difficulty is with the small tanners. The middlemen exploit their weakness and the small tanners are often forced to sell their products below cost and are thus eventually ruined. Organisation of co-operative sale and supply societies among small tanners offers a solution of this problem. Such sale societies should undertake selling of Bengal leathers not only in India but also in other principal markets where those are sold. These societies will be able to do away with the middlemen as well as consignment sales in England.

Shoe Industry

The leather shoe industry in Bengal has developed to the extent of having an annual output worth more than a crore of rupees. But as yet not more than 20% people of the province wear shoes. With the spread of education and rise in the standard of living shoe wearing and demand for leather shoes will gradually increase. To meet the growing requirements of this province alone the industry will have to be considerably expanded. It may also manufacture shoes of a suitable quality for export and sale in the overseas markets. Thus there is a very big scope for the development of this industry in the province.

Another line of development will be manufacture of military and police boots. As yet there is no establishment in Bengal in which this line of

work has been taken up. For the manufacture of army and police boots and shoes the factory must be equipped with modern machinery.

As yet the share of the Bengalees in the shoe industry of the province is very small. The Bengali leather working caste, the *rishis*, having lost all grit and stamina due to poverty have to a very large extent given up shoe making and leather work. The middle-class Bengalee considering it derogatory to pursue shoe making as a profession have always looked down upon it. So there was practically none in Bengal to seek a share of this growing industry of the province. It was only after facilities were offered for training in the craft with the establishment of Boot and Shoe and Leather Goods Making Department of the Bengal Tanning Institute that the educated *Bhadrolok* youths of Bengal were attracted to this line of business. At present the trained students of the Bengal Tanning Institute are holding a small share in the present shoe industry of the province.*

* Adapted from a lecture delivered at the Calcutta Corporation Commercial Museum on July 20, 1940.

ERRATA

In the article entitled, 'Artificial Fertilizers in Indian Soils', published in the last September issue, on p. 136 please read the sixth line from the bottom of the left column as "2,000 tons per annum are manufactured, *according to Sen Gupta (1940)*, by Messrs." The italicised portion was left out.

In the same issue, in the article entitled, 'India's Industrial Waste: Fusel oil,' in Table III on p. 171 in the third column read the figure for ethyl alcohol from Cawnpore Distillery (U.P.) as 0·57 *instead of* 5·57.

MEDICINE & PUBLIC HEALTH

Training of Public Health Officers

THE annual report of the All-India Institute of Hygiene and Public Health for the year 1939 reviews modern trends in the training of public health officers. Current thought is increasingly, throughout the world, attaching a much wider significance to the functions of public health. These now imply a study and control of all factors which affect the health of the community. Medical measures alone are insufficient to ensure that the community has or attains a normal standard of health.

The function of investigation and training in public health is the development of the most efficient and practicable methods of scientific medical protection through organized community effort and the provision of opportunity for students to train themselves in the principles and application of those principles and methods. For the provision of opportunity to the students to train themselves and for a study of all the factors covered by the term public health, the necessity for the inauguration of "controlled areas (to permit exemplification of methods) of a size sufficient to provide quality and quantitative facilities for students' self-participation" is emphasised. The development of the most efficient and practicable methods of scientific medical protection through organised community effort can be achieved through research. The absence of controlled community fields however places the Institute under the same disabilities as would be faced by a department of clinical medicine in undertaking research in the absence of a teaching hospital.

The report points out the deficiencies in the present organisation of the Institute and in the curriculum and training and mentions that stress has been laid on the definite requirements of this country in determining the line of reorganisation.

"Public Health", the report points out, "is organised community effort for medical protection, and, as such, is social medicine, the utilisation of which must be different under varying social-economic conditions even although the principles derived chiefly from medical biology are universally similar. Consequently, it is essential that organisation for instruction and research must vary from country to country during the levelling up process. Malaria must be afforded an importance in India that would be uncalled for in England. Health insurance cannot be given the same prominence in China as in Germany."

An account is given of the progress made in the introduction of reforms in the training of public health officers and mention is made of the proposals under consideration for bringing the All-India Institute up to a standard comparable with similar institutions in other and more advanced countries.

The report goes on to say: "The D.P.H. training should be one of the first educational fields to demonstrate the greater demand for local qualifications in the light of local variabilities in administrative practices. This recognition will be accorded shortly after the students are given adequate practice locally under Indian community conditions".

State Monopoly of Medicine

IN a discussion on State Medicine: Its Proper Sphere, at the Royal Society of Medicine, London, Dr Alfred Cox's argument against making medical service totally a State one was that it would degenerate to the ordinary out-door practice and only "mass medicine", and a proper examination would not be possible. While treating a case, individual attention of a doctor counts much, hence medical attendance is to be left to the profession without being encumbered with any restrictions from outside. He said that the State should be more active with regard to the (*a*) public health schemes, (*b*) health insurance schemes, and (*c*) research work under the universities and research councils. Dr Andrew Topping was very pungent in his remarks and said that the general practitioners practising for about ten years knew less medicine than they did when they had qualified and that in course of their practice they sometimes hoodwinked the public. The consultant branch was also not spared by him. The

pecuniary condition has been at a low ebb and jobbery there is quite rampant. For proper medical work, a medical man should be relieved of his worries for an annual income sufficient to live according to his proper status. Dr Fraub Gray stressed the difficulties which officialdom would bring in the work and hinted that assured income would lead towards slackness in work of the officially employed persons. The general view after the discussion was that some sort of specialist practice should be encouraged and the national insurance scheme should receive more support from the State and should be applied widely as the general health of the people is a matter vitally concerned with the administration of a country.

P. K. C.

Nutrition Research

THE Indian Research Fund Association was formed in 1911 and since then it has devoted increasing attention to the study of nutritional problems and to the practical application of the fruits of such study to the improvement of the diet of the people. Nutrition research has proceeded on the lines of surveys of the state of nutrition and the dietary habits of the people in various parts of the country, the analyses of the common foodstuffs of India for ascertaining their nutritional value, and discovering cheap substitutes in order to meet recognised deficiencies in Indian diets. Rice, as the staple diet in many parts of India, received special attention during 1939, for which year the Report of the Scientific Advisory Board of the Association has recently been released for the public. A memoir entitled *"The Rice Problem in India"*, which deals with different aspects of the subject, has been published. The results of over 50 diet surveys in different parts of the country have been embodied in a special publication by the Association and this should prove to be of value to provincial Departments of Agriculture in shaping agricultural policy in order to meet existing diet deficiencies.

The training of health personnel in nutrition work, which was started in 1937, continued in 1939 and seventeen workers from various provinces and Indian States attended a three-months' course. A new edition of Health Bulletin No. 23, entitled *"The Nutritive Value of Indian Foods and the Planning of Satisfactory Diets"* was issued during the year and a nutrition museum was established at the Nutrition Research Laboratories at Coonoor, which is maintained by the Indian Research Fund Association. Researches into different nutritional problems involved investigations in many centres, including medical colleges in Lucknow and Bombay, the departments of chemistry in Dacca and Calcutta universities, the All-India Institute of Hygiene and Public Health, Calcutta, the Nutrition Research Laboratories Coonoor, and the Imperial Agricultural Research Institute, New Delhi.

Study of Major Diseases

The Malaria Institute of India took a leading part in directing anti-malarial operations and research on scientific lines. The annual class for training in malaria for medical officers from different parts of the country was held at Delhi by the Institute and 24 medical men attended this course. A new health bulletin entitled *"Lectures on Malaria"* was prepared and a new edition of the practical entomological course for medical officers was published.

Plague research is mainly centred at the Haffkine Institute, Bombay. At the Cumbum Valley in Madras Presidency various field studies in regard to the control of epidemic outbreaks of the disease have also been in progress for the past eight or nine years. At the Haffkine Institute as a result of research work on an anti-plague vaccine a serum for the treatment of plague patients had been prepared by this Institute and had undergone limited trials with encouraging results during certain epidemic outbreaks of the disease. At Cumbum Valley the research consisted mainly of work on the prevention of plague by the use of chemicals for rat destruction in rat holes and by the reduction of rat infestation in houses through improved construction.

An investigation was carried out into the existence of varying degrees of disability among the population of certain areas in Madras Presidency as the result of high concentrations of fluorides in the drinking water supplies of those areas.

Researches by field and laboratory studies into leprosy have shown that, in respect of chronic bone and nerve pain associated with leprosy, the adoption of a wheat diet by the patient affords considerable relief. Another important finding is that the administration of skimmed milk to children with the more severe forms of leprosy appears to help towards a cure.

The enquiries supported by grants from the Indian Research Fund Association include most of the major diseases affecting the health of the people of the country. A total sum of nearly Rs. 4,76,000 was distributed during 1939 in the form of grants to the different enquiries.

Some Aspects of Biometry

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A PHYSICAL event, quantitatively described, is produced by the operation of one or more causes. For instance, the weight of a man is causally linked with his heredity, age, occupation, diet and numerous other small factors. Experiment, the tool of the scientist, derives its use from the ability of the experimenter to replace complex systems of causation by simple systems in which only one causal factor is allowed to vary at a time. This is an ideal which is rarely approached in practice. For, consider a problem in nutrition to assess the influence of two different diets on the growth of children as measured by the increase in weight. The subjects of the nutritionist's experiment, namely, children, cannot be brought under complete control in the sense the laboratory conditions like temperature and the like can be controlled. The nutritionist may however try to control his experiment as far as he can by allotting children which are of the same race, religion, caste, sex etc., to the two different diets under consideration or in other words by equalising the two groups in respect of all these factors. He may even ensure that the two groups enter the experiment at the same age, but if he decides that ages of the two groups must be the same, then other factors like the weight etc., will necessarily differ and will affect the differences in the final weights of the two groups. The situation is analogous to the agricultural experiment in which different numbers of plants might grow on two plots equal in area but treated with different manures. The difference in yields of the two plots may here partly be due to the different number of plants grown in the two plots. On the other hand, if the experimenter decides to calculate the yield on equal number of plants, then the areas occupied become different.

It will thus appear desirable to introduce into the experimenter's comparisons of the two yields a correction which makes allowance for the variation in yield due to differences in plant number itself. In precisely the same way, the nutritionist may like to estimate the effect on final results of the differences in initial weights and adjust the final results in accordance with the estimated effects with almost as great an accuracy as if complete equalisation had been possible in regard to weight. Even so there may be numerous other genetic and personal factors which cannot be measured but which will seriously affect the differences in weights of the two groups. The experimenter cannot possibly eliminate those factors. Even in physics and chemistry the errors of personal observation, of instruments, changes of moisture, etc., cannot be completely eliminated, but they generally form so small a part of the real differences that they can be ignored in arriving at conclusions. The nutritionist cannot afford to do so.

It is with quantitative problem in which the data are affected by numerous causes that the science of statistics is concerned. Its object is two-fold: (*i*) to build up a statistical design so that valid and conclusive inferences are made possible, and (*ii*) to interpret the quantitative data of the experiment so that due attention is paid to the influence of the numerous uncontrolled factors. The tool or the method which is considered appropriate to interpret the data in question is called the statistical method. The principles from the consideration of which the method is derived constitute statistical theory and the means by which it is derived is pure mathematics. When the problem under consideration is a biological problem, the science of statistics is said to be biometry.

Whether it is an experiment to assess the difference between different diets given in different quantities and in different environments or an enquiry to estimate the incidence of tuberculosis in the population, the first question with which the statistician is concerned is the planning of the experiment or the enquiry under consideration by which is meant not the drawing and numbering of items in the schedules to suit the requirements of the sorting machine but the structure that will guarantee in the first instance valid inferences through the appropriate process of randomisation and in the second instance greatest accuracy for the results through such devices technically known as that of equalisation, concomitant observations, replication, confounding, stratification and the like. It is not possible to explain here even the rudiments of these principles which constitute what is known

as the science of design of experiments but I shall illustrate later what rôle some of them can play in securing greater accuracy for the results.

It is a historical accident that this science which should have been developed before or simultaneously with the statistical method, actually had its foundation laid much later. The necessity of developing it was always perceived by experimental scientists as will be clear from the following quotation by Robert Boyle in 1673. He writes to his friend, "I am very sorry, that to the many difficulties which you may meet with, and must therefore surmount, in the serious and effectual prosecution of experimental philosophy I must add one discouragement more, which will perhaps as much surprise as dishearten you ; and it is, that besides that you will find many of the experiments published by authors, false and unsuccessful, you will meet with several observations and experiments which, though communicated for true by candid authors or undisturbed eye-witnesses, upon further trial, disappoint your expectation, either not at all succeeding constantly or at least varying much from what you expected." This difficulty in experimentation has been all through at the back of the experimenter's mind, but the concepts of inductive reasoning, of arguing from observational facts to the theories which may explain them, such as were developed in those times, were too rudimentary to surmount it. Thomas Bays, the author of the celebrated treatise on inverse probability, was the first to attempt to give an exact quantitative theory of inductive reasoning, but he was never satisfied with the validity of the theory which he put forth. He was so critical of its validity that he never agreed to publish it. It was actually published after his death by his friend Price. To R. A. Fisher goes the credit of laying the theoretical foundation of this science. It was he who first perceived that statistical method and experimental design are only two different aspects of the same whole and that whole is the logical requirement of the complete process of adding to knowledge by experimentation. He outright rejected Bays' "inverse probability." He showed that it could lead one nowhere. He instead proposed a new concept known as likelihood, which is the theoretical foundation of modern statistics.

Having obtained his data and satisfied himself that these are reliable enough to permit him to proceed, the statistician must rearrange them until they are ready for the application of his method. For when we have a large number of values noted merely in the arbitrary order in which they occur, the mind cannot grasp the full significance of the whole record. Some shape of condensation becomes necessary. The most common form of condensation is known as the frequency distribution. Its concept would be clear from figure 1 which shows the frequency distribution of lethal doses of strophanthin. On the horizontal scale of the diagram are marked the lethal doses. On the vertical are marked the number of frogs killed. A lethal dose of ·235

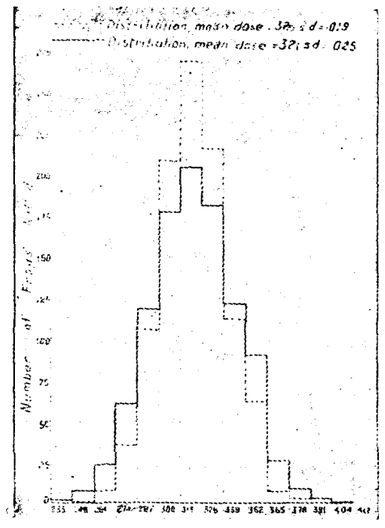


FIG. 1. Illustrating the frequency distribution of lethal doses of strophanthin (indicated on the horizontal scale).

was given to each of 1,000 frogs. As the dose was gradually increased from ·235 to ·248, two frogs were killed. As the dose was increased from ·248 to ·261 a further number of 7 frogs was killed and so on. The intervals from ·235 to ·248 or from ·248 to ·261 etc., are known as class intervals. The numbers of frogs killed by doses defined by the class intervals are called frequencies. The manner in which the frequencies are distributed over the class intervals is known as the frequency distribution. The diagram shows that the average lethal dose was about ·32. It shows that majority of frogs was killed by a lethal dose ranging round about ·32. In particular it shows that about 95 per cent of the frogs were killed by a dose ranging from ·27 to ·37. The diagram shows that as the lethal dose increased or decreased, frequency becomes less and less.

It will be clear that by condensing information in the form of frequency distribution we have got a very necessary clarity about the behaviour of the number of frogs killed with the increase or decrease of lethal doses, but it is also clear that in doing so

we have sacrificed a certain amount of information. For 13 groups cannot possibly replace, thousand different figures without a loss of some information. We shall not however dwell on this point much longer. It is sufficient to remark that while clarity must be gained at the expense of some information, the loss of information is generally negligible if the magnitude of the class-interval chosen is sufficiently small, so that the whole number of frequency-classes lies approximately between 15 and 25.

If the frogs were more homogeneous in their resistance to the dose of strophanthin then the above group of 1,000 would be shown in continuous line. In other words, if the two frogs which were killed by lethal dose of ·235 to ·248 were less sensible to strophanthin than they actually were or the two

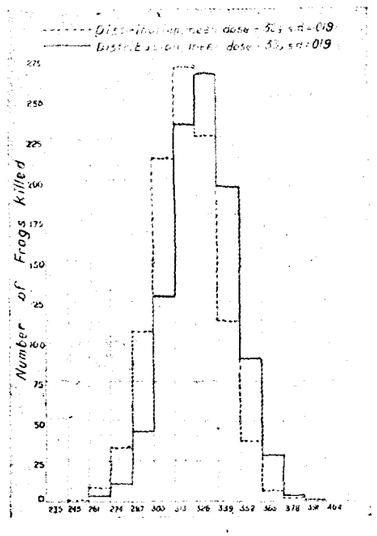


FIG. 2. Illustrating the frequency distribution of modified lethal dose of strophanthin (indicated on the horizontal scale).

frogs which were killed by the lethal dose between ·391 to ·404 were less resistant, then with the average lethal dose remaining the same, the scattering of the frequency distribution about the average value would be less than that in the first group of 1,000. In other words, variability of the lethal dose in this more homogeneous group of frogs would be less than that in the first group. The situation is clearly depicted in figure 1. In exactly the same way we may have a group of frogs all with uniformly better resistance than those belonging to either of the two groups shown in figure 1 thus giving a larger value for the average lethal dose. The situation is illustrated in figure 2.

A comparison of the two frequency distributions in the first diagram shows that the two distributions differ in one important respect, namely their variability about the average value or central value. A comparison of the two distributions of the second graph shows that while the shape of the two graphs is identical, the central values are different. Symmetrical distribution are thus seen to differ from each other in two important respects: (*i*) the central value about which the frequency distribution is scattered, and (*ii*) the variability of the frequency distribution about its central value.

The central value is commonly measured by what is known as the arithmetic mean, which may be defined as the sum of all the values divided by the number of the values. The variability is measured by what is known as the standard deviation. It is the square root of the variance which is the quotient of the sum of squares of deviations of observations from arithmetic mean by the number of observations. For the two distributions of lethal dose shown in figure 1 the average values are the same, but the variabilities are different, namely ·019 and ·025. For the distributions in figure 2, the variability is the same, but the average values are different, namely ·32 and ·33.

With homogeneous material, the frequency distribution generally takes the shape similar to that shown in the diagrams. It is symmetrical on either side of the central value. Most of the distributions we meet with in practice, although they are not quite symmetrical, follow closely the properties given by a symmetrical distribution known as the Gaussian or normal frequency distribution. In the Gaussian distribution about two-thirds of the observations lie between the ranges of arithmetic mean plus and minus the standard deviation, about 95 per cent of the observations lie between the ranges plus and minus two times the standard deviation and less than ½ of 1 per cent lie outside the ranges of arithmetic mean plus and minus three times the deviation.

In any scientific enquiry, we rarely have time and money at our disposal to investigate each and every member of the universe we set out by study. Almost invariably we try to base our conclusions on the basis of sample data. Thus if we want to ascertain the incidence of tuberculosis in the population of Calcutta, we do not examine each and every individual, but try to base our conclusions on a representative sample of individuals of the town. Now if I were to select a sample of 1,000 persons and arrive at a figure x for the incidence of tuberculosis,

another gentleman selecting his own sample of the same size may not necessarily arrive at the same figure for the incidence of tuberculosis, namely x. Indeed if we take repeated sample of 1,000 individuals the figures for the percentage incidence will vary from sample to sample not because there has been any bias in the selection of samples, but because of the inevitable chance fluctuations which must be present in the selection of different random samples.

The larger the sample, the more is our confidence in the conclusions. Thus if we are to base the figure for the incidence of tuberculosis on a sample of 10,000 instead of on 1,000, anyone would have more confidence in the conclusions from the sample of 10,000, provided of course both are representative samples of the population. The reason for this increased confidence in the conclusions of larger samples in terms of the concept of variability is easily made clear. Repeated samples of 1,000 will show a larger variability in the values of the incidence of tuberculosis than repeated samples of 10,000. We can well imagine the case in which we have investigated the whole of the population resulting in zero variability, for then there will be only one and one figure for the incidence of tuberculosis in the population. Confidence grows in direct proportion to the size of the sample. Alternatively, we may express these results by saying that the accuracy of the estimate for the incidence of tuberculosis varies inversely as the variance or directly as the size of the sample.

Such were the great contributions of Karl Pearson towards the close of the last century, which drew the attention of the scientific world to this subject and gave it the status of an exact science. There was however a significant departure in the way of thinking of Karl Pearson with the entry into the field of two outstanding personalities in statistics, namely W. G. Gossett, who wrote under the pseudonym 'Student', and R. A. Fisher. It was realised that while the accuracy of the estimate arrived from the sample would certainly increase with the size of the sample, it would also be governed by other factors such as the way in which the sample is selected, the method by which the estimate of incidence is made and so on. The former is the sort of problem falling under the category of the design of experiments ; the latter under that of estimation.

To illustrate how the accuracy of the result depends on the technique of selecting the sample we may conceive of a population of a town residing in two parts in one of which the incidence is very high and in the other very low. More simply we may think of estimating the average income of the population and imagine that in one part of the town people drawing exactly the same annual income are living and in the other people of varying incomes from rich to poor are residing. To be specific, let the population of the town be 10,000, of which 3,000 are staying in one part and the remaining 7,000 in the other. If the time and money to estimate the average income is just sufficient to collect a sample of 1,000 then the problem to be considered is how to select a typical sample of 1,000, so that the average income of the whole town will be estimated with the greatest accuracy. A statistician of the older generation would allot equal representation in proportion to the size of the parts of the population. He would argue thus—"if in one part the population is 3,000 and in the other 7,000 then they must select 300 individuals from the first and 700 from the other, thus giving proportional representation." Little consideration will however show that this would be a very unwise selection. If it is known that the variability is zero for the first part of the population, in other words, if it is known that all the 3,000 individuals of the first part have the same income, of what avail would it be to select 300 individuals when one individual is just as good for the purpose? The proper division would be one man from the first group and the remaining 999 from the second. What is true of this imaginary example in which variability is assumed to be zero is equally true of populations in which the variability is different. The allotments of the sample to different strata of the population cannot be governed by the size of the strata but must be made to depend on the consideration of accuracy of the final estimate.

The bearing of the method of estimation on accuracy is stated in general terms as follows. If from a sample of 1,000 observations we calculate an estimate A and a second estimate B having twice the variance of A to estimate, say, the central value of a known, say, normal frequency distribution, then although B might be a valid estimate of the centre it will be one definitely inferior to A in its accuracy. Using the statistic B a sample of 2,000 values would be required to obtain as good an estimate as has been obtained by using the statistic A from a sample of 1,000 values. An example from serology will illustrate the importance of estimation.

The phenomenon known as Land-steiner reaction enables us to classify the blood of individuals into four groups, O, A, B and AB. The characteristics of cells or sera of these blood groups are shown in the following figure. In the group O the cells having no agglutinogens cannot be clumped by any serum, but its serum will clump the cells of all the

other three groups. In the group A, the cells are clumped by sera of groups O and B while its serum clumps the cells of group B and AB. In the group B, the cells are clumped by sera of group O and A while its serum clumps the cells of group A and AB, and lastly in the group AB, the cells are clumped by the sera of all the other groups, but its serum having no agglutinins at all can clump no cells whatsoever. The inheritance of blood-groups, has been explained by Bernstein or what is known as the theory of triple allelomorphs. Bernstein postulates the existence of three genes A, B and R concerned in the blood group formation involving only

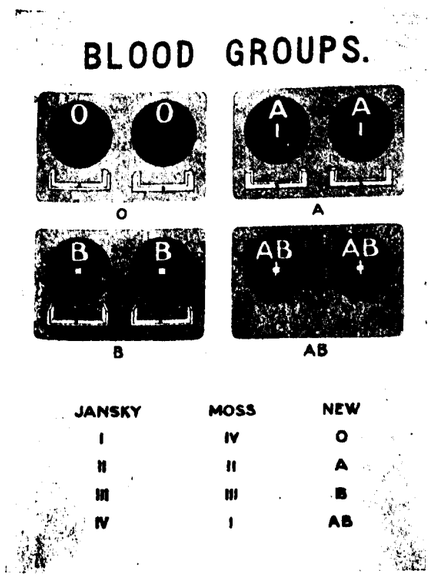


FIG. 3. Illustrating the group-classification of human blood.

one pair of chromosomes. Of the three genes A and B are dominant to R. The presence of the A gene causes the appearance of the A agglutinogen on the corpuscles independently of other factors. The presence of B gene causes the appearance of B agglutionogen, this also being unaffected by the presence or absence of either A or R. When the two loci are each occupied by an R gene the result is a recessive condition in which neither A nor B agglutinogen is present giving haemotype O. If A be present and not B, the haemotype is A. If B be present and not A, the haemotype is B, and if both be present they cause the appearance of respective agglutinogen independently, thus resulting in the haemotype AB. The situation is clearly grasped from table I. On this theory, the haemotypes possible in children of different matings of parents will be as shown in the table II. Thus the mating of parents with blood groups O, O results in a child

TABLE I.

Showing the possible combinations of genes A, B and R and the resulting haemotypes.

	A	B	R
A	A	AB	A
B	AB	B	B
R	A	B	O

with haemotype O, for neither the mother nor the father will carry any other gene except the gene R. In the same way the mating of parents with blood-groups O and A will result in children with blood groups either O or A and so on.

TABLE II.

Haemotypes possible in children in different matings according to Bernstein's Triple Allelomorph Theory.

Mating.	Resulting haemotypes.
O × O	O
O × A	O, A
O × B	O, B
O × AB	A, B
A × A	O, A
A × B	O, A, B, AB
A × AB	A, B, AB
B × B	O, B
B × AB	A, B, AB
AB × AB	A, B, AB

Now if p, q and r denote the frequencies with which the three genes A, B, R are present in the population, it follows that the frequency with which individuals with blood groups O, A, B, AB will occur will be given by the equations set out below

$$O = r^2$$
$$A = p^2 + 2pr$$
$$B = q^2 + 2qr$$
$$AB = 2pq$$

We have thus four equations to estimate only three unknowns. The situation is one calling for the use of the theory of estimation. It is analogous to the following problem. If 10 persons investigating the incidence of tuberculosis in 10 parts of Calcutta got 10 different figures for the estimation of the incidence of tuberculosis in their respective parts what will be the best estimate of the incidence of tuberculosis in the whole population. We must combine the figures in such a way that the final estimate will show the least variation or the least variance.

Bernstein gave one set of solutions for the unknowns p, q and r. Later on he gave another set of solutions for the same unknowns, and called the later set of solution as an improved method of estimating the blood groups gene frequencies. He was aware that this later set would show a smaller variation in repeated samples of the same size than the first set of estimation. He thus got two estimates for the unknown r which we might denote by r_1 and r_2. For r_1 Bernstein found out the sampling variance. For r_2 while he recognised that its variance was smaller than that of r_1 for the same sample size he never actually calculated it. I have shown elsewhere that this variance is about 10 to 12 per cent smaller than the variance of r_1. The meaning of this finding is explained as follows. From the view point of estimating the R-gene frequency in the population, the time and money spent in examining the blood groups of 12 per cent of the individuals are a pure waste. The force of this argument can be brought home if I illustrate to you what it means in field enquiries like, say, the estimation of the state of nutrition or the incidence of a disease in the population and so on. What one would think if as many as 12 per cent or more of the observations collected can be considered a clear waste from the viewpoint of the object of the enquiry ?*

* Adapted from a lecture at the Journal Club, All-India Institute of Hygiene and Public Health, Calcutta.

THEELIN FOR BROKEN BONES

Knitting of broken bones, especially in elderly women, may be speeded by treatment with the female sex hormone, theelin, Dr G. A. Pollock, of the Mayo Foundation, declares as a result of studies of the effects of theelin on broken bones in laboratory animals.

Women over 60 years of age get so-called 'broken hips' with 'striking' frequency, Dr Pollock points out. The condition, although popularly known as a 'broken hip', is actually not a break of the hip but of the neck of the thigh bone near where it is joined to the hip. A change in the bones of older women suggested a relation to the cessation of ovarian function in women past 50 years. Several other scientists, Dr Pollock found, had also noted a relation between female sex hormones and bone formation.

—*Science Service.*

Research Notes

Bacteriophage, its Nature and Behaviour as Studied by the Electron Microscope.

ULTRAMICROSCOPES has been used to investigate the nature of bacteriophage which are too small to be visible by ordinary microscopes. d'Herelle showed that the phage element is first adsorbed on the cell-wall ; it then penetrates inside, multiplies and after sometime bursts the cellwall and thus the newly formed phage elements come out. Eisenberg (*Brit. J. Exp. Path., 19,* 338, 1938) has taken some photo-micrographs of phagelysis of *Coli* bacteria and he supports d'Herelle's 'particulate nature of bacteriophage'. Recently Ruska (*Naturwissenschaften,* Heft. 3, 45, 1940), and Pfankuch and Kansche (*ibid.,* 46) have taken some photo-micrographs with the help of electron miscroscopes (Siemens & Halske) at magnifications ranging from 14,000 to 25,000. Ruska has carried out some experiments to study some aspects of phagelysis of *Coli* bacteria. He found that the phage elements are adsorbed on the bacterial membrane and dissolve it after sometime, allowing the plasma to be liberated. The phage elements have been purified from the associated proteins obtained from bacteria and the culture medium by adsorption and elution from aluminium hydroxide C, γ. The size of the phage corpuscles has been measured to be 40—80 mμ. in diameter (this has also been established by Andrews and Elford, *Brit. J. Exp. Path., 13,* 446, 1932 by their diffusion experiments). From experiments on highly purified phage samples they postulate that the phage elements are associated with high molecular proteins and this is in agreement with the ultra-centrifugal experiments of Northrop (*J. Gen. Physiol., 21,* 335, 1938) and Wyckoff (*ibid.,* 367) and with the chemical analysis of Schlesinger (*Lancet, i,* 818, 1935). They have further found that during protracted irradiation the phage corpuscles are destroyed by the electrons leaving only some hollow round bodies.

D. K. R.

Indication of a New Chick Growth Factor in Rice

HOGAN and his co-workers (*Jour. Biol. Chem., 64,* 113, 1925) suggested that polished rice contains a chick growth factor not present in any significant amount in yeast. MacFarlane *et al* (*Jour. Nutrition, 4,* 331, 1931) supported this observation. Stokstad and Manning (*Poultry Science, 18,* 413, 1939) studied this problem and found that polished rice has a growth-promoting effect which cannot be provided by levels of dried yeast up to 15 per cent of the ration. Very recently Almquist, Stokstad, Mecchi and Manning (*Jour. Biol. Chem., 134,* 213, 1940) have found that glycine is required in the diet for optimum growth of the chick. When adequate glycine is present in the diet chondroitin has a growth-promoting action on the chick. A combined effect of glycine and chondroitin can replace the "rice factor".

A. C. M.

The Iron of the Plasma.

THE iron content of the plasma probably plays a very important part in the transport of iron. Much work has been done regarding the nature of the iron present in the plasma. Barkan (*Klin. Wschr., 16,* 330, 1935) has shown that the plasma iron is present in the ferric state and is non-extractable with trichloroacetic acid but becomes easily extractable if the plasma is incubated with dilute HCl at 37° for 24 hours previous to extraction.

Tompsett (*Biochem. Jour., 34,* 959, 1940) has confirmed the work of Barkan and states that probably the iron is present in the plasma in complex combination with phosphatides which prevent the ultrafiltration of the iron. But it has been shown that if the plasma is acidified and allowed to stand the Fe becomes reduced to the ferrous state, probably by the plasma protein, and becomes ultrafiltrable. So, according to the author, the plasma Fe will, at least in part, be changed into the ferrous state before being utilizable.

K. C. S.

BOOK REVIEW

Scattering of Light and the Raman Effect—by S. Bhagavantam. Published by the Andhra University, Waltair, 1940. *Pp 333+x, with 2 plates and 41 figures. Price Rs. 15/- or 22sh.*

This book deals with the experimental details as well as theoretical treatment of various problems in classical scattering of light and of the Raman effect. The author is a well-known worker in these lines of research and was one of the collaborators of Prof. Sir C. V. Raman for a number of years. It is well known that the intensive study of various aspects of scattering of light by Prof. Sir C. V. Raman and some of his collaborators has not only resulted in important and valuable contributions to the present state of our knowledge of the subject but has also led to the discovery of the Raman effect. This effect has found its application in various branches of science and a large volume of literature has accumulated during the last twelve years, and a large part of this literature has been contributed by the discoverer himself and his collaborators. Before the publication of this book there was not a single treatise in English giving a connected detailed account of the experimental and theoretical aspects of both the unmodified scattering and the Raman effect. The famous article of Placzek in *Handbuch der Radiologie*, Band 6, Part II, 1934, deals with the theoretical aspects of this subject quite thoroughly, but it is written in German and the experimental details have been omitted. The publication of this book has therefore removed a long felt want. This book will be useful to the Post-Graduate students who have to study this subject, as well as to beginners in researches in these lines.

The first eight chapters of the book deal with the theory and experimental details regarding Rayleigh scattering by anisotropic molecules in the gaseous state, by liquids, amorphous solids and by liquid mixtures and liquid boundaries. The experimental results have been discussed in the light of these theories. Chapter VII has been devoted to an account of the theoretical attempts which have been made so far to calculate the anisotropy of molecules in certain crystals and of some diatomic molecules in the gaseous state. Chapter IX deals with the classical theories of some allied optical phenomena, *e.g.*, natural, mechanical, electric and magnetic birefringence in which the optical anisotropy of the molecules plays an important role.

The remaining nine chapters deal with the Raman effect, its theory, experimental arrangements and results, and its application to various subjects. Chapters XI and XII deal with the theory of vibrational and rotational Raman scattering and are based on the theories put forward by Placzek and by Placzek and Teller. The relation between selection rules for Raman scattering and the symmetry of the molecules as originally given by Placzek in his article mentioned above has been treated lucidly in Chapter XII. Chapter XV dealing with the experimental technique is quite useful. As regards the discussion of experimental results, it is difficult for any author to do justice to such a large amount of data which has accumulated. So, although attempts have been made in the book to classify these results on the basis of the nature of the different problems which have been solved by the application of the Raman effect, some interesting results have been overlooked by the author in discussing a few of the applications. Chapter XVIII dealing with Raman effect in relation to organic chemistry is by no means an exhaustive account of the work done so far on this particular topic, but attempt has been made to refer briefly to most of the aspects of this particular topic.

There are seven useful appendices at the end of the book dealing with "radiation from moving charges", "convergence correction", "fluctuations", "evaluation of the various matrix elements of the polarisability tensor", "tensor components and their transformation from one co-ordinate system to another", "groups and group characters" and "group theory and normal oscillations of molecules".

The printing is quite satisfactory, the letters being of fairly big size and the paper (Esparto Imperial Octavo) being of good quality. There are about forty-two line blocks and two plates. Considering the increase in the cost of materials in printing the book during the war-time, the price of the book is quite moderate and it is hoped that the book will have wide circulation both in India and abroad.

S. C. Sirkar.

An Attempt at the Correlation of the Ancient Schistose Formation of Peninsular India—by Sir Lewis L. Fermor. (*Memoirs. G. S. I.* Vol. 70, Pt. 2. No. 2, 1940).

Sir Lewis Fermor has been given a heavy responsibility and arduous task of writing an account of the correlation of the ancient schistose formations of Peninsular India—a subject of very great importance in Indian stratigraphy. Two issues have already appeared and the present one under review is the third of the series and the entire subject will perhaps be covered by several more yet to be published. These publications appear to be very valuable as they come from the pen of one who has devoted his life to the study of the older formations of India. In these publications the works of the other officers of the G. S. I. have also been taken into account. Amongst other things Mr West's important work on origin of streaky gneisses of Nagpur area and Deolapar nappe structure has aptly been mentioned herein.

The present volume deals only with the Sausar-Balaghat Province of the non-charnockitic region. This province is occupied by granulites, marbles, quartzites, schists and phyllites, in general parallel banding with ortho-gneisses, paragneisses, composite gneisses and also with intrusive granites and pegmatites. The rock units comprising this Archaean terrane have been divided into two main groups, namely (*i*) the rocks of presumed Dharwarian age that are mainly or entirely of sedimentary origin, and (*ii*) the ortho-gneisses and granulites.

There is a great difference between the intensity of metamorphism in two sections of the province, the western end being so highly metamorphosed that it has proved exceedingly difficult in many cases to separate the metamorphosed sediments from the metamorphosed igneous rocks. Close mapping has however led to the separation of the stratified succession under the term Sausar Series, which include several stages consisting of calc-granulites, marbles and calciphyres with manganese ores, mica gneisses, biotite-sillimanite schists with gondite series, and manganese ores, chlorite schists, dolomite marbles with serpentine, spinel, diopside etc., hornblende schists, garnet amphibolites, pyroxenites, chlorite schists etc. In the eastern section the grade of metamorphism is so much less intense that sedimentary and igneous units are clearly distinguishable and in fact have always been mapped separately and the metamorphosed sediments have been known as the Chilpi Ghat Series composed mainly of micaceous phyllites with quartzites and manganese ores and some greenstone.

The ortho-gneisses have been sub-divided into: (*i*) Granodiorite biotite-gneisses and porphyritic and augen-gneisses, (*ii*) Streaky gneisses due to introduction of aplitic material into (*i*) and into schistose members of the Sausar Series. This has been clearly proved by West, and (*iii*) Later granites and pegmatities, including the fine-grained Amla granite.

All these gneisses are younger than the Sausar Series and no basal conglomerate to the Sausar Series has been found, nor the floor upon which this series was deposited.

The problem whether the Sausar Series and the Chilpi Ghat Series are contemporaneous was discussed by Fermor and the nature of the conglomerates of the Chilpi Ghat Series and the similarity of petrographical peculiarities of the rocks of the two series have also been taken into due consideration. From these evidences Fermor has accepted that the Chilpi Ghat and Sausar Series are two aspects of the same period of deposition. The interpretation that has been put upon this conglomerate does not however appear to be very convincing and some more detailed field work may throw sufficient light on this problem.

Fermor has also accepted the Sakoli Series as the equivalent of the Chilpi Ghat Series. He also suggests that the Sakoli beds are mainly higher in the succession than the Sausar Series, with possibility of a separating plane or zone of movement with downthrow of the Sakoli rocks relative to the Sausar rocks. On this interpretation the Chilpi Ghat Series which is equivalent both to the Sausar Series and to the Sakolis must have a longer upward range than the Sausars.

On the lithological grounds Fermor suggests the following correlation with rocks in other parts of India:

(*a*) The gonditic rocks and associated manganese-ores of the Nagpur-Balaghat area with the gonditic rocks of the Gangpur series in the Singhbhum-Orissa Province, and of the Aravalli series in Narukot and Jhabua States in the Rajputana-Gujarat Province: and also with the manganese-garnet-bearing rocks of Sakrasanhalli in Mysore.

(*b*) The black manganiferous limestone (Lohangi stage) of Devi in Chhindwara district with the black manganiferous limestone of Sakrasanhalli in Mysore.

(*c*) The calc-granulites (Utakata stage) of the Sausar Series with the tarurites of Mysore.

(*d*) The hornblende-schists of Sitapar with the hornblende-schists of Mysore.

(*e*) The schists and streaky gneisses of the Nagpur-Balaghat area with portions of the Peninsular gneiss of Mysore.

(*f*) The phyllites and schists of the Chilpi Ghat series with rocks of similar character in the Sakoli series of the Chanda-Bastar Province, and with similar rocks in the Dharwars of the Dharwar-Mysore-Nellore Province.

(*g*) Allowing for differences of grades of metamorphism Fermor is tempted to correlate the gonditic rocks, manganese-ores and associated schists, marbles and calc-granulites of the Sausar Series, with the koduritic rocks, manganese-ores, khondalites, marbles and calc-granulites of the Eastern Ghats Province.

According to Fermor there appears to be little doubt that in general both the Sausar Series and the Chilpi Ghat Series may be regarded as equivalent to the Dharwars of South India. But on account of the lateral changes of character of the Dharwars, he finds it rather difficult to effect any precise equation of sections of the Sausars or of the Chilpis with occurrences in the Dharwar-Mysore-Nellore Province. He also admits that it is also difficult to equate the relatively small occurrences of hornblende-schist of the Sitapar stage of the Sausar Series with the much larger developments of hornblende-schists in Mysore. These intricate problems relating to detailed correlation of the ancient schistose formations occurring at several places in Penunsilar India have yet to be solved by future workers.

N. N. Chatterjee.

A Student's Book on Soils and Manures—by SIR E. J. RUSSELL, D.Sc., F.R.S., Director of the Rothamsted Experimental Station. 3rd Edition. Published by Cambridge University Press, 1940. *Pp. 296 with index. Price 8s. 6d. net.*

The book is familiar to all students of agricultural science as also to teachers and research workers. It is no exaggeration to say that Sir E. J. Russell, through his books and writings, has acted for a generation as a teacher of agricultural science throughout the English-speaking world. His simple and easy style combined with authenticity of the information make his writings so attractive and fruitful. This book first appeared in 1915. It has been revised and rewritten for the present edition. As stated in the preface, the author has "endeavoured to steer a straight course between the elaboration which most students would find unnecessary and the over simplification which often leaves the student with a good deal to unlearn if he proceeds to a fuller study of the subject." A student often finds it necessary but greatly difficult to unlearn much of what he has learnt through an unhappy choice of books. Not many are in a position to write books bearing on the subject matter of the present one and avoid at the same time the pitfalls. It is really wonderful to find how much reliable, up to date and balanced information has been compressed in lucid and easy language within the compass of the 290 pages of the small book. The book will be indispensable for students and teachers of the subject. The book has been mainly written for the students in Britain, much of its contents is however useful for students in other countries. One cannot help comparing the information relating to soil conditions in Britain which can be placed before a student, with that relating to Indian soils, their management and treatment with manures and fertilisers which can be utilised for teaching. There is no single publication which would convey a general idea of Indian soils and the results of treating them with fertilisers and manures. The dearth of authentic information and the immature nature of many experiments are undoubtedly in part responsible for this state of affairs. Besides, advisory work has scarcely yet been undertaken in any concrete form by the Indian Agricultural Departments. The Indian student can only envy his British compatriot.

The book is divided into four parts. Part I gives an account of the soil under the heads ; what the plant needs from the soil ; the composition of the soil ; the organic matter of the soil and the changes it undergoes ; the effect of climate on the soil and on fertility. Part II deals with the control of the soil under the heads ; cultivation and the control of soil fertility. The latter naturally constitutes the largest chapter in the book. Part III deals with fertilisers under the heads ; the food of plants ; the nitrogenous fertilisers ; the minor elements of plant nutrition ; manures supplying organic matter (the simpler organic manures) ; organic manures supplying plant food and humus, farmyard manure, composts, town refuse ; chalk limestone and lime ; manurial schemes for crops. There are appendices dealing with (*i*) field experiments using the modern statistical technique ; (*ii*) some useful data ; (*iii*) fertiliser substances contained in crops ; and (*iv*) books and references on soils and crops for further study.

As already stated the book is indispensable to teachers and students alike.

J. N. M.

LETTERS TO THE EDITOR

High Frequency Properties of Soil.

In view of the future expansion of radio in India a complete survey of the high frequency properties of soil throughout the country is very necessary. For a better understanding of the nature of the H.F. properties of soil, such soil surveys are generally extended up to ultra-short waves. Very few observations[1,2], however, have been reported so far. Recently some experiments have been started in this laboratory for the measurement of the dielectric constant and conductivity of different kinds of soil for different frequencies and under different conditions. Some preliminary experimental results and a few points emerging therefrom are contained in the present note.

While the measurement of above mentioned properties of soil for medium and short waves by the usual direct methods do not present much of experimental difficulties, the same is not true for ultra-short waves. In the latter case the sources of error become more numerous. The amount of error was found to be as high as 20 per cent in the experimental results obtained by Rose-Smith.[3] An alternative method was, however, suggested by him and Mcpetrie[4], in which the actual length of the ultra-short waves are measured over a pair of Lecher wires which was immersed in soil contained in a wooden box. This method with certain modifications was used by Banerjee and Joshi[1] and also by Chakravarty and Khastgir,[2] for the measurements of the dieletric constant and conductivity of soil. Adopting the same method the dielectric constant and conductivity of a sample of local soil were determined for different moisture contents. The results are shown in figures 1 and 2 by means of graphs B and C respectively. These values were obtained for a wavelength of 4·45 meters.

During the performance of these experiments, it was realised by us that in spite of the simplicity and other advantages of this method, it cannot be very convenient when making a survey of soil properties over largely extended areas, as the amount of soil required in this method is considerably large. Further, the process of sieving, drying and packing of such large quantities of soil would not only take considerable time but may be very often unsatisfactory. With this point in view attempts were made

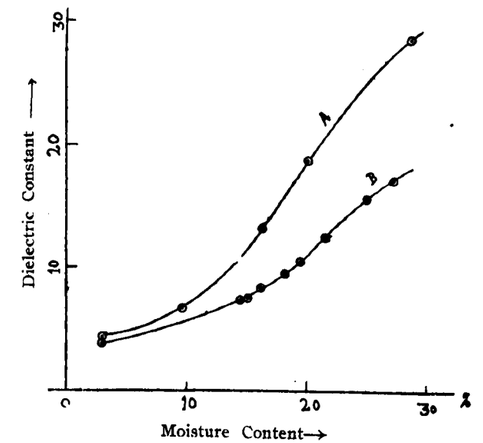


FIG. 1.

by us to measure the dielectric constant of soil for ultra-short waves by the direct measurement of the capacity of a specially designed condenser when empty and also when packed up with soil. The leads of the condenser were kept as small as possible, and whatever capacity they possessed, could be measured fairly accurate by removing the plates from the leads. For the measurement of all the capacities a pair of Lecher wires of suitable diameter and separation was used. The experimental value of condenser was found to agree closely with that calculated from its dimensions. This was further checked by filling the condenser with distilled water. The condenser was connected at the ends of the

Lecher wires and the various capacities were calculated from the measurements of the shifts in the resonance positions. Errors due to corresponding changes in inductance were found to be considerably small. The experimental values of dielectric constant of the same sample of soil as used in the first experiment, for different moisture contents are shown by means of graph A in fig. 1. The wavelength used was 4·45 meters.

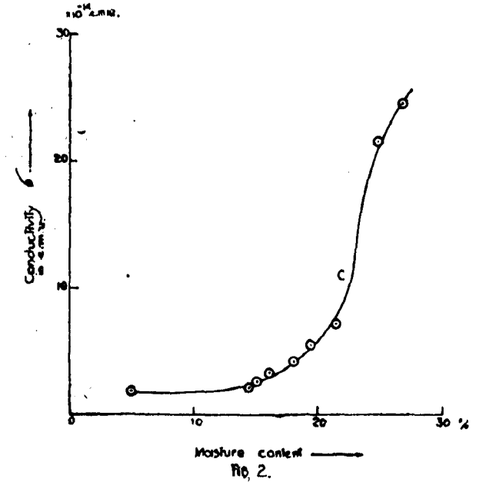


Fig. 2.

It will be seen that the values of dielectric constant obtained by this method are higher than those obtained by the previous one and the increase is greater for higher moisture contents. This difference in the two results may be due to the fact that in the previous method the soil was not packed to maximum capacity and the distribution of moisture was not uniform throughout the entire mass of soil. Further, in spite of best arrangements, when sliding the contact over the Lecher wires for the measurement of wavelength, soil was disturbed to some extent.

Independent experiments were also performed to see the effect of packing on the value of dielectric constant. For fairly dry soil, starting with very loose packing the maximum capacity was reached and the corresponding increase was found to about 20%. For soil of higher moisture contents the increase in the value of dielectric constant was found to be much greater.

Further investigations are in progress. We are grateful to Prof. K. Prasad, B.A. (Cantab.), for giving us every facility in carrying out the present work.

Physics Laboratory, S. P. PRASAD
Science College, B. N. SINGH
Patna, 1-8-1940. BASUDEO SINHA.

[1] Banerjee, S. S. and Joshi, R. D., SCIENCE AND CULTURE, 2, 587, 1936-37. See also, *Phil. Mag.*, *25*, 1025, 1938.
[2] Chakravarty, K. and Khastgir, S. R., *Phil. Mag.*, *25*, 793, 1938.
[3] Smith-Rose, R. L., *Proc. Phy. Soc.*, *47*, 923, 1935.
[4] Smith-Rose, R. L. and Mepetrie, J. S., *Proc. Phy. Soc.*, *46*, 649, 1934.

The Distribution of the Mean for Certain Bessel Function Populations

Mckay (1932) had shown that the Bessel Function Distributions

$$p_1(x) = C_1 e^{-\frac{c}{b}x} \cdot |x|^m I_m\left|\frac{x}{b}\right|, \qquad (1)$$

where

$$C_1 = \frac{2\sqrt{\pi}\,(c^2-1)^{m+\frac{1}{2}}}{(2b)^{m+1}\,\Gamma(m+\frac{1}{2})},$$

and

$$p_2(x) = C_2 e^{-\frac{c}{b}x} \cdot |x|^m K_m\left|\frac{x}{b}\right|, \qquad (2)$$

where

$$C_2 = \frac{(1-c^2)^{m+\frac{1}{2}}}{\sqrt{\pi}\;2^m\;b^{m+1}\;\Gamma(m+\frac{1}{2})}$$

were suitable for graduation in a definite region of the Pearsonian β_1-β_2 plane. It is to be noted that (1) is to be used when $|c|>1$, and further that if $c>0$, x is to lie between o and ∞ and if $c<0$, x is to lie between $-\infty$ and o. Similarly (2) is to be used when $|c|<1$ and in that case x is permitted to range from $-\infty$ to ∞ It is also to be noted that b is a positive constant and $(m+\frac{1}{2})>0$.

It might be mentioned that both in (1) and (2) only the index of the exponential term changes sign with x.

It has recently been found by the author of the note that the type of the distribution is conserved when we proceed to the distribution of the mean of samples from (1) and (2). This follows immediately by the use of the method of characteristic functions.

For (1), the characteristic function of the distribution law of x is given by

$$C_1\int_0^{\infty} e^{itx-\frac{c}{b}x}\, x^m I_m\left(\frac{x}{b}\right)dx = \left[\frac{c^2-1}{(itb-c)^2-1}\right]^{m+\frac{1}{2}}. \qquad (3)$$

The characteristic function of the distribution law of the mean x of a sample of size n is, therefore given by

$$\left[\frac{n^2(c^2-1)}{(itb-nc)^2-n^2}\right]^{\frac{2mn+n}{2}}. \qquad (4)$$

whence it is apparent that the distribution law of $\bar{x}$ is

$$p_1(\bar{x}) = C_1 e^{-\frac{nc}{b}\bar{x}} (\bar{x})^{\frac{2mn+n-1}{2}} I_{\frac{2mn+n-1}{2}}\left(\frac{n\bar{x}}{b}\right) \qquad (5)$$

where

$$C_1 = \frac{2\sqrt{\pi}\,(c^2-1)^{\frac{2mn+n}{2}}}{\left(\frac{2b}{n}\right)^{\frac{2mn+n+1}{2}}\Gamma\left(\frac{2mn+n}{2}\right)}.$$

In the same way the characteristic function of the distribution law of x for (2) is

$$C_2\int_{-\infty}^{\infty} e^{itx-\frac{c}{b}x}\, x^m K_m\left(\frac{x}{b}\right)dx = \left[\frac{1-c^2}{1-(ibt-c)^2}\right]^{m+\frac{1}{2}} \qquad (6)$$

Hence the characteristic function of the distribution law of the mean $\bar{x}$, of the sample of size n is given by

$$\left[\frac{(1-c^2)\,n^2}{n^2-(ibt-n)^2}\right]^{\frac{2mn+n}{2}} \qquad (7)$$

and the distribution law of $\bar{x}$ is, therefore, given by

$$p_2(\bar{x}) = C_2 e^{-\frac{nc}{b}\bar{x}} (\bar{x})^{\frac{2mn+n-1}{2}} K_{\frac{2mn+n-1}{2}}\left(\frac{n\bar{x}}{b}\right) \qquad (8)$$

where

$$C_2 = \frac{2\,(1-c^2)^{\frac{2mn+n}{2}}}{\sqrt{\pi}\left(\frac{2b}{n}\right)^{\frac{2mn+n+1}{2}}\Gamma\left(\frac{2mn+n}{2}\right)}$$

It may incidentally be noted that if c is made zero and b unity in (2) we get Karl Pearson's well-known $T_m(x)$ function, viz.,

$$T_m(x) = \frac{1}{\sqrt{\pi}}\cdot\frac{1}{2^m}\cdot\frac{1}{\Gamma(m-\frac{1}{2})}\, x^m K_m(x), \qquad (9)$$

and, it follows immediately from (6) that

$$T_m(\bar{x}) = \frac{1}{\sqrt{\pi}}\cdot\frac{\frac{2mn+n+1}{2}}{\frac{n}{2}^{\frac{2mn+n-1}{2}}\Gamma\left(\frac{2mn+n}{2}\right)}(\bar{x})^{\frac{2mn+n-1}{2}} \times K_{\frac{2mn+n-1}{2}}(n\bar{x}) \qquad (10)$$

Statistical Laboratory,
Presidency College, M. P. SHRIVASTAVA
Calcutta, 8-8-1940.

[1] McKay, A. T., *Biometrika.*, *24*, 39, 1932.
[2] Karl Pearson and Others, *Biometrika.*, *21*, 184, 1929.

Vitamins B_1 and B_2 content of *Ata* (whole wheat flour), White Flour, and *Suji* (Semolina)

Vitamins B_1 and B_2 contents of a few samples of bread have already been investigated in this Laboratory[1]. Recently we have determined the vitamin B_1 and B_2 content of *ata*, white flour and *suji*. In the estimation of these vitamins the biological method of assay with young albino rats as described by Guha and Chakravorty[2] was employed.

Five rats of each group, deficient in vitamins B_1 and B_2 respectively, were fed with *ata*, white flour and *suji* respectively, in 2 grammes daily dose, for 3 weeks and their average weekly growth was determined. The substances were produced from the local co-operative stores.

The results of the experiments, in terms of the units of vitamins B_1 and B_2 as defined by Guha and Chakravorti[3] are given in the following table:

Substances Tested	*Units of Vitamin B_1*	*Units of Vitamin B_2*
White flour	68·5	66·0
Ata	50·3	32·0
Suji	33·5	5·0

From the table it is evident that from the standpoint of vitamins B_1 and B_2, *ata* is an exceptionally rich substance. The vitamin B-content of white flour too is of a high order and both the articles contain a much greater amount of vitamins B_1 and B_2 than the unboiled rice[4]. The vitamin B_2-content

of *suji* has however been found to be negligibly small.

My sincere thanks are due to the authorities of this firm for their help and encouragement in the work.

Biochemical Laboratory,
Bengal Chemical & Pharmaceutical Works, Ltd., H. G. Biswas
Calcutta, 5-9-1940.

[1] Biswas, SCIENCE AND CULTURE, *4*, 361, 1938-39.
[2] *Ind. Jour. Med Res., 20,* 1045.
[3] *Ibid., 21,* 221.
[4] Biswas, SCIENCE AND CULTURE, *2*, 272, 1936-37.

Radiation Laws and the Enumeration of the Wave-Functions for a Continuum.

In the usual derivation of the radiation laws the number of wave-functions lying in the frequency range $\nu, \nu+d\nu$ or the wave-length range $\lambda, \lambda+d\lambda$ for a continuum of volume V is taken to be

$$a(\nu)d\nu = 2\frac{4\pi\nu^2 V}{c^3}d\nu, \qquad (1)$$

$$a(\lambda)d\lambda = 2.\frac{4\pi V}{\lambda^4}d\lambda.$$

These, however, are asymptotic expressions (though this point is not often clearly stated). The problem of enumerating the wave-functions for a continuum more accurately than given by (1) has received a good deal of attention in recent theoretical literature[1] on architectural acoustics, and though no general solution is available, in the case of a *cubical* enclosure the value of $a(\nu)\,d\nu$ or $a(\lambda)\,d\lambda$ to a third approximation is

$$a(\nu)d\nu = 2.\frac{4\pi\nu^2 V}{c^3}d\nu\left\{1+\frac{c}{8V^{\frac{1}{3}}\nu}+\frac{c^2}{8\pi V^{\frac{2}{3}}}\frac{1}{\nu^2}\right\}, \qquad (2)$$

$$a(\lambda)d\lambda = 2.\frac{4\pi V}{\lambda^4}d\lambda\left\{1+\frac{\lambda}{8V^{\frac{1}{3}}}+\frac{\lambda^2}{8\pi V^{\frac{2}{3}}}\right\}.$$

The replacement of the expression (1) by the more exact expression (2) will introduce corresponding small correction-terms in the radiation laws. Taking Stefan's law, if u denotes the energy-density of the total radiation in a (cubical) enclosure of volume V and at a temperature T, we have,

$$uV = \int_0^\infty \frac{a(\nu)d\nu.\ h\nu}{e^{h\nu/kT}-1};$$

and on substituting (2) and integrating

$$u = \frac{48\pi k^4 T^4}{h^3c^3}\zeta(4)\left\{1+\frac{1}{24}\frac{\zeta(3)}{\zeta(4)}\frac{hc}{kTV^{\frac{1}{3}}}+\frac{1}{48\pi}\frac{\zeta(2)}{\zeta(4)}\times\left(\frac{hc}{kTV^{\frac{1}{3}}}\right)^2\right\} \qquad (3)$$

where $\frac{hc}{k}=1{\cdot}43$, and ζ (s) is the Riemann-Zeta function.

It will be noticed that the energy-density is strictly not an *intensive* quantity, for it depends on the volume, this dependence disappearing only in the limit of $\frac{hc}{kTV^{\frac{1}{3}}}\longrightarrow 0$. The correction to Stefan's law (as usually stated) is, as is evident from (3), (4), ordinarily negligible, but will be appreciable for low temperatures; and it is interesting at least from a theoretical point of view to observe that at extremely deep temperatures we have a wild departure from the usual fourth-power law.

Lest the above discussion should appear to be rather disconcerting in view of the supposed thermodynamical proof of the fourth-power law, it may be remarked that the thermodynamical proof as usually given of the fourth-power law involves the assumption that $\left(\frac{\delta u}{\delta V}\right)_T = 0$. When this assumption is not made we obtain

$$4u = T\left(\frac{\delta u}{\delta T}\right)_V - 3V\left(\frac{\delta u}{\delta V}\right)_T \text{ or } u = aT^4\ f(TV^{\frac{1}{3}}) \qquad (4)$$

where a is constant and f is arbitrary. Equation (3) is in accordance with (4).

Physics Department,
University of Delhi. D. S. KOTHARI
Delhi, 25-8-1940.

[1] R. H. Bolt, *Jour. Acous. Soc.* (America), *10*, 228, 1939.
[2] Dah-You Maa, *Ibid., 10,* 235, 1939.
[3] R. L. Hill, *Amer. Jour. Phys., 8,* 158, 1940.
Also see K. Husimi, *Proc. Phys.-Math. Society* (Japan), *21*, 759, 1939.

Debye's Theory of Specific Heat and the Enumeration of the Wave-Functions for a Continuum

In a previous communication[1] to this journal the effect of a more exact enumeration of the wave-functions for a continuum on Stefan's fourth-power law has been considered. In the present note the discussion is extended to Debye's T^3-law[2] for the specific heats of solids. The number of normal modes of vibration lying in the frequency range

$\nu, \nu+d\nu$ for an isotropic solid in the form of a *cube* of volume V is to a third approximation

$$a(\nu)d\nu = \frac{4\pi\nu^2 d\nu V}{c_1^3}\left\{1+\frac{c_1}{8V^{\frac{1}{3}}\nu}+\frac{c_1^2}{8\pi V^{\frac{2}{3}}\nu^2}\right\} + \frac{8\pi\nu^2 d\nu V}{c_2^3}\left\{1+\frac{c_2}{8V^{\frac{1}{3}}\nu}+\frac{c_2^2}{8\pi V^{\frac{2}{3}}\nu^2}\right\}, \qquad (1)^*$$

where c_1 is the velocity of longitudinal waves and c_2 for transverse waves. The total energy of the solid (cube) for all possible modes of vibrations is

$$U = \int_0^{\nu_m}\frac{a(\nu)\,h\nu}{e^{h\nu/kT}-1}d\nu, \quad h\nu_m = k\theta, \qquad (2)$$

where θ is the Debye-characterstic temperature, and is given by Debye's assumption

$$3N = \int_0^{\nu_m} a(\nu)\,d\nu, \qquad (3)$$

where N is the number of particles. Differentiating U with respect to T for constant volume, we have

$$\left(\frac{\delta U}{\delta T}\right)_V = \frac{4\pi k^4 T^3 V}{h^3}\int_0^{\theta/T}\frac{\xi^4 e^\xi}{(e^\xi-1)^2}\left[\left(\frac{1}{c_1^3}+\frac{2}{c_2^3}\right)+\frac{h}{8kTV^{\frac{1}{3}}}\left(\frac{1}{c_1^2}+\frac{2}{c_2^2}\right)\frac{1}{\xi}+\frac{h^2}{8\pi k^2T^2V^{\frac{2}{3}}}\left(\frac{1}{c_1}+\frac{2}{c_2}\right)\frac{1}{\xi^2}\right], \qquad (4)$$

where $\xi = \frac{h\nu}{kT}$.

Restricting ourselves to very low temperatures *i.e.*, $\theta/T\longrightarrow\infty$, we have on integration

$$\left(\frac{\delta U}{\delta T}\right)_V = \frac{4\pi k^4 T^3 V}{h^3}\left[\frac{1}{5}\xi(4)\left(\frac{1}{c_1^3}+\frac{2}{c_2^3}\right)+\frac{h}{8kTV^{\frac{1}{3}}}\frac{1}{4}\zeta(3)\left(\frac{1}{c_1^2}+\frac{2}{c_2^2}\right)+\frac{1}{8\pi}\left(\frac{h}{kTV^{\frac{1}{3}}}\right)^2\frac{1}{3}\zeta(2)\left(\frac{1}{c_1}+\frac{2}{c_2}\right)\right], \qquad (5)$$

where ζ (s) is the Riemann-Zeta function.

* This corresponds to equation (1) of the previous note.

The integration of equation (3) gives us

$$\frac{9}{4\pi}\frac{N}{V}\left(\frac{h}{k\theta}\right)^3 = \left[\left(\frac{1}{c_1^3}+\frac{2}{c_2^3}\right)+\frac{3}{16V^{\frac{1}{3}}}\left(\frac{1}{c_1^2}+\frac{2}{c_2^2}\right)\frac{h}{k\theta}+\frac{3}{8\pi V^{\frac{2}{3}}}\left(\frac{1}{c_1}+\frac{2}{c_2}\right)\left(\frac{h}{k\theta}\right)^2\right]. \qquad (6)$$

From equations (5) and (6) we have, on neglecting terms of the order of $1/\theta$ compared to $1/T$ to be in conformity with our assumption $\theta/T\longrightarrow\infty$ made in integrating (4),

$$\left(\frac{\delta U}{\delta T}\right)_V = 3Nk\frac{12\pi^4}{15}\left(\frac{T}{\theta}\right)^3\left[1+\frac{1}{3^2}\frac{\zeta(3)}{\zeta(4)}\left(\frac{h}{kTV^{\frac{1}{3}}}\right)\left(\frac{1}{c_1^2}+\frac{2}{c_2^2}\right)\Big/\left(\frac{1}{c_1^3}+\frac{2}{c_2^3}\right)+\frac{1}{9\epsilon\pi}\frac{\zeta(2)}{\zeta(4)}\left(\frac{h}{TV^{\frac{1}{3}}}\right)^2\left(\frac{1}{c_1}+\frac{2}{c_2}\right)\Big/\left(\frac{1}{c_1^3}+\frac{2}{c_2^3}\right)\right]. \qquad (7)$$

Thus we see that the constant volume specific heat depends upon the volume of the specimen, and though the correction due to this cause is ordinarily altogether negligible, yet for deep temperatures and when the substance is in the form of a fine powder (small value of V) the correction would be appreciable.

A detailed discussion including the effect of a more accurate enumeration of the normal modes on the magnetic properties will be given elsewhere.

Physics Department,
University of Delhi. D. S. KOTHARI
Delhi, 25-8-1940.

[1] SCIENCE AND CULTURE, *6*, 246, 1940.
[2] See Saha and Srivastava, *A Treatise on Heat*, § 443.

Indian Science News Association
Proceedings of The Fifth Annual Meeting

The fifth Annual General Meeting of the Indian Science News Association was held at the University College of Science, Calcutta, on the 27th August last at 6 P.M.

Dr. S. C. Law, President of the Association, was in the Chair and Dr. S. S. Bhatnagar was the guest-of-honour.

The proceedings of the last Annual General Meeting were read and confirmed.

On behalf of the secretaries Professor S. K. Mitra submitted the following report of the working of the Association and the audited statement of accounts for the year, 1st July, 1939 to 30th June, 1940.

REPORT.

The Council of the Indian Science News Association have pleasure in submitting this, the fifth annual report and the statement of accounts for the period July 1, 1939 to June 30, 1940.

MEMBERS

The Association has at present only one category of members, *viz.*, life-members and their total number in the list as corrected up to 30th June, 1940, was 88. We had to delete, with regret, names of 3 members as they had been in default in spite of repeated reminders. Eight new life-members joined us during the year.

SCIENCE AND CULTURE

Our journal continued to maintain the high standard in scientific journalism which it had attained in the few years of its existence. Well-known scientists and experts contributed authoritative and instructive articles in the last volume. Amongst these mention may be made of Dr R. A. Millikan, Sir M. Visvesvaraya, Dr John B. Grant, Lt.-Col. D. H. Gordon, Col. R. N. Chopra. In our editorials and in the various articles published in the section "Science in Industry" we drew pointed attention of the public, to the necessity of approaching the economic and industrial problems of our country in the proper scientific way. You will remember that for sometime past we have been urging upon the Government the necessity of establishing a department for initiating researches into industrial problems and of mobilising the scientific talents of the country. It is gratifying to note that our campaign has borne some fruit and that under the stress of war the Government of India has formed a Board of Scientific and Industrial Research, whose director, Dr S. S. Bhatnagar is our guest-of-honour today. We are sure the Board will in near future attain the same status and importance and play the same role in the industrial regeneration of the country as the Department of Scientific and Industrial Research of Great Britain. We are glad to note in this connection that many of the members of our editorial board and of our editorial collaborators are serving on the various committees of this newly formed Board.

The total number of copies of SCIENCE AND CULTURE despatched in June, 1940, was 717 as compared with 692 in the same month in 1939. We had a steady increase in the number of subscribers during the period under review. The number on June 30, 1939 (including life-members) was 500 and that on the same date in 1940 was 572 showing an increase of 72.

We continued to send the journal free to a number of distinguished persons and scientific writers in India and abroad so that the views expressed by us might have wider publicity through them. We have already received appreciative letters from them, and may mention for instance the comments made by Sir John Marshall on our editorial on the Report of Sir Leonard Woolley on the work of the Archaeological Survey of India.

Foreign and Indian journals like the *New York Times, Armchair Science, Discovery, Statesman, Aryan Path, Indian Review, Modern Review,* etc., quoted from our articles and notes, and commented on our views on various subjects.

During the period under review we had some changes in the printing arrangement of the journal. You are aware that in June, 1935, when the Association was started, we entered into an agreement for a period of two years with the Indian Press Ltd., in regard to the printing and publishing of SCIENCE AND CULTURE. It was a part of the agreement that they would be responsible for publishing the journal every month under the editorial direction of the Association. After the period of agreement was over the Indian Press chose to continue as printers up to October 1939, when, we were reluctantly compelled to sever our relations with them as they wanted a substantial increase in their rates. We would like to record here our appreciation of the services rendered by the Indian Press Ltd., and would specially mention Mr H. K. Ghosh, the General Manager of the Press, for his coming to our assistance and undertaking the responsibility of publishing the journal in its earlier days. Arrangements for printing the journal was then made with the Commercial Gazette Press in November, 1939. We are sorry to report that for various reasons we were unable to continue the arrangement and, from the first number of the present volume, the printing is being done at the Sri Gouranga Press. We wish to record here our sense of appreciation of the helpful co-operation which this Press has extended to us by agreeing to a substantial reduction in their usual rates.

EXCHANGE JOURNALS

The total number of copies sent out every month in exchange and for review purposes was 63 on June 30, 1939. The number increased to 72 by December, 1939. After that date, however, the number dropped to 53 due to war conditions and to a revision of the list. Amongst the journals received in exchange we have 11 English, 15 American, 7 Indian and 1 Australian journals. We receive proceedings of 15 learned societies and 3 Calcutta newspapers on exchange. There are 20 scientific societies and public institutions in this country and abroad to which the journal was regularly sent on request.

Unfortunately, we have not yet been able to make the journals, received in exchange, available to our members and to the interested persons by displaying them in a reading room of the Association. We have however arranged to issue these journals on loan to the members from the office of SCIENCE AND CULTURE and an announcement to this effect was published in the journal on several occasions last year. A few of the journals are now kept on the table of the library of the physics department of Calcutta University where students have an opportunity of reading them.

GRANTS AND DONATION

We are glad to announce that the University of Calcutta, the Indian Association for the Cultivation of Science and the Bengal Chemical and Pharmaceutical Works renewed their annual grants. Dr S. C. Law and Sir Upendranath Brahmachari have made further substantial donations to encourage us in our work and Dr Bimala Churn Law, one of our new patrons, has made the handsome donation of Rs. 1,000. We express our sincerest thanks to them. The list of the grants and donations are as follows :—

University of Calcutta	Rs.	500/-
Bengal Chemical & Pharmaceutical Works, Ltd.	Rs.	500/-
Indian Association for the Cultivation of Science	Rs.	100/-
Dr. S. C. Law	Rs.	1,500/-
Sir Upendranath Brahmachari	Rs.	500/-
Dr. Bimala Churn Law	Rs.	1,000/-
Mr. Prahlad Chandra Roy	Rs.	200/-

To the authorities of Calcutta University we are further grateful for allowing us to use one of the rooms in the buildings of the University College of Science.

APPEAL

There is no need for us to dilate here upon the importance of the various subjects concerning national welfare which we have been discussing in our journal. We desire very much that the articles, the discussions, the news regarding the latest advances in science and their applications and the various other matters which appear in our journal should receive the widest possible publicity. You can render great help in regard to this if you take a little trouble to bring the journal to the notice of your acquaintances. You have probably received a leaflet containing an account of the principal contents of the last volume, together with a circular letter requesting you to recommend names of prospective subscribers. Your personal efforts in the matter, coupled with our own, will certainly bear fruit. In this connection we would mention the name of Mr S. Basu, Meteorologist at Delhi, who has secured for us a dozen subscribers for which the Association is grateful to him.

You will appreciate that we are not yet in a position to create a reserve fund out of the fees of the life-members and of the donations received. The financial help which we have been receiving for our good cause just enables us to meet the annual deficit. It should not be forgotten that this source of income is very limited and hinders us in preparing our budget in advance. We would appeal to our members and to the friends who have kindly come here today to extend their sympathy and to help us in raising more funds.

There are now signs that our countrymen have begun to realise the extreme importance of studying the effects of the impact of science on society. The contemporary world situation itself is a forceful reminder of the obligations of science to society and of society to science. At such times a journal like SCIENCE AND CULTURE is of the greatest value in disseminating knowledge and inculcating the critical as well as the constructive scientific spirit among our fellow countrymen.

RECEIPTS AND PAYMENTS ACCOUNT FOR THE YEAR ENDED 30TH JUNE, 1940.

RECEIPTS	Rs.	as.	p.	Rs.	as.	p.	PAYMENTS	Rs.	as.	p.	Rs.	as.	p.
To Opening Balances on 1-7-39 :							By Establishment				2,868	0	0
(a) At Bengal Central Bank, Ltd. in Current A/C as per Pass Book ...	715	7	11				,, Printing				5,080	13	6
(b) At Bengal Central Bank, Ltd. in Science & Culture S. B. A/C as per Pass Book ...	451	8	10				,, Paper				2,242	10	8
(c) Cash at Office ...	94	9	9				,, Postage & Receipt Stamp ...				674	15	0
				1,261	10	6	,, Conveyance & Travelling ...				282	1	0
,, Donation				8,200	0	0	,, Telephone				215	7	6
,, Grant				1,100	0	0	,, Miscellaneous				107	18	0
,, Life-Membership Fee ...				1,009	0	0	,, Audit Fee				30	0	0
,, Subscription				2,592	9	9	,, Bank Charges				26	6	0
,, Advertisement				2,575	12	9	,, Furniture				93	12	0
,, Reprint				321	18	0	,, Binding Charges				7	12	0
,, Bank Interest				23	11	11	,, Stationery				88	0	8
,, Miscellaneous				259	12	10	,, Closing Balance on 30-6-40 :						
							(a) At Bengal Central Bank Ltd. in Current A/C as per Pass-Book ...	845	0	9			
							(b) At Bengal Central Bank Ltd. in Science & Culture S. B. A/C. as per Pass-Book	313	7	6			
							(c) Cash at Office ...	18	4	0			
											1,176	12	3
				12,344	6	9					12,344	6	9

I have audited the above Receipts and Payments Account of INDIAN SCIENCE NEWS ASSOCIATION for the year ended 30th June, 1940, with the books and vouchers and have obtained all the information and explanations I have required. Subject to my separate report (printed below) of even date I certify that the said account is correctly stated and is in accordance with the books of accounts of the Association.

10, Old Post Office Street,
Calcutta, the 6th August, 1940.

Sd/- S. K. MITRA,
9-8-40.
Secretary.
Sd/- P. C. MITTER,
9-8-40.
Treasurer.

Sd/- A. K. GHOSH,
Government Diplomaed Accountant
Registered Accountant.

Auditor's Note

"With reference to the qualifying clause in the Receipts and Payments Account of the Indian Science News Association for the year ended 30th June, 1940, I am to observe as under :—

Life-Membership Fee : It is desirable that the amounts received on account of life-membership fee be ear-marked and specially invested.

General : Of Rs. 2,242-10-3 disbursed under Paper Account, I am informed by the Hony. Secretary that Paper worth Rs. 660-12-0 was in stock as on 30th June last. The outstanding bills payable to Creditors as also the amounts receivable in respect of Advertisement, Subscription and Life-Membership Fee should be properly ascertained at the end of the financial year. An inventory of Furniture purchased up to 30-6-40 should be made at an early date."

In presenting the statement of accounts together with the auditor's note, Professor Mitra observed that they had cleared last year dues to the Indian Press of about Rs. 2,000/- on account of printing costs outstanding during the past two years. He assured the members that from next year accounts will be kept up showing the amounts receivable and payable at the end of the year and also an inventory of furniture, which have been purchased very recently. Regarding the creation of a reserve fund, he regretted that the present financial position did

not allow such a fund but as soon as the conditions improve the Council will be too glad to provide for a reserve fund.

Office-Bearers

After the adoption of the annual report and the statement of accounts, the following office-bearers of the Association and members of the Council for the year 1940-41 were elected :—

President: Dr S. C. Law ; *Vice-Presidents*: Sir Upendranath Brahmachari, Dr Baini Prashad, Prof. M. N. Saha, Dr B. C. Law, Dr S. P. Mookerjee and Prof. P. N. Ghosh ; *Treasurer*: Prof. P. C. Mitter ; *Secretaries*: Prof. S. K. Mitra and Prof. B. C. Guha ; *Members*: Prof. S. P. Agharkar, Dr S. S. Bhatnagar, Mr. H. P. Bhaumik, Prof. D. M. Bose, Mr Rajsekhar Bose, Lt.-Col. A. C. Chatterjee, Col. R. N. Chopra, Mr A. T. Ganguly, Prof. J. C. Ghosh, Dr M. Qudrati-Khuda, Dr D. S. Kothari, Mr. B. N. Maitra, Dr S. C. Mitra, Prof. H. K. Mookerjee, Prof. J. N. Mukherjee, Prof. B. B. Ray, Mr N. C. Ray, Prof. P. Ray and Prof. N. R. Sen.

The editorial board for the journal, Science and Culture was constituted with Prof. M. N. Saha, Prof. J. C. Ghosh, Dr A. C. Ukil and the two Secretaries of the Association, Professors S. K. Mitra and B. C. Guha.

Dr S. C. Law next welcomed the guests. His speech is published on p. 197 of this issue. Dr S. S. Bhatnagar next addressed the gathering. His address appears on p. 194 of this issue.

Mr A. L. Ojha in proposing a vote of thanks to Dr S. S. Bhatnagar observed that the recent establishment of the B. S. I. R. with Dr Bhatnagar as the director augured a bright future for the industrial enterprises in the country. So long there was very little co-operation between science and industry in this country and the capitalists and the industrialists of the country had been condemned for this but a share of this blame should be borne by the scientists too, who are only now interesting themselves in industrial problems. He was certain that finance would not be lacking. The capitalists, who, as Dr Bhatnagar hinted, speculated so much in the stock exchanges, require to be convinced of the potentialities of the various industrial ventures. He hoped that the basic researches for rehabilitation of some of the present industries and for starting news ones would be carried on under the aegies of the B. S. I. R., and science would be closely associated with the industries for ushering in a new economic era in the country.

Dr John B. Grant in proposing a vote of thanks to Dr S. C. Law said that on his coming over here from China he felt for sometime the absence of an academic atmosphere in Calcutta. But his connection with the Indian Science News Association has partly made up that deficiency. Its monthly journal, Science and Culture, has been doing a good service in creating the much-needed scientific vision. People here are slow to realise that science in one form or other has entered into every element of our social structure. It can no longer be considered as separate and distinct from other forms of human activity. Science and Culture is likely to be a standard scientific journal like the *Nature* of England and the *Science* of U S. A. It is in the fitness of things that Dr Law has contributed a great deal to the success of the Association. He has heard several times about Dr S. C. Law's varied interests and munificence towards similar worthy causes. He combines wisdom with wealth and a broad outlook with his philanthropy.

Mr G. L. Mehta associating himself with Mr Ojha and Dr Grant complimented the scientists, who have organised the Indian Science News Association, for having put energy into Dr Law, whom we find here today. Due to shyness he generally keeps away from public platforms. Dr Law's interests in matters, industrial, economic and scientific are really very encouraging. He has been doubly blessed by the goddess of wealth and the goddess of learning. The Law family of Calcutta stands out as a rare example in this direction.

Science and Culture

A Monthly Journal of Natural and Cultural Sciences

Vol. VI NOVEMBER, 1940 No. 5

Need for a Planned Development of Broadcasting in India

We are publishing elsewhere in this issue a review of the *Report on the Progress of Broadcasting in India* published by the Government of India. A perusal of the report leaves one with the impression that at a time when broadcasting had been making enormous strides in other countries the government of this country had been pursuing a half-hearted policy in regard to its development. The funds allocated by the Government of India for broadcasting development have till now been strictly limited and it is doubtful if, under the circumstances in which the All India Radio had to work, a quicker and greater development of broadcasting than what has been achieved in the last few years, could have been expected. The Controller of Broadcasting remarks that the sum of Rs. 40 lakhs available for development of broadcasting over an area 30 times that of the British Isles and a population of 400 million is less than the money available for providing only a television service to the city of London. The result of this policy, or rather the lack of any policy has been that India still remains the lowest in the scale of broadcasting development. The latest figures for the number of listeners in this country is 3·3 per 10,000 of population and may be compared to (about) 300 per same number for England. The Government of this country has evidently failed to realise the immense importance of broadcasting and is oblivious of the fact that it is a powerful tool in the hands of any Government, which knows how to use it, in shaping the character and the political views of a nation. Broadcasting is no longer a luxury ; it is a necessity in the cultural life of a nation.

The development of radio and its fuller utilisation on a wider and planned basis has special significance for India. The root cause of the backwardness of this country in almost every sphere of life is ignorance and poverty, and, these two act and react on each other. There is the perpetual vicious circle of ignorance leading to poverty and poverty standing in the way of dispelling ignorance. There is, however, at least one country in the world, the U. S. S. R., whose problems are not very different from those of India but which has been able, by strenuous efforts, to break this vicious chain. And, one of the most powerful tools employed by this country for the purpose has been the extensive use of radio amongst the rural population. The first step towards dispelling ignorance and superstition amongst the masses, handed down from generation to generation, and inculcating progressive ideas in their minds is to devise a scheme by which they can be talked to, taught and advised with sympathy and understanding—not once or twice—but continuously day after day and year after year. Any ordinary scheme like that of covering the rural areas with a network of schools for adult education is obviously impossible on account of its tremendously expensive nature. The only scheme which is practicable and which will not be of prohibitive cost is one of

teaching the masses through radio. If the Government launches upon a well-planned scheme for this purpose, they would not be doing a thing which has not been tried elsewhere. As hinted above, it has been used with so great a success by the U. S. S. R. that their Government is determined to continue making its fullest use till it strikes at the very root of ignorance and poverty, the greatest curse of the peasant class who forms the backbone of a nation. We are glad to note that the A. I. R. have made attempts in this direction by installing what may be called community receivers. Such sporadic attempts are, however, of little value and we think that the time has come for the Government to launch a properly planned scheme for installation of community receivers throughout the whole country.

SOME SUGGESTIONS

We may perhaps be permitted to make a few definite suggestions to the Government in regard to broadcasting development as we have spent some thought on the subject. In making the suggestions we would be drawing freely on the recommendations made by the Communication Services Sub-Committee of the National Planning Committee.

1. The Government should adopt a definite policy in regard to the fullest utilisation of the broadcasting service for rural uplift work as is being done by the U. S. S. R. which had been faced with problems similar to those in this country.
2. A representative body called the Central Broadcasting Advisory Council should be set up, the function of which would be to advise the Government in regard to the policy of expansion of the service in all its branches. The Council should be a representative public body drawn mainly from men and women outside the Government and consisting of scientists, educationists and outstanding figures in public life. It will be incumbent on the Government to pay due regard to the advice of this body in formulating their policy. Our object in proposing this Council is that, because of its immense scope in nation-building work, the responsibility of formulating the policy of development ought to be in the hands of an equally responsible public body commanding the country's confidence.
3. Since the fullest utilisation of the service depends upon the nature of the programme, it is suggested that there should be a Central Programme Board which will lay down from time to time the general policy of the national programmes. There should also be Provincial Boards which would indicate the subjects which are of immediate benefit to the rural and urban population of the provinces or regions concerned.
4. The service should be expanded to give first grade reception, if not over the whole of India, at least over its populous parts.
5. Broadcasting service is not of much use without a wide distribution of receivers. At present the cost of even the lowest priced receiver is beyond the means of the middle class people, who should form the bulk of listeners. It is therefore of utmost importance that cheap receivers should be made available and a drive should be made for increasing their number from 3·3 per 10,000 to 3 per 1,000 in course of next ten years. For this purpose it will be necessary to investigate on the manufacture and distribution of cheap people's sets.
6. There should be wide installation of community receivers on a planned basis. Each Provincial Government should appoint an agency whose duty would be to do propaganda work in this connection.
7. The Research Department should be strengthened for carrying on efficiently researches of a technical nature which are of immediate importance to the engineering side of broadcasting.
8. A Radio Research Board on lines similar to those in England should be established for carrying on investigations on problems of a fundamental nature, specially those peculiar to the country, in collaboration with universities and other research institutions where equipments for such work are available.*

The above plan of development may be made on a 10-year basis and an adequate sum should be set apart for the purpose. Considering that only Rs. 40 lakhs have been spent for the present development, a sum of 4 crores of rupees, for the purpose, spread over ten years is not certainly extravagant. We are strongly of opinion that the allocation of funds for broadcasting development should not be made on a rigid profit and lost basis.

* The necessity of establishing a Radio Research Board has already been discussed in this journal and the reader is referred to Vol. 2, pages 469-72, 1936-37.

Progress of Broadcasting in India

FOR the first time since 1932, when the Government of India definitely decided to continue the broadcasting service under State management, the Controller of Broadcasting has published a Report* on the working of All India Radio, extending to March 31, 1939. Though presented in the form of an annual report, the present volume includes a historical survey of the development of broadcasting in this country.

HISTORY OF THE DEVELOPMENT

The history of organised broadcasting in India dates back to 1927 when the Indian Broadcasting Company, started as a purely commercial concern, opened their transmitting stations at Calcutta and Bombay. The next five years saw very little progress. In 1930 the company went into liquidation and the Government of India was urged to take up the work. The Government however could not come to any decision until 1932, when they finally made up their mind to continue the service under State management. Like many other activities of the Government of India in the scientific and technical spheres, the progress, even after 1932, was extremely slow. Some advancement however has been achieved since 1935 when the Government decided to allot a sum of Rs. 20 lakhs for the development of broadcasting and a separate office of Controller of Broadcasting was created under the Department of Industries and Labour of the Government of India. The first controller to be appointed was Mr Lionel Fielden, recruited from the British Broadcasting Corporation. In the next year a further grant of Rs. 20 lakhs (making a total of Rs. 40 lakhs) was made for the same purpose and the services of Mr H. L. Kirke of the B. B. C. was requisitioned for working out a scheme of expansion of broadcasting in India. The present volume gives a resumé of the development scheme put forward by Mr Kirke, and the later modifications suggested by the Chief Engineer, Mr Goyder. This is followed by an account of the activities of the department, such as programme composition, maintenance of public relations, general administration and technical and research work.

In drawing up the scheme for the expenditure of Rs. 40 lakhs, Mr Kirke rightly observed that the service which can be given to India for this paltry sum must be very poor indeed as compared with that given in western countries. As an instance, he mentions that in Europe, which may be compared with India from the point of view of size and coverage, there are over 100 high and medium power stations representing a total cost of nearly 10 crores of rupees.

Mr Kirke recommended the establishment of seven medium wave stations (in addition to those existing at Delhi, Calcutta and Bombay) and one short wave station at Delhi for the transmission of news from a central point. He also proposed that one medium wave station of 100 kW power, five stations of 5 kW power and two stations of 2 kW power should be established in various centres. It was estimated that the scheme would provide a service area giving a signal strength of 10 milli-volts per metre to 14 million people and a signal strength of 3 milli-volts per metre to about 35 million people, though, in the light of later experience, it has been found that Mr Kirke's estimates were rather too optimistic. His report also stressed the necessity of setting up a research department to undertake such work as field strength measurements, transmission tests, collection of information regarding atmospheric disturbances and the development of radio links. Mr Kirke also suggested that a Chief Engineer should be appointed without delay to supervise the technical and research departments. The general policy underlying the recommendations was "based on a compromise between providing a service to urban areas from which licence revenues may be anticipated, and providing such service to rural areas as may be offset in cost by the revenue obtained from the urban areas". This somewhat mercenary policy of regarding the State Broadcasting Service as more or less a commercial undertaking and not as a social service, was attempted to be justified on the ground that if broadcasting is to develop in this land, "the service must have a

* *Report on the Progress of Broadcasting in India.* Published by the Manager of Publications, Government of India, Delhi, 1940. Price Rs. 3 or 5 shillings.

life of its own and strength to survive budgetary fluctuations".

Following the recommendations of Mr Kirke, Mr C. W. Goyder, formerly of ths British Broadcasting Corporation, was appointed Chief Engineer in 1936. Mr Goyder did not fully agree to the proposals of Mr Kirke in concentrating upon medium wave transmitters which would make it possible to cover only a small percentage of the total area of the country, with the funds allotted by the Government. He put forward an alternative scheme of providing a basic short wave service even though of a somewhat inferior grade, to the whole of India, and then supplementing the same with first grade medium wave service at important centres which may be gradually extended as, and when, further funds become available. It is remarkable that Mr Kirke's full report never saw the light of the day nor are the public aware if the Government of India considered it necessary and proper to consult Mr Kirke before deciding upon the alternative scheme suggested by Mr Goyder. On too many occasions specialists are readily imported from Great Britain to render advice in connection with particular problems or development schemes and the reports submitted by these experts are pigeon-holed in the archives of the Government. We do not know if the Government realises that the public funds spent in importing such specialists serve scarcely any useful purpose if their reports are only of academic value and the Government does not find it possible to make much use of them.

As a result of discussions between the Government of India and Local Governments it was decided to modify the scheme of Mr Kirke and start, in addition to the already existing medium wave stations at Delhi, Bombay, Calcutta and Peshawar, four 10 kW short wave transmitters at Delhi, Bombay, Calcutta and Madras which could be regarded as almost covering the whole of India and providing a service (second grade) which would not be unsatisfactory to the average listener. The modified scheme also made provision for 5 kW medium wave stations at Lahore, Lucknow, Dacca and Trichinopoly and a 5 kW short wave station at Delhi. The new transmitters were ordered in January 1937 and have since come into operation.

At the time of formation of the Indian State Broadcasting Service the engineering and technical control was vested in the Posts and Telegraphs Department but, following the recommendations of the Kirke report, these activities were re-transferred to All India Radio to avoid divided control between administration and engineering. The activities of the engineering department have been concerned with the planning, installation, maintenance and operation of broadcasting centres.

RESEARCH DEPARTMENT

Pursuant to the report of Mr. Kirke a research section was added to All India Radio in 1937. The section consists of a research engineer and a technical staff, and is required to collaborate with the engineering department. It is fit and proper that the All India Radio should maintain such a department. Research is the fountain head of progress and without it all development comes quickly to a standstill. Unfortunately, the attitude towards research in this country, even of men who ought to know better, is sometimes distressing. There are men who style themselves as "practical men" or "men of action", who think that research is only an academic affair and has little bearing on the successful maintenance of a technical service. They are of opinion that once the requisite machineries have been installed and the thing has been set going one need not bother oneself about research. If the machines wear out they are simply to be replaced by importing fresh ones; if any improvement is desired that can be easily achieved by bringing from abroad newer types of machines of the latest models. These so-called men of action are all clever people and it is difficult to believe that they do not know the far-reaching importance of research; in their own countries they must have seen ample evidence of it. Yet, whenever the question of carrying on research in India is raised, they develop this practical frame of mind and maintain that if any research work is to be done let that be done at Home; here in India we need only utilise the fruits of these researches. One wonders how such clever people could be ignorant of the fact that there are problems, the solutions of which can only be obtained by intensive research in the country of their origin. This is particularly true in the case of problems connected with broadcasting development and we may quote here in this connection the opinion expressed by some very famous scientific men of England.* Says Dr E. V. Appleton: "India has its own radio problems the solutions of which depend upon workers in India. This cannot follow from work carried out in other

* See SCIENCE AND CULTURE, *1*, 755, 1936-37.

parts of the world". Sir Frank E. Smith says, "The problems associated with the field strength of received signals at different times of the days and at different seasons of the year with different wavelengths and with different aerials are examples of those of a local nature which can only be solved by work in the country desiring information". Sir Richard Gregory (Editor of *Nature*, since retired) says, "It does not seem to be realised by people in power in India that every country has its own problems in regard to satisfactory transmission and reception of broadcasting and that this can only be solved by systematic study of the conditions in different parts of the country". We therefore repeat that the All India Radio moved in the right direction when it decided to establish a research department, be that only as an appendage of the engineering section.

A perusal of the *Report* shows that the research department has undertaken the study of subjects like field strength measurement, atmospherics, design of village receivers, studio design and the ionosphere. Considering the men and money at the disposal of All India Radio it is indeed an ambitious programme. We doubt if the research department of the B. B. C. at Nightingale Square with its large resources would dare undertake such a programme which is a combination of its own with that of the Radio Research Board. A problem like acoustic properties of a studio is a technical problem directly concerned with the operation of a broadcasting centre and, as such, naturally falls within the scope of the research department. But it may be questioned if the research department can do justice to subjects like atmospherics or the study of the ionosphere which fall within the category of *geophysics* and which, like all other subjects in this category—*meteorology* and *seismology* for instance—require long continued observations for their elucidation and for abstracting any data regarding their nature and behaviour which may be of practical use. We are sure the department realises that it is fallacious to draw any general conclusion from a record of observations made at a particular place for a few days in the year. If it is thought that the necessary knowledge about the origin and distribution of the Indian atmospherics (for instance) have been gained from the set of curves given on page 100, the position would be the same if the India Meteorological Department were to claim that they know all that is necessary to know about Indian climatic conditions as they have records of, say, the rainfall, the temperature and the mean wind velocity at Delhi for some selected months of a particular year. We venture to remark that it is only from a close analysis of records kept over long periods by observational stations properly distributed over different parts of the country according to their climatic peculiarities that one can hope to obtain any reliable information which may be of practical value for subjects like ionospheric condition, atmospherics or the angle of incidence of downcoming waves from outside stations. Here we anticipate a retort from the All India Radio. We hear them saying, "We know all these; we know the importance of synoptic studies of phenomena connected with radio wave propagation; but you cannot expect us to carry out a programme of observations on a grand scale as suggested by you with the men and money at our disposal." We thoroughly agree with this. But, under ordinary circumstances, what does a man do when he is short of resources? He seeks co-operation. We therefore ask, "Has the All India Radio at any time sought the co-operation of or has suggested establishment of an organisation through which such co-operation could be brought about between the research department of All India Radio on the one hand and the scientific institutions of the country on the other, at which many of the problems mentioned above were being investigated long before the All India Radio came into existence?" We find that under the stress of the war the Government of India have thought fit to bring into existence a Board of Scientific and Industrial Research the aim of which is to mobilise the scientific talents and the research institutions of the country for investigations on subjects of immediate importance to the war. We wonder why the All India Radio has not moved in similar lines and sponsored the formation of a Radio Research Board which would act as a sort of clearing house of urgent problems by distributing them to the universities and other institutions which have been carrying on investigations on similar problems. Such a co-operation will be extremely helpful, not only for the present but also for future development of radio in this country.

Apropos the publication of the results of investigations carried out by the research department we would like to make a few observations. We see, from time to time, announcements regarding the researches carried out in the popular journals or in reports submitted to the Government. But we look in vain for any technical account of the same in scientific journals. Such descriptions of the researches of the

department on village receivers, on atmospherics, on pulse records would be extremely useful and important. The B. B. C. for instance, adopts a commendable practice in this connection. They publish technical accounts of the investigations on which they base the designing of their new undertakings. We read with considerable interest in a recent issue of the *Journal of the I. E. E.* a paper embodying results of investigations carried out by them on the design of suitable aerials and feeder systems for Empire broadcasting. We would have certainly liked such a technical paper from the research department of A. I. R. on the investigations which, we believe, they must have made before they decided upon the type of aerials and their locations above the ground, the wavelengths to be used and the sites for the erection of transmitters, for the very novel type of service they introduced, namely, serving up to a distance of 800 km. around the transmitter with indirect ray using wave-lengths in the 60 and 90 km. bands. We must confess that the sketchy account of the researches given in the *Report* (pp. 92-95) is not only disappointing but also confusing. It can neither be understood by the lay public, nor, can in the least satisfy the technical expert.

Technical Training

We note that there is arrangement for training of two members at a time in the programme side, at the B. B. C. This is a very desirable arrangement as the highly developed B. B. C. organisation affords unique opportunity to the A. I. R. staff for learning every aspect of broadcasting. We only wonder why this arrangement is confined only to the programme section. We believe there is equal, if not better, scope for training for the young technicians of the A. I. R. in the engineering and research sections of the B. B. C. If the scheme for training could be framed and worked successfully for the administrative side, there is no reason why it should not be so for the engineering and research sections. We cannot help noting in this connection that in the matter of pay and prospects also men in the programme side are given preference to men of similar, or better qualifications, in the engineering and research sections. It is difficult, for instance, to appreciate the difference between the scales of pay of a programme assistant and a technical assistant.

Conclusion

In concluding our review we would mention that the *Report* issued by the Controller is a most readable one and contains a variety of information which is otherwise not available. There are tables, charts, graphs and diagrams depicting the results of observations and enquiries. We read with particular interest the comments made by the author of the *Report* on the language difficulties in this country and also his enumeration of the various viewpoints taken in this connection, by men of different schools of thought (p. 67). His remarks regarding classical and light music and the possibility of orchestration and of introducing harmony in Indian music are worth considering (p. 23). These views, coming as they are from a foreigner who had an opportunity of looking at the questions from a dispassionate viewpoint, are particularly valuable as they show what an outsider thinks of the social and cultural problems with which we are faced in India.

Role of Mathematics in Economic Statistics*

H. Sinha

Department of Economics, Calcutta University.

ETYMOLOGICALLY as well as historically, there is an intimate relation between "State" and "Statistics". It is no wonder therefore that Economic Statistics forms a large part of the subject. In early days, statistics meant economic statistics alone,—not only in the days of the *Artha-Sastra* by Kautilya, nor even in the days of the *Ain-i-Akbari* by Abul-Fazl, but even in the days of *Political Arithmetick* by Sir William Petty. Even at the present time the importance of economic statistics cannot be overrated. With the gradual development in other branches of the subject, economic statistics has also continued to advance. Formerly it meant simply averages, diagrammatic presentation of data already collected, but now it has attained greater practical importance as the results of sample economic surveys are being applied to large "populations" in accordance with the theory of probability.

Random Sample Survey

This is of great practical importance for two reasons, *viz.*, on grounds of economy in expenditure and in time. In these days of rapid changes, a complete enumeration may involve so much delay that by the time the inquiry has been completed with meticulous care, the conditions investigated may have changed so greatly that the results obtained are of no practical use whatsoever. The modern mathematical theory of sampling has been put on a satisfactory footing only a generation ago, with the discovery of the X^2-test by Karl Pearson in 1900. But the application of the sampling theory to economic data is beset with many difficulties. The "population" is generally extremely unstable and the variance does not remain substantially the same over time. The purely random errors are not sufficiently small to provide a suitable criterion for judging the character of systematic variations. More light is needed from mathematicians in order that sampling may be resorted to with confidence in economics.

Index Number

Let us consider for instance the problem of index numbers of prices, which is of vital importance in economics for measuring the value of money. So far as the purely economic aspect is concerned, that has been put on a satisfactory basis by Keynes nearly ten years ago. The different uses of money —for buying goods and services for consumption, for settling debts, for carrying on speculative transactions etc., have been gone into in detail and appropriate series of index numbers have been evolved. But much remains to be done in the mathematical aspect of the subject.

Base Period

The first problem is that of the base period, with reference to which variations in prices are to be studied. It has been said by somebody,—not an economist,—that twelve economists have thirteen opinions. But so far as the question of the base period is concerned, there is a substantial measure of agreement among economists. Internally, price and cost should be at a parity in order that *entrepreneurs* may continue to produce at a steady rate, there being no stimulus of windfall profit to increase their production, nor any brake of windfall loss to curtail their output. Similarly the conditions of external equilibrium have been formulated. But there still remains the serious and difficult problem of interpreting such conditions of external and internal equilibrium in terms of available statistics not only in India but even in advanced countries.

* Adapted from an address delivered before the Calcutta Mathematical Society.

WEIGHTING

Another difficulty arises out of the fact that all prices are not equally important. Appropriate weights must therefore be applied before averaging. But how to do so? The relative importance of the goods and services in the base period might have been different from that in the period under consideration. What set of weights is then to be chosen? Here also the economics has been worked out by Cournot as early as 1838. At any given time, the relative quantities must be functions of prices. If butter is very dear, margarine will have to be consumed in place of butter. This is quite evident. Both from the point of view of demand and from the point of view of supply, substantial advance has been made in the principle of equivalence or substitution in economic theory. But even with the help of *n*-dimensional space, the system of indifference curves representing bundles of goods and services yielding the same utility has not been satisfactorily studied. But until that is done, "weights" cannot be expressed as functions of prices and there must remain the present conflict between weights in the base period and weights in the period under consideration.

AVERAGING

There remains also the problem of averaging. It must be remembered that the price data are extremely intractable and that for two reasons,—firstly because they do not constitute a normal "population" and secondly because they are mutually correlated. Some attempts have been made by mathematicians either to "normalise" data which are not normal, or to make some allowance for the absence of "normalcy". But no successful efforts have as yet been made to develop the theory of distribution of correlated items. If mathematicians continue to interest themselves only in abstractions, they have no right to blame economic statisticians. For the latter are only too conscious of imperfections in their methods which they try to improve as best as they may.

TIME SERIES AND HETEROGENEITY

In economics most of the data are in the form of time series and are therefore mutually correlated, thus violating, as stated above, the basic assumption of independence required for the application of the probability theory on which all modern statistical tools are founded. The "population" again does not remain stable throughout. If we have a series of value figures, say for the foreign trade of a country, we cannot assume that the purchasing power of money has remained the same throughout. The number of inhabitants of a country may have gone up in the meantime so that the aggregate consumption has also increased but the consumption per head may have declined. This is sound common sense. But this common sense is conspicuously absent when it is argued that because there has been an increase in the number of schools, in the number of school-going children, and in the amount spent on elementary education, there has necessarily been educational advancement, for it is obvious that if the number of children of school-going age has increased to a larger extent than the number of children actually going to school, there has in fact been a set-back to elementary education in the country concerned.

POLICY OF DIVIDE AND RULE

The close connection between "State" and "Statistics" has already been referred to. Like an astute statesman, an economic statistician divides and rules. Thus in the case of value data, he divides them by the appropriate index number of prices, and with these ratios or what he calls "deflated values", he lords it over undismayed by heterogeneity. Similarly he reduces consumption to a *per capita* basis by simple division so as to get a comparable set of figures. In the case of the last instance he divides the number of children actually going to the school by number of children of school-going age, and works with the ratios thus obtained.

STATIC AND DYNAMIC ECONOMICS

But a policy of divide and rule is successful only in the short run. We often have to pay very dearly for political short-cuts. Similarly in economic statistics, the process of simple division fails to reduce the data to homogeneity, if they cover a fairly long period. For there is an inherent assumption about other things remaining the same, which is not always valid in practice. Economic statisticians have by now realized the futility of classical or statistical economics, in which the forces of demand and supply and all other economic forces have full play, resulting into a condition of substantial equilibrium, a small departure from which under the stress of a limited number of disturbing factor is the only subject matter of study. They have now come to know the importance of dynamic economics, that is to say, conditions actually ruling in a stage of disequilibrium intervening between one position of equilibrium and another. Thus changes or fluctuations have now become of vital importance in economics.

IMPORTANCE OF SERIAL STATISTICS

This is also desirable from the strictly mathematical point of view. For, as stated above, since the theory of distribution for mutually correlated items has not been fully worked out, it is clearly desirable to get rid of the interconnections as far as possible so as to be able to treat the residuals as random samples. For it must be remembered that this difficulty confronts not only economic statistics but many other types of serial statistics handled by sociologists, biologists, doctors, public health workers etc. The technique of analysis followed by economic statisticians may therefore prove to be of some use to a large body of statisticians, although the account given here must necessarily be very brief.

ECONOMIC CYCLES

The various changes in a time series have been analysed into four components: (*a*) secular trend; (*b*) cyclical movements; (*c*) periodic including seasonal factors; (*d*) irregular fluctuations. At the first sight, it may seem rather incongruous that cyclical movements and periodic factors have been separately classed. The fact is that economic cycles have neither their period nor their amplitude entirely the same throughout. On the other hand, such movements can scarcely be called random in view of the fact that the cycle at any time is influenced by the state of business during the preceding few months and does in its own turn affect the state of business during the succeeding few months. Whether we accept or not the "self-generative" theory enunciated by W. C. Mitchell, the doyen among cycle investigators, there is no doubt whatsoever that there are a series of ups and downs in most economic activity although such pulsations do not proceed with the regularity of a pendulum.

SEASONAL FACTORS

Periodic factors on the other hand repeat themselves with substantial similarity at regular intervals. Probably the type of periodic movement which has engaged the greatest attention is seasonal variation. Here the pattern is repeated within an interval of one year in each case. The chief reason is the earth's annual motion round the sun, bringing about variation in temperature, rainfall, insolation etc., which affect not only industries such as agriculture and building construction, but also industries catering to the manifold consumption needs of the modern society and the accompanying currency and exchange problems. In such cases the climatic factors are less pronounced, but their place is taken up by conventional seasonal factors such as religious festivals, *e.g.*, the Pujah, Id or Christmas and business practices such as periodical closing of books and preparation of balance sheets. As summed up by Simon Kuznets in his monumental work on *Seasonal Variations in Industry and Trade* (p. 10), "Social life, like individual life, runs in grooves set by habits and customs, many of which spell recurrent modifications in the rate of economic activity."

SECULAR TREND

Mitchell in his scholarly treatise on *Business Cycles* sums up the features of the secular trend in the following words: "Lines of secular trend show the effects of causes which, though subject to change at any moment, have influenced an economic process in some regular or regularly acting way through periods of time long in comparison with business cycles." The lack of precision is apparent but unfortunatey the definition cannot be improved upon. Two distinct methods of approach have been developed. One is based on what is called the law of growth. For instance, in the *Journal of the American Statistical Association* for 1922, Mr R. B. Prescott argues that every economic process has an initial period of experimentation, a subsequent period of growth into social fabric, a third stage during which this rate of growth is successively accelerated, becomes stationary and retarded, and a final stage in which there is no further growth. He therefore seeks to represent trends by Gompertz or Logistic Curves. Apart from the fact that this "law" is largely speculative, it cannot be applied to many series, for which however there seem to be

trends, *e.g.*, index number of prices. Another method of approach, which is usually resorted to, hits on an empirical law from a study of the data themselves, the technique is bewildering in its diversity. To quote from *Business Cycles* once again: "In the same piece of work, an investigator may fit a straight line to one series, a parabola to a second, compute three-year moving medians of a third and seven-year moving arithmetic means of a fourth, run a freehand curve through a fifth, use ratios to some other series for a sixth and devise some novel method for a seventh. He may even use two or three unlike methods of determining the trend in different sections of the same series!" Even if we make allowance for the fact that the business cycle investigators are concerned not with studying secular trends but with eliminating them so as to get at the required cyclic fluctuations,—even then we must agree that there is enough scope for improvement in methods for determining not only secular trends but also seasonal, cyclic and irregular factors.

Least Square Fitting

To give only one instance, in least square fitting, we assume that whatever error there is to be found in the ordinates, the abscissae is absolutely correct. In the case of the demand curve or of the supply curve, the error is associated both with quantity and with price. Economic statisticians have fitted straight lines such that the sum of the squares, not of the y-deviations but of the perpendicular distances, is the least possible. But mathematicians have not yet given us any indication with regard to the standard error of the gradient of such lines. For higher degree curves, the method has not been worked out at all, probably because there may be more than one normal to such curves from an external point.

Conclusion

The above account incomplete and discursive as it is, nevertheless points to the fascinations as well as to the risks in the study of economic statistics. Here is a field which calls for acute mathematical sense, for it is mathematicians who can replace the present subjective methods by accurate objective processes. The practical importance of such a study cannot be over-emphasized. To give only one instance, if we can form accurate notions about the behaviour of time series, we should be able to forecast the general trend of business and avoid maladjustments in economic life now causing untold human misery. How unsatisfactory our present state of knowledge on the subject is may be inferred from this one fact that not even one economic statistician could give us any timely warning about the Great Depression of 1929. It is time that our technique for studying economic statistics should be improved.

Recent Technical Development in Wireless and Broadcasting in Great Britain

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THE author of this article was awarded by the University of Calcutta a Ghose Travelling Fellowship in Science (1938-39) for studying the recent developments in the technique, research and methods of instruction in wireless in general and in broadcasting in particular. The choice of these studies was made mainly on the following considerations: It was being felt for sometime that more stress could with profit be given to the vocational aspect of the post-graduate teaching in some of the science subjects of this University, particularly those which have wide practical applicatons. The subject of wireless is pre-eminently such a branch of physics. It has on the one hand intensive application in the practice of the art of radio communication and on the other has close association with the teaching of electric and magnetic phenomena in physics. It was therefore further felt that if the teaching of this subject —courses of the study of which already exist in the post-graduate physics classes—could be reorganised after the methods followed in the European countries, the students pursuing the course would be better fitted to take up responsible posts in the industries or in the communication services which are rapidly developing.

The author visited England in the year 1938 and spent about a year in touring round various centres of wireless research and teaching, such as Marconi's Wireless Telegraph Co., Ltd., Standard Telephones and Cables, Ltd., British Broadcasting Corporation, British Post Office, National Physical Laboratory, etc. Brief descriptions of the places and institutions visited are given below.

The Marconi School of Wireless Communication

The first institution visited was the Marconi School of Wireless Communication at Chelmsford, England. The Marconis are the biggest manufacturers of wireless equipments in Europe and they maintain this school for imparting an all-round engineering knowledge in all branches of wireless communication to advanced students. The maintenance of such a school under the direct supervision of the pioneer manufacturers has the immediate advantage that the students can handle all types of commercial equipments. Such facilities are not available in any university college because of prohibitive expenses both for initial outlay and also for maintenance.

The School was originally intended for training university graduates joining the Marconi Company as wireless engineers. Gradually it became also a training centre for foreign engineers who were employed by the customers of the Marconi Company. At present it has developed itself into a regular institution whose facilities are also available to students who may not in any way be associated with the Company or its customers.

The School has a number of laboratories for general experimental work, a standard laboratory for specialized and precision work and a fairly well-equipped workshop. In additon, there are a number of field "huts", each of which is intended for a particular type of work; for example, one hut is reserved for work on broadcasting transmitters, one for general experimental transmitters for short and long waves, one for telephone terminal equipment, one for television and one for aerial measurements. There is also provision for some field work, specially in connection with feeders and their matching.

The course of instructions imparted in the School is broadly divided into two sections. The first is the general course and the second the advanced course. The School also undertakes to provide special facilities for work outside the normal curriculum for qualified engineers. The different subjects included in the course are approached more

from the practical and the engineer's point of view rather than from the academical point of view. There are, of course, regular theoretical lectures delivered both by the teachers of the School as well as by the research engineers from the Marconi Works, who specialise in the different branches. The School also arranges special lectures by experts from other organizations like the B. B. C. and the British Post Office.

Amongst the subjects in which the author took special interest while at the School, mention may be made of the design and testing of short wave broadcasting transmitters, matching transmission lines and feeders, receiver measurements, absolute measurement of frequency, studies of radio frequency transmitting pentodes and feeding self-radiating towers. Short descriptions of the principal equipments are given below.

The model shortwave broadcasting transmitter is designed to give an output of about 500 watts. The quartz-controlled master oscillator is followed by a buffer stage and then by two frequency doubling stages. The output of the second frequency doubler feeds a single-ended neutralized r.f. power amplifier. This is in turn link-coupled to the final balanced push-pull power amplifier. The transmitter being a model one, there is provision for various types of modulation, both high- and low-level. The final r.f. power amplifier can be used either as Class-C for high-level modulation or as Class-B for low-level modulation by suitable adjustment of grid bias. There is also provision for "keying" the transmitter for telegraphy work. The transmitter also contains a built-in cathode ray oscillograph unit which can be used for checking the modulation visually. The studio equipment of the transmitter is located in a separate room of the transmitting "hut" and consists of three channels—microphone or otherwise—, and a mixer amplifier. The output is fed to a line connected to the sub-modulator unit at the transmitter. In the studio this line input is also fed to a monitor amplifier having an output meter for visual inspection of line level. The studio equipment also includes a built-in beat frequency oscillator.

The transmitter for investigations on the matching of transmission lines and feeders consists of one MT 12-A master oscillator followed by a balanced push-pull amplifier with two MT 12's giving an output of about 0·5 kw. Neutralization is done first by the "cold" and then by the "hot" process. The line can be coupled to the amplifier either inductively or capacitively.

The distribution of current along the line and the effect of various resistive terminations, including aerial loads, are studied in great detail. Both open wire and concentric feeders are studied. The properties of $\lambda/4$ and $\lambda/2$ lines as impedance matching devices are also studied. The value of any unknown resistive load is also measured in terms of the characteristic impedance (which is separately measured) by carefully noting the distribution of current along the open wire line.

In connection with receiver measurements an interesting problem is the determination of the intermediate frequency of a commercial receiver. It is well known that the i.f. circuits are first aligned and then the signal and oscillator circuits and that the i.f. adopted by the designer must be accurately known. In case this is not known, any residual misganging can be used as an indication of the nature of the wrong choice of intermediate frequency. If the i.f. chosen for alignment is greater than the designer's value then the ganging is such that for the longer wavelength side of a waveband the signal circuit demands an increase of capacity and for the shorter wavelength side a decrease of capacity for proper tuning. The reverse is the case if the selected i.f., is less than the designer's value. Thus by noting carefully the apparent demand of signal tuning capacity on the two extreme ends of a waveband (centre being properly ganged for the i.f. chosen) one can judge whether the i.f. selected is correct or above or below the correct value.

The equipment for absolute measurements of radio frequencies is the Marconi type 482-C Frequency Measuring Equipment in which the master oscillator is quartz-controlled and operates the usual multivibrator system. The lowest frequency output (100 cycles/sec.) from the system drives a synchronous clock, the time-keeping of which provides an exact indication of the master oscillator frequency. The frequencies of British and Continental stations are measured with great accuracy and their short-time variations are also studied. The variations of the frequency of an oscillator with electrode voltages and with loading are also studied with this equipment. It may perhaps be of some interest to note that the B. B. C. also use one such equipment at their frequency checking station at Tatsfield. The British Post Office also uses this system at Baldock for routine measurements of the frequencies of all British (also Continental) stations.

The feeder used in connection with investigations on feeding self-radiating towers is of the concentric type. Matching is effected by means of the so-called reactance transformer. The towers are usually insulated from the ground and the first step for matching adjustments is to measure with a R.F. bridge the resistive and reactive components of the impedance between the aerial base and earth. From the known characteristic impedance of the concentric feeder the components of the reactance transformer are calculated. With these components the final matching is tested with the help of an impedance matcher.

E. K. COLE, LIMITED.

The next important establishment visited was the Factory and Development Department of E. K. Cole, Ltd., Southend. This firm is one of the biggest manufacturers of broadcast and television receivers and is the pioneer manufacturer of radio communication instruments in Great Britain. The activities of this organisation are divided mainly into two sections. One is known as Government Contract and Instruments section, and the other as Receiver Manufacture section. The author was privileged to work in both the sections and got thorough acquaintance with their activities. It may be noted that the instruments manufactured by this company are marketed as Marconi-Ekco instruments.

Government Contract & Instruments Section.—In this section the author was mainly interested in the development, testing and standardization of measuring instruments as are used in wireless and acoustics. Of the instruments critically studied mention may be made of standard signal generator of all frequencies, beat frequency oscillator, wave analyzer, Q-meter, impedance measuring bridge, attenuator, distortion factor meter, wavemeter and thermionic voltmeter. The details of design and methods of standardization of these instruments are beyond the scope of this article and the author therefore refrains from making any special references.

Receiver Manufacture Section.—This section is concerned with the manufacture of both broadcast and television receivers. Some components, such as coils, r.f., i.f., and l.f. transformers, power transformers, chassis, bakelite cases, etc., are manufactured in the Company's factory. For testing and calibration, instruments manufactured by the Instruments Division are used as far as possible. It may perhaps be mentioned that so far as receiver manufacture alone is concerned this is one of the biggest of such factories in Great Britain and the author had the opportunity of studying the different stages in the manufacture and testing of commercial receivers in mass production. A brief description of the method of manufacture may perhaps be interesting.

Any particular type of receiver is first designed and fitted up in the development section where preliminary tests are made. Next, this receiver is passed on to the regular commercial testers in the manufacturing section where further tests are made specially from the commercial and servicing point of view. The remarks of these testers are then passed on to the development section where some further additions and alterations are usually made. After these preliminary trials a number of such receivers are built on a semi-commercial scale and if these are found satisfactory and marketable then and then only real mass production begins. These remarks hold for both broadcast and television receivers.

The manufacture of a receiver may be broadly subdivided into several distinct stages. First comes the assembling of all the components on the chassis. This assembled unit is then passed on to the mechanical tester who tests the components and fittings from the mechanical point of view. After this, the connections are made—the entire process being on the "belt" system. The chassis with all components mounted is made to pass slowly on a belt, the motion being discontinuous. Each individual working in the chain is entrusted with a certain number of specified connections and is allotted a definite time during which these have to be finished. At the end of this period the receiver is passed on the belt to the next person who in turn does the connections entrusted to him. In this way the receiver passes on to the end of the belt where once again all the connections are checked from the mechanical point of view. Next it passes to the first tester who tests the power consumption, preliminary alignment and other minor tests. Finally it goes to the last tester a short description of whose equipments and method may be of some interest. This tester has on his bench permanently mounted a number of testing instruments and also supplies of

audio, radio and intermediate frequencies. The main instruments are one standard signal generator, one output meter, one avometer and one mains consumption meter. The audio, radio and intermediate frequency supplies are generated centrally in screened rooms and are of sufficient power to feed all the testing benches where these are wanted. The supplies are given by means of screened cables to avoid any interference. With the help of the mains consumption meter, the tester first checks the consumption to see if it is normal. Then, applying the calibrated audio supply, he measures the output. If this is within the prescribed limits he proceeds with the alignment of the i.f. circuits and then the A.F.C. system, if there be any. When these are done the signal and oscillator circuits are adjusted carefully. Finally the receiver is taken to a cabin for tests with actual broadcast stations. The cabin has got a supply of continuously varying audio frequency from a central source in the factory.. With the help of this, the l.f. response of the receiver is tested aurally and then the aerial tests are made. The actual aerial is located far away from the workshop and in the open ground in order to avoid the local electrical interference from the various factory plants. The lead-in is taken to the cabin by means of screened cables. The receiver is now passed on to the cabinet fitting section where it is completed in the form available in the market. To test the mechanical stability of the receivers due to probable bad handling during transport, some of the receivers are made to undergo a special test. The finished receiver is packed in its box and by means of a machine operating automatically it is raised to a certain height and thrown down at random on the floor. This process is repeated for a certain number of times and the receiver is then unpacked and again tested. After this final test it is ready for the market.

RESEARCH STATION OF THE BRITISH POST OFFICE AT DOLLIS HILL

The next important establishment visited was the British Post Office, firstly their Research Station at Dollis Hill and then their Transmitting and Receiving Stations at Rugby, Baldock and St. Albans.

The station at Dollis Hill is maintained by the Post Office for investigations on problems connected with the various communication systems maintained by the department. New apparatus required in the different services are designed and developed here. The activities of the Station may broadly be classified under the two heads—telephone and radio. In the telephone section the author was primarily interested in its acoustic work ; he also followed their methods of testing the articulation of lines and other networks and, also, the mass-testing of telephone receivers under all possible operating conditions.

In the acoustic department, microphones, telephones, loudspeakers and other similar equipments are designed, tested and calibrated. This department also carries on work on studio design, auditorium testing, noise measurement and tests of telephone lines and associated gears. Sound-on-disc recording for the Post Office is also done here. For the purpose of quantitative measurements on electro-acoustic apparatus, *e.g.*, absolute calibration of microphones and loudspeakers, the department has built an acoustic cabinet. The design of this cabinet (a similar one is being used by the B. B. C. at Nightingale Square, London) has been made very carefully and is almost 'dead' acoustically. The cabinet is provided with a point source of sound of special design which generates spherical waves.

For "free air" calibration of microphones this source is used in conjunction with a Rayleigh disc. Sometimes a substandard condenser microphone calibrated by the N. P. L. is also used for comparison. For "pressure" calibration the Rayleigh disc is also used but under different conditions. For this purpose a system of plane standing waves is maintained in a resonating closed air column, at one end of which (a position of maximum pressure) the microphone under test is placed. This end is made air tight with plasticine. The Rayleigh disc is placed at a position of maximum velocity, generally at the midpoint of the column. To the other end is fixed the source of sound, a watch type telephone receiver. Both ends of the resonating tube have telescopic adjustments.

This acoustic cabinet is also used for loudspeaker testing. The loudspeaker is suitably placed in the cabinet and is fed by an amplifier located outside; the input of the amplifier is supplied by a beat frequency oscillator of uniform characteristics. The sound emitted is picked up by a calibrated condenser microphone connected to an amplifier placed outside the cabinet. The output of this amplifier operates the recording rectifier-galvanometer system. The record thus obtained by varying the frequency of the oscillator gives the overall response of the entire chain of equipments used. Another similar record is taken which gives the combined characteristics of the oscillator and all the amplifiers involved. From these two records and from the known characteristics of the microphone, the actual loudspeaker response is obtained.

An important measurement in connection with studio design is that of the reverberation time. For this purpose the Post Office makes use of both objective and subjective methods. For objective measurements a special bridge circuit developed at the Post Office is used. The apparatus gives very good results when the rate of decay of sound in the studio is expothential. In general, the decay is not exponential and some difficulty is experienced in maintaining a proper bridge balance. This is obviated to a great extent by making the source of sound rhythmic over a short range of frequencies round that at which the test is desired.

The subjective method is straightforward and hardly needs any explanation. It has been found that a reverberation time as small as 0·5 second can be easily measured with a certain amount of practice. This method has the advantage that the reverberation is directly related to its effect on the ear. It might seem that a large room with adequate absorption would have the same order of reverberation time as a much smaller room with little absorption; yet it is found that the physiological effects of reverberation in the two rooms are different. A measurement of reverberation time, although the most generally useful, is not the sole criterion of reverberation *effect*, and its pursuit to greater precision by an objective method may not always be justifiable.

For noise measurements the Post Office generally use the objective method, particularly because the subjective method is applicable only to controlled sounds. The main difficulty in an objective noise meter is the introduction of a frequency weighting network in the amplifier chain in order to simulate the characteristics of the human ear. It is of interest to note that the International Acoustics Conference (1937) decided that such a weighting alone is not sufficient when impulsive sounds are concerned. It was further considered that the time was not ripe for the specification of a universal objective noise meter.

The Radio Section at Dollis Hill is mainly concerned with the development of short and ultra-short wave transmitters, receivers and other associated equipments used at the different P. O. stations. They are now giving very close attention to the development of single-sideband short wave transmitting and receiving gears. The interference and piracy detector divisions of the P. O. also belong to this section. As is well known, the British Post Office use ultra-short waves of length about 4 metres for telephone and telegraph "links" for communication across channels, rivers, etc., where it would be costly to instal and maintain cables. During the author's visit one such equipment was being developed for a link between India and Ceylon.

For field service the British military authorities sometimes use a special type of transmitter and receiver controlled by light waves. Such services are strictly "local" and are quite beyond any possible interception by an unwanted party. The principle is that the voice from the sender operates a microphone, the output of which is amplified and then modulates a strong source of light. This light is transmitted in the form of a concentrated beam to the distant receiver, the range of operation being about 2 miles. The modulated light is received on a photo-cell at the receiver end and the message is easily obtained from same. These equipments are also developed by the Post Office.

The Radio Section also maintains a very accurate frequency standard and frequency measuring equipments. The primary standard is a valve-maintained tuning fork of frequency 1000 cycles/second determined in terms of mean solar time. The fork equipment is located in a specially designed and closed underground room in which a constant temperature is carefully maintained. It may be mentioned that a similar primary standard is maintained by the N. P. L. which regularly radiates this standard 1000 cycle note by modulating the 396 Kc/s carrier of the N. P. L. transmitter G5HW. The P. O. have recently developed a very accurate system of comparing these two primary standards to an accuracy of ± 5 in 10^8. For short wave working the P.O. are now developing a quartz standard. The Section has got a special department dealing with quartz crystals; the P.O. crystals are now being favoured by many establishments such as the B. B. C.

THE RUGBY RADIO STATION (BRITISH POST OFFICE)

The Station, situated 90 miles from London, was originally designed for long wave radio-telegraphy communication with all parts of the world

and was inaugurated on January 1, 1926. It is now one of the most powerful of similar stations in the world. With the development of radio-telephony, a long-wave transatlantic telephony service to America was opened on January 7, 1927. From economical consideration it was not possible to extend this long-wave telephony to more distant places as it was soon found that with the use of efficient directional antenna systems, short wave telephony services could be established much more economically for linking England with practically any part of the globe. The Station is now equipped for both long-wave and short-wave services. It covers 900 acres of land and has got two groups of buildings. The main building houses the two telegraph transmitters G. B. R. and G. B. V. and also the long-wave telephony transmitter G. B. Y. In an adjoining small building there are two short-wave transmitters, one for Indian service and the other for service to Japan and South America. The new short-wave building contains eight short-wave telephone transmitters.

The G. B. R. (16 Kc/s) was the first high-power telegraph transmitter using thermionic valves. Both G. B. R. and G. B. V. are tuning fork controlled and the rated aerial powers are 450 and 40 kw respectively. The final amplifier of G. B. R. uses two (at times three) banks of 18 water cooled valves in parallel, each valve capable of yielding 10 kw output. Some special precautions have had to be taken to avoid the usual difficulties associated with the paralleling of high power valves. As an alternative to one of these banks, a single 250 kw valve of the demountable type is sometimes used. The "keying" is controlled entirely by a small relay inserted in the grid circuit of a valve at a point where the r.f. power level is less than one watt. The transmitter frequency being only 16 kc/s, it cannot obviously be used for high speed telegraphy. In this respect the G. B. V. (78 kc/s) is superior and is equipped for high speed transmission.

The final tank circuit and aerial coils of G. B. R. are of 565/36 S.W.G. cables (about 1¾ inches diameter) wound in the form of spiders. The electric stress is so high during transmission that these huge coils shake mechanically. During experimental stages the leading-in of the aerial presented a difficult problem. The aerial was led in through a glass window; the dielectric loss in the wooden frame was so great that the wood burnt out. This has been avoided by removing the wooden frame and using, instead, an earthed guard ring.

The long wave aerial system is supported by 12 insulated masts, 820 ft. high. Each mast is provided with an electric lift capable of carrying three persons. The aerial height being very small compared with the wavelength, the radiation resistance is low and care has been taken to keep the total loss resistance as low as possible. A very efficient earth system has therefore been developed.

The G. B. Y. (68 kc/s) is of the single sideband type and is one of the most powerful telephone transmitters in the world. It was installed by the Standard Telephones and Cables, Ltd., in co-operation with the Post Office. The final amplifier panel has six 100 kw water-cooled valves of which three are used at a time and are sufficient to give full output. The transmitter is designed for an acoustic range of about 400 c/s to 2600 c/s, which is essential for fair articulation. The power delivered to the aerial is of course variable with modulation but sometimes reaches about 150 kw. It should be noted however, that this power is equivalent to that of a broadcast transmitter having an output of several times this value.

The two short wave transmitters in the small building adjoining the main one are crystal controlled and of the single side band double channel type. One of these was installed by the Standard Telephones and Cables, Ltd., and the other by the Post Office. Each is designed to operate on 3 or 4 spot frequencies and the modulated power output is about 10 kw. There is provision by which, if desired, the required aerial system can be fed from the penultimate stage instead of from the final stage of the amplifiers. From the penultimate stage an output of about 3 kw is obtainable.

The designs of the transmitters in the short wave building are practically the same as above. They are of the single side band type and balanced push-pull circuits are used throughout in the amplifiers. In the low power stages screen grid and pentode valves have been frequently used. It does not need to be emphasized that symmetry of circuits is essential for the operation of short wave amplifiers. In this connection the coupling of a single valve stage to a push-pull stage, as used at Rugby, may be of some interest. In the diagram (Fig. 1) the anode circuit of the pentode is parallel tuned and capacity-coupled to the next push-pull stage. The tuning coil is earthed (as regards r. f.) by a 0·01 μf. condenser connected at its midpoint. The tuning condenser (series-gap type) is not earthed at any point and

this has the effect of making the oscillatory currents in the two halves of the coil approximately equal. The voltage to earth at one end of the inductance is thus equal and opposite in phase to that at the other end making the arrangement suitable for push-pull driving. To maintain symmetry of the circuit, the

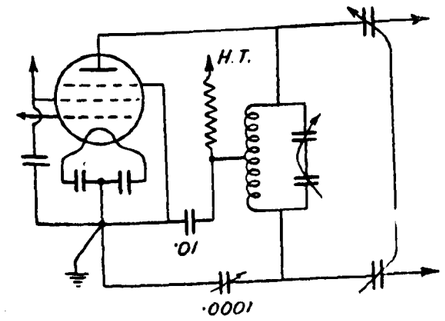


FIG. 1

capacity between anode-end of the coil and earth due to the valve, is balanced by a 0·0001 μf. condenser connected between earth and other end of the coil. It is interesting to note the special care that is taken to make the symmetry as perfect as possible with respect to other portions of the circuit and the metal enclosure. The balancing condenser is

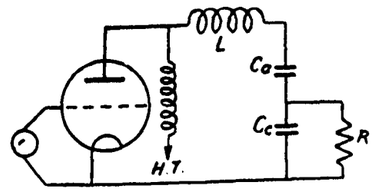


FIG. 2

made cylindrical (similar to valve electrodes) and is kept vertical and as close to the valve as possible.

Another important feature in the Post Office transmitters is the use of series-tuned anode circuit in the high power 20 and 60 kw stages. The scheme is shown in Fig. 2; only one valve of the push-pull is indicated for simplicity. It can easily be shown that in such a system the maximum output is obtained when the coupling condenser C_c is given by

$$C_c = C_v/\sqrt{R_v/R},$$

where C_v is the anode-filament capacity of the valve of impedance R_v and R the load resistance. These series-tuned circuits are only possible for short waves and with large water-cooled valves which possess a large anode-filament capacity.

It is also interesting to note that in some transmitters the 20 and 60 kw stages are built in separate "units" connected to the respective exciter stages by appreciable lengths of feeder lines. These exciters or intermediate stages are therefore designed as power amplifiers and not voltage amplifiers.

The directional aerial systems, used at Rugby are of various types, such as Sterba, Koomans, T. Walmsley, plane and cage dipole. It seems that the P. O. prefer the Koomans type specially because of its simplicity and ease of maintenance. Two-wire open transmission lines are used throughout with standard characteristic impedance of 600 ohms. The P. O. have adopted the method of matching by means of quarter-wavelength lines. The magnitude of the termination in terms of the characteristic impedance of the line is found out by noting the readings of maximum and minimum currents along the transmission line. The characteristic impedance of the matching quarter wave section is at once known and it is then accordingly designed.

THE P. O. RECEIVING STATIONS AT BALDOCK AND ST. ALBANS

All official wireless telephony communications between the United Kingdom and other countries are maintained and controlled by the British Post Office. The receiving station for the purpose is at Baldock, 40 miles from London. The station, with its large number of short wave aerial systems and one long wave aerial, covers an area of 1,000 acres. All the receivers are of the single-side-band type. The latest of these are of the Post Office (Dollis Hill) design; the earlier ones were installed by Standard Telephones and Cables, Ltd. The audio outputs of the receivers at Baldock are, for secrecy, "inverted" and are passed on directly to the Central Radio Office at London where, by suitable arrangements, the signals are made normal again. Since single-side-band reception has special advantages the B. B. C. often utilises the Baldock receivers for important foreign re-broadcasts, *e.g.*, King George VI's message to the Empire from Canada during his recent visit there.

The receiving aerial systems used for short waves are of various types. Some are rhombics and cage type dipoles. These are generally used for a

quick search-over for a station in conjunction with normal receivers of usual design. When the station has been found or, in the case of a station radiating simultaneously on a number of frequencies, when the frequency giving the best reception has been found, the single-side-band receiver is adjusted for the corresponding frequency.

There is also provision at Baldock for checking the frequencies of the P. O. and other transmitters. There are two main equipments, one Marconi type 482C, and the other developed by the P. O. In the Marconi type each of the five multivibrator circuits are stepped down in the ratio 10 : 1 and each is synchronized directly by the previous stage. These make the system somewhat unstable and the multivibrators sometimes "slip" off synchronization. Moreover, the method of suspension of the quartz in the master oscillator circuit is rather unstable mechanically. The P. O. equipment, wherein quartz crystals developed at Dollis Hill are used, is better in this respect. The frequency of the master oscillator is checked by comparison with the primary standard at Dollis Hill. With these equipments the frequencies of the various British and foreign stations are systematically measured and recorded.

The receiving station at St. Albans, 14 miles from London, is meant only for radio-telegraph signals. The station occupies about 25 acres of land and some new land is being acquired for expansion. There are ten long wave and four short wave receivers, the former are of the "straight" type and the latter of the double detection type with band filters, thus giving both second channel discrimination (high i.f.) and selectivity (low i. f.)

The aerial systems are mainly supported by eight masts arranged in the form of two squares one inside the other with the station building at the centre. The four outer masts (200 ft. high) support the long wave Bellini-Tosi aerials and also a number of open aerials. One big rhombic is also supported on one side of the building jointly by the outer and inner masts.

The received signals are relayed directly to the central office at London, St. Albans being more or less a relay station. Each radio receiver is, however, provided with a Wheatstone receiver for monitoring by which the operator can see the signals being sent through the line.

To be Continued.

Telescope Making at Home

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THE hobby of telescope-making has gained wide popularity in America, where a large number of clubs and societies[1] have been established for the study of astronomy. There are more than two thousand members in these clubs—men and women—grinding mirrors and lenses for telescopes, with which they make occasionally interesting observations. Many interesting new stars (*e.g.*, Nova Aquila of 1918) were discovered by amateurs. In fact, the contributions of amateur astronomers and radio-amateurs

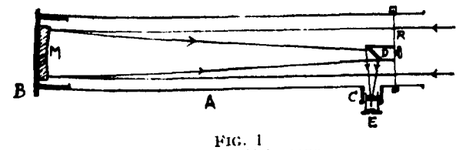


FIG. 1
Newtonian Telescope
A. Tube; B. Cap or mirror-holder; M. Concave parabolic mirror; C. Eyepiece socket; E. Eyepiece; D. Diagonal flat mirror, front surface silvered; R. Thin rod for holding D.

to scientific studies are not insignificant. Unfortunately we have no such organization in India ; nor many of us have ever paid a serious attention to this matter.

In this article an attempt will be made to briefly describe the construction of reflecting telescopes at home with the minimum workshop assistance.

THE MAKING OF MIRROR AND ITS TEST

The mirror is the most important part of the telescope, and it can be made quite perfect if proceeded patiently and methodically. It was Newton who first devised the reflecting telescope, with his first mirror 1⅓ inch in diameter. Thereafter many astronomers of repute found the reflecting system advantageous and made larger mirrors for themselves. Lord Rosse as early as 1845 constructed a reflector that was 6 ft. in diameter. This mirror for the first time revealed the spiral structure of the extragalactic nebulae.

But much smaller mirrors will show them up now. For, the early mirrors were not so perfect as they are now made, because the early ones were made of speculum metal (an alloy of 68% copper and 32% tin) on which thermal distortion and other distortive effects were prominent. Modern reflectors are made from glass discs which are ground concave, polished, tested and then coated with bright film of silver or aluminium. Glass mirrors are accurate, permanent, and the surface can be easily replaced by fresh film whenever necessary.

Glass of optical quality is not necessary for reflectors. Ordinary plate glass ½, ¾ or 1 inch thick is quite suitable for making small mirrors. The ideal glass is the Pyrex, for, it has the lowest co-efficient of thermal expansion. The Chance Brothers manufacture a special type of glass for making reflectors. This has a very low expansion ranging between that of Pyrex and ordinary plate

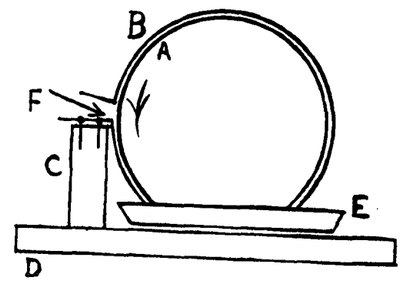


FIG. 2
Edging the rough-cut-disc.
A. Rough-cut glass disc rotated in B. B. flat iron 1/32 in. thick, 2 in. wide, bent into a circle, one end nailed to C. C. Wooden pillar 2×2×4 in. D. Wooden board. E. Tin tray. F. Feed for carborundum and water.

glass. A number of firms in America are now engaged in supplying 'kits' complete with glass discs and grinding and polishing materials for the use of amateur telescope makers.

Curvature Grinding : When two thick glass discs are ground one over the other (Fig. 3), with carborundum powder and water between them, the upper disc becomes concave, and the lower one convex. In fact there are three motions which



FIG. 3
Grinding and Polishing.

must be combined in order to get the proper curvature: (*i*) To and fro 'strokes'—centrally over each other, and making the total play equal to about the length of the disc's diameter or a little more. This is called 'full' stroke, and it is customary to refer as ½ stroke or ¾ stroke according to the length of play relative to the diameter of the glass disc. (*ii*) Rotation of the upper disc about its handle axis with ⅛ or ⅙ turn after each stroke, and (*iii*) The worker going round and round the table on which the tool-disc is fitted, completely circling in 10 or 12 strokes' time. The 'strokes' brings about 'curvature' (Fig. 4), and the other two motions make it 'spherical'.

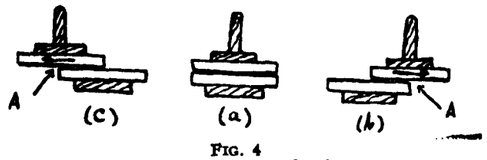


FIG. 4
How the curvatures develop.
As soon as the mirror (upper) disc passes the position (a), the edge of the lower (tool) disc begins to exert scooping action shown by arrow (A) in (b) and (c) positions.

There is no hard and fast rule for the grades of abrasive, but the following series is found to be satisfactory: Carborundum powder Nos. 60, 80, 120, 220, 3F and 303, and flour emery for the finest grinding at the final stage. The edging (Fig. 2) of the rough cut circles is quickly done by the coarsest grade No. 60, and for the finer finish it may then be changed over to Nos. 80 and 120. The curvature-grinding may be begun with No. 60 or No. 80. It should be remembered that the work must be thoroughly washed up between the change of grades, or scratches will result. For the final stage, the flour emery is washed up by settling, as it contains coarser particles. Three tea-spoonful of flour emery is stirred up in a glass of water and allowed to stand for one minute. The upper muddy liquid is then taken off and allowed to stand for another minute. The upper liquid is again collected, and allowed to settle. The fine sediment which now settles is used for the final grinding.

A well-finished ground surface looks velvety grey and is free from scratches and pits. It would be absolutely unwise to try to save five minutes at the fine stages (3F, 303, emery), because this gain of five minutes would make for a loss of half an hour in polishing which is a tedious job.

The time of grinding depends upon the size of the mirror and the focal length desired. A six-inch mirror, which size is a good choice for the beginner, may be ground up into 48 inches focus, which means F/8. A list of mirrors and their aperture-ratios are given in the table. A 6 inch F/8 mirror will require grinding of about ½ hour with each grade of powder. But the focus must be checked at every stage of grinding.

Checking the focus : As the grinding proceeds, the curvature deepens, and the focus becomes shorter. The focal length, which is half the radius of curvature, can be measured by a spherometer. But more convenient method is that by reflection. The glass, however, at any stage of grinding, is white and non-reflecting. But it can be made temporarily reflecting by smearing the surface with water. So long as it is wet the image of the sun can be focussed on the wall, and the distance of the image from the mirror gives the focal length as developed.

The accuracy of measurement of focus at the rough grindings (No. 60, 80) may be taken to be within 2 inches, at the medium stage (120, 220) within 1 inch, and at the fine stage (303, 3F, emery) within ½ inch. The major part of the hollowing out is effected by full strokes with No. 60, 80 and partly by 120. The grade No. 220 also removes some amount of glass, but its chief action is to get the uniformity of curvature with ¾ and ½ strokes. With the 3F and finer, practically no change in focus takes place.

The depth of curvature at the centre of the mirror is given by $h=\frac{r^2}{2R}-\frac{r^2}{4F}$, where r=radius of the disc, R=radius of curvature and F=focal length. Thus, for 6 inch disc, 48 inch focus, depth is less than $\frac{1}{20}$th of an inch ; it is only 0·0487 inch or 1·2 mm.

During the fine grindings, there is the danger of sticking of the discs, as the mirror and tool discs closely fit each other and produce a partial vacuum between them. This may be carefully avoided by keeping the abrasive well supplied with water. If, however, the discs stick together badly, warm water should be applied on one disc and then given a tangential thrust. This last resource helped me wonderfully in a case of very obstinate sticking.

Polishing : After grinding is over, the process of polishing will bring back the full transparency of the surface. All surfaces, whether a telescopic mirror or a spectacle lens, after being ground to the desired curvature are polished up to perfect transparency by a suitable material.

The polishing material is rouge used on a softer base such as pitch, resin, paper, leather etc. For our present purpose pitch is very suitable. It may be remarked here that the hardness and the structure of the polishing tool play very important part in the speed and quality of polish.[2,3]

The tool disc is covered with a layer of molten pitch which is moulded into proper curvature by pressing it with the mirror. The mirror surface should be coated with rough emulsion (2 tea-spoonful of fine grade rouge and 4 spoonful water) or soap water in order to prevent the plastic pitch to stick while it is warm.

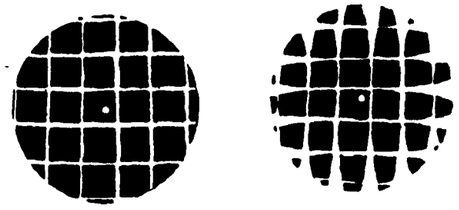


FIG. 5
(a) Polishing pitch tool.
(b) Parabolizing tool.

After getting the pitch layer uniform, it has got to be channeled into 1 inch squares as shown in Fig. 5(*a*). The squares should be decentered with respect to the tool circle. Symmetrically cut squares tend to develop defective zones on the mirror owing to the repetition of the symmetry. The channels may be cut with a hacksaw blade or a knife point with a regular supply of water to avoid chipping and clogging. Sufficient time must be allowed to equalise the temperature before the polishing is begun.

Polishing strokes are just the same as for grinding, but only that rough is now used on the pitch tool. The 6 inch disc will take about 5 hours of work to complete polishing. It is better to do the polishing job in spells of 15 or 20 minutes at a time, and then allow the work to cool. It is found that long spells develop 'hollow' and 'ring' in the centre of the mirror, which is clearly detectable under the knife-edge test. It is due to the fact that heat of hand penetrates down the handle and dilates the middle part of the mirror. This part therefore polishes out more quickly, leaving a defective hollow when cooled.

When polishing is done the next work is to test the surface for correct spherical curvature.

Knife-edge Test: A French physicist, Leon Foucault devised an ingenious method of testing mirrors. His 'knife-edge' method for testing the spherical curvature is so sensitive that it can detect a defect of radius of curvature of about 10^{-5} inch. It is sensitive enough to detect the thermal bulging of the mirror surface due to the touch of fingers for a few seconds.

The arrangement (Fig. 6) is extremely simple, requiring only a pin-hole lamp, a straight knife-edge and some means to stand the mirror vertical. The spherical mirror under test is placed on a small table with its face in the vertical plane. A pin-hole source of light is made by perforating a tin foil with a fine needle and placing it in front of the small window in a box in which an electric torch bulb is housed. An oil lamp or a candle flame may also be used. The pin-hole light is placed approximately at double the focal distance where the centre of curvature is lying; for, the radius of curvature is equal to twice focal length ($R=2F$). Now a little patience will find out the reflected image of the pin-hole formed in its vicinity. The pin-hole source is then moved until the image comes just by its side. If it were exactly at the centre of curvature of the mirror, the image would merge with the source. But this would not

allow us to make the test, so that the image should be kept as close to the source as practicable. If now the eye is placed at the reading distance away from the lamp the bright point image will be seen floating in space. But if the eye is brought too close to it, the image will blur off and the surface of the mirror will appear to be full of uniform luminosity.

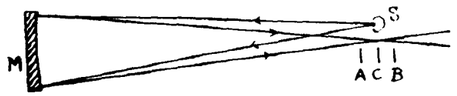


FIG. 6
Arrangement for knife-edge test.
M. The spherical mirror under test. S. Pin-hole light source. A, B, C refers to the three typical positions of the knife edge.

If a straight knife edge is then moved close to the eye to cut the reflected cone of light, a straight shadow will appear to pass across the luminous disc. If the knife edge is within the centre of curvature of the mirror (A position, Fig. 6) the shadow will travel with it. But if the knife edge is beyond the centre (B position), the shadow will travel in the opposite direction of the knife movement. A point (C position) will be obtained between these positions, where no travelling shadow of the knife edge can be recognised. The whole of the disc will then evenly darken down quickly by the slightest cutting movement of the knife. This is the true image point which would give the centre of curvature of the mirror.

When the spherical curvature is defective and there are more than one centre of curvature for different zones, no position of the knife will be found where uniform darkening down of the whole disc may be obtained. It will then be found that some portion of the disc is shaded and some portion lighted up irregularly, or there may appear illuminated or shaded ring on the mirror (see Fig. 7). The common defects are the rings (elevated or depressed), hollow in the middle, and turned down edge. The characteristic shadows are readily interpreted when accustomed to such tests.

The local corrections by pencil polisher or small tool are not necessary for small mirrors, but a little polishing continued over an altered pitch tool with careful central short strokes will cure the defects which are usually small. Details of different methods of correcting local defects are described in books referred to at the end of this article[3,4].

PARABOLIZING AND MEASURING THE FIGURE

When we have a correct spherical mirror, it has to be parabolized. As the parabolic correction for such a mirror is very small, there is a risk of over-doing it. Let us first see how much is the difference between the sphere and the paraboloid. For a spherical surface, each part has the same curvature and focus, but a paraboloid gradually flattens out towards the periphery. Thus the radius of curvature, hence focus also, is longer for the peripheral regions than the central part of a parabolic mirror.

The difference in the radii of curvatures for the centre and for the rim is given by $\Delta R = \frac{r^2}{R} - \frac{r^2}{2F}$, where r is the radius of the mirror disc and R the mean radius of curvature ($R = 2F$). Thus for the 6-inch mirror just described, $\Delta R = \frac{3 \times 3}{0 \cdot 6} - \frac{3}{3 \cdot 3} = 0 \cdot 09$ inch or 2·38 mm. A 12-inch F/6 mirror will have the difference ¼-inch.

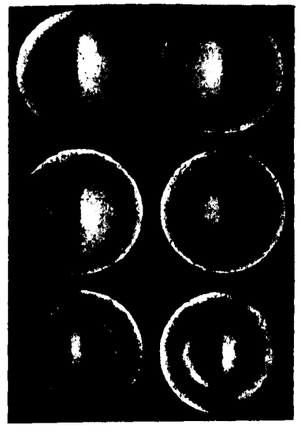


FIG. 7
Characteristic shadows under knife-edge test.

Since the workers are more accustomed to think in terms of the 'aperture' or diameter of the disc, and 'focal ratio' (such as, F/4·5, 6, 8 etc.), $\Delta R = \frac{r^2}{R}$ may be converted in terms of A and N, where A = aperture, N = the focal number (4·5 6, 8 etc.). Then, $\Delta R = \frac{1}{8} \frac{A}{N}$. Thus, for 12-inch F/6 mirror $\Delta R = \frac{1}{8} \times \frac{12}{6} = \frac{1}{4}$ inch and for 6-inch F/8 mirror $\Delta R = \frac{1}{8} \times \frac{6}{8} = \frac{3}{16}$ inch, as told before.

The following table gives the list of different types of mirrors with their △R values.

Aperture (inch)	Focal-length (ft.)	Aperture-Ratio (F/N)	Δ R (inch)	Remark
6	2	F/4	0·18	Short-focus R.F.T.
6	4	F/8	0·09	Beginners' first.
12	8	F/8	0·18	Common type.
28¼	11¾	F/5	0·70	Observatory at Heidelberg (construction by Zeiss).
39¼	10	F/3	1·63	Hamburg (Zeiss).
48½	27½	F/6·9	0·87	Berlin-Bebelsberg (Zeiss).
100	41⅔	F/5	2·50	Mt. Wilson Observatory, California.
200	55	F/3·3	7·50	Hale Observatory, Mt. San Diego.

The table also shows that parabolizing becomes more important for shorter focus and larger aperture. Parabolizing can be effected in two simple methods: (*a*) by changing the polishing strokes, (*b*) by changing the polishing tool. In any case, parabolizing is done by the polishing method and not in the grinding stage, and it is done when a perfect polished spherical curvature has been obtained.

(*a*) *Over-hang Method :* If the spherical mirror is now polished on the pitch tool (as it was) with about 1/5 or ¼ diameter "over-hang" (Fig. 8) the

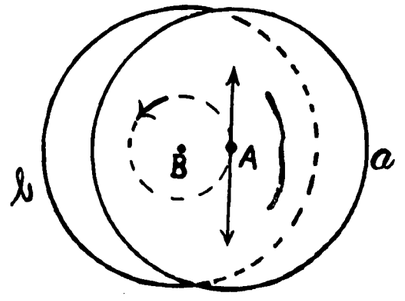


FIG. 8
Over-hang strokes
A is the centre of mirror disc a, B is the centre of tool disc b. AB gives the over-hang of the mirror across the edge of the tool. The straight arrows showing strokes. A will move round the dotted arrow.

centre of the mirror will polish out more quickly than the outer parts tending to a parabolic figure. Five minutes' work is sufficient to test the progress of the figure. But about half an hour must be allowed to equalise the temperature. The measurement is done by the knife edge method. This is to measure the difference (Δ R) between the radii of curvatures for the centre and the rim of the mirror. A cardboard is taken and perforated at the centre with a 1½ inch aperture and the mirror is covered with it. The centre of the mirror is thus exposed and the knife edge locates the centre of curvature as described in the Foucault's test. The position of the base of the knife edge is marked. Then the cardboard is removed and replaced by another having two sectors opening the extreme rims ¼ inch wide and 2 inch arc on the diametral ends. The position of the knife edge is marked again when both the illuminated sectors darken down simultaneously. The change of position of the knife gives the difference of radii of curvatures (Δ R).

It is however useful to under-correct the mirror due to the falling temperature of the evening atmosphere when the observations are usually taken. For plate glass mirror 1/3 of the calculated amount may be left uncorrected. Thus, for the 6 inch F/8 mirror we may stop parabolizing when we find $\Delta R = \frac{2}{3} \times 2.38$ mm. or nearly so.

(*b*) *Graduated-facet Method :* The other method of parabolizing is to alter the tool. The tool used for polishing the mirror had pitch squares cut by straight channels. But now the cuts are gradually widened out at either ends (Fig. 5*b*). If now polishing is continued with diametral short strokes (exactly the repetition of the spherical polishing process), the sphere will tend to a paraboloid. The underlying principle is that the outer pitch squares are gradually smaller than the middle ones, so that the centre of the spherical mirror polishes out faster —tending towards a parabola.

THEORIES OF GRINDING AND POLISHING OF GLASS

After these practical hints, it will be interesting to discuss here the underlying principles. Let us first see what 'grinding' really means. Diamond is harder than glass, so that the diamond point will cut or scratch glass. As the point is dragged along the glass surface, the latter goes on breaking in fine scales. When examined under a microscope the scratch shows a series of conchoidal breaks. Carborundum is also much harder than glass, and it does the same job in grinding. When carborundum is put between the faces of two glass plates and ground on,

the grit breaks the surfaces into tiny conchoidal flakes.

It is interesting to compare the action of glass-tool and metal-tool used for mirror or lens grinding. When glass is ground on glass-tool, the carbo or emery cuts both the discs (*e.g.*, mirror and tool) equally, so that both of them take up the same curvature. But a metal-tool does not itself grind off so fast when used against glass. In fact, the softer the metal, the faster it will cut glass with an abrasive. Naturally so, because the cutting particles are embedded in the soft metal (lead, copper, brass, iron) which drags so many scratching points over the glass. There is very little relative motion between the metal and the abrasive when there is glass under them, and so the metal-tool is not put to wear. This is why copper rod or tube is preferred in drilling glass. Such drilling will be necessary for the amateur telescope-maker if he wants to make a Cassegrainian Mirror which will be described in the next part.

The phenomenon of glass polishing is rather difficult to understand. Many theories have been put forward, but no single theory has proved conclusive. At the very first sight it appears that the rouge acts as fine abrasive and cuts the rough surface so finely that the final surface becomes smooth and polished. It is surely a major operation. But rouge is not all. It has already been said that the tool (pitch, resin, felt, leather, cloth, paper, etc.) plays an important part in the speed and quality of polish.

A simple and long-standing theory is that rouge particles behave as tiny cutters. But later another theory has been advanced, which they call the 'flow theory'. The idea is that the glass-molecules are removed from the peaks of the uneven ground surface to flow into and fill up the pits below, the rouge acting as lubricant. Investigations were carried out to conclude between the 'cutting' and 'filling' action in the process of polishing, and it has been demonstrated that both the actions are present. The molecular-flow is explained by holding that the energy expended in polishing is manifested as heat which is sufficient to lower the viscosity of the glass near the surface to such a degree that the hyper thin film—'beta-layer'—can be made to flow. The 'flow' effect has been demonstrated in a very interesting way. A scratch was polished with strokes perpendicular to it, it worked out quite well and quickly. But when this area was etched with hydrofluoric acid, the scratch was again revealed.

The chemical examination of the spent rouge after polishing showed a very small quantity of silica coming out of the glass surface by the process of polishing. This by all means proves that there is some removal of glass by the abrasive action of the rouge. The removal of glass may also be concluded from the fact that a polished spherical glass mirror takes up the parabolic figure by the very act of polishing.

SILVERING

The last work on mirror is the silvering. Among other chemical processes Brashear's method is the best. The process may be found described in many books on chemistry and on laboratory technique, so that only a very brief account will be given here. A solution of silver salt is reduced to metallic silver by a reducing solution, and this silver can be deposited on a glass placed in the bath. The silvering should be done at temperatures below 18°C, preferably between 12-14°C, with the help of ice-bath. We require three solutions *A*, *B* and *C* as follows:

A. Reducing solution (stock)

Sugar (ordinary clear crystal)	... 45 gm.
Nitric acid	... 2 gm.
Distilled water	... 500 c.c.
Ethyl Alcohol	... 88 c.c.

Boil the sugar, acid and water together, add the water lost by evaporation, and when cool, mix up the alcohol. Old solution works better, so prepare the stock solution a few days in advance, and stock the excess for future.

Now make the stock silvering solutions as follows:

B. Silver nitrate 15 gm. + 150 c.c. distilled water.
C. Caustic Potash 8 gm. + 80 c.c. ,, ,,

Remembering that ¼ gm. of silver nitrate is required for 1 sq. inch of surface, we shall require 7 gm. of silver nitrate (= 70 c.c. of soln., *B*) for 6-inch disc which has 28 sq. inch surface; and half this amount (= 35 c.c.) of solution C. The quantity of reducing solution will be 42 c.c. (6 c.c. for each gm. of silver nitrate).

The mirror surface is thoroughly washed up with soap, caustic potash 10% soln., and strong nitric acid, and finally with plenty of tap water and then with distilled water. The chemically clean mirror is then kept waiting face up under distilled water in a suitable dish.

70 c.c. of *B* is taken in a beaker and ammoniated with strong liquor ammonia. Ammonia must be added drop by drop and stirred up thoroughly. The solution first turns black, but the precipitate dissolves with excess of ammonia. When a trace of turbidity is retained the ammoniation should be stopped.

Then 35 c.c. of solution *C* is added when the solution turns again dark. The ammoniation is repeated until pale yellow or straw colour is regained. One must be very careful not to overdo the ammoniation. Now about 10 c.c. of *B* is again put into it when the whole thing turns black. The solution is then filtered and the straw coloured clear liquid is mixed up with 42 c.c. of solution *A*, and immediately poured over the mirror. The water in which the mirror was waiting need not be poured off. It will be found at once that the solution is turning black indicating the separation of metallic silver from the solution.

Silvering is complete in five minutes. The mirror is then washed under a softly running tap, and the surface swabbed lightly by a lump of wet cotton wool. The mirror is finally washed with distilled water, and dried quickly before a blower (hot or cold) to avoid the formation of yellow stain. The silver film need not be polished, for that usually means more harm than good.

To be Continued.

References.

[1] A list will be found in *Scientific American, 152,* 265, 1935.

[2] *Dictionary of Applied Physics,* Vol. IV (Glazebrook), under the head 'Optical parts, the working of'.

[3] *Procedures in Experimental Physics,* Chap II—John Strong (1939).

[4] *Mirrors for Telescopes*—McHardie (1937).

[5] *Scientific American, 159,* 336, 1938.

LAZY CORN EXPLAINED

Lazy corn, that sprawls flat on the ground instead of standing erect, is given a physiological explanation in *The Botanical Gazette,* by Dr John Shafer, Jr, of Cornell University.

If a normal cornstalk (or any other plant) is laid horizontally, about 60 per cent of its auxin, or growth-promoting hormone, becomes concentrated on the lower side, making that side grow faster and causing the stalk to curve upward into normal position again.

In lazy corn this condition is reversed. The plant perversely concentrates 55 per cent of its hormone on the upper side of the stalk, keeping it in its prostrate position.

Laziness in corn is a hereditary defect. Such corn is useless for practical purposes and is grown only as a curiosity.

—*Science Digest.*

Silvicultural Researches in India

SILVICULTURAL research is concerned with the whole of the production side of forestry. If forests are to be managed commercially so as to produce the maximum net returns to their owners, it is necessary to have detailed silvicultural knowledge of how the forests should be treated from the time of sowing the seed until the trees are finally felled. It is the constant aim of silvicultural research to improve the productivity of all land dedicated to the growing of forest crops.

Regeneration Experiments

It is axiomatic that a forest cannot be worked continuously without degradation unless young trees are established to take the place of those felled. In the mixed tropical evergreen forests, of parts of Madras, Bombay, Assam and Bengal, for instance, no intensive working was possible up to within recent years because we did not know how to regenerate them, and consequently the returns from this type of forest were very low. Intensive silvicultural research has recently shown how a certain degree of success can be obtained by planting valuable evergreen species under high top canopy shade, or by the use of auxiliary shade crops and as a result more intensive exploitation is now possible with correspondingly improved financial returns, and furthermore, the new crops that are being raised will have a higher proportion of valuable species in them than the original forest.

Improvement of Dry Fuel Forests

Another example of silvicultural research stepping in to save a difficult situation is in the fuel forests of the hot dry localities in South India and elsewhere. Previously these forests had been worked by clear felling on a short rotation of 30 to 40 years, relying for regeneration on the sprouting of the stumps of the trees ("coppicing") together with a certain amount of new regeneration from fallen seed. Statistical studies by the local Silviculturist elicited the fact that these forests were gradually deteriorating under the treatment then in practice. After 10 years of intensive silvicultural research it has now been discovered how to raise at an economic cost many of the more important firewood species under conditions of great heat and very low and irregular rainfall. As a result, it is possible to continue intensive working of these forests which are vital to the local population, supplying their requirements of fuel and small timber; and instead of the forests deteriorating and annual yields becoming less and less they are now being improved.

Reduction in Plantation Costs

Silvicultural research is constantly at work on problems connected with the reduction of costs of plantation operations. Studies have to be made of the best ways of getting seeds to germinate, the best quantity of seed to use in nurseries and in the field, improved methods of sowing, whether to shade or not, whether sowing should be done direct in the plantation, or whether nursery raised transplants or "stumps" (root and shoot cuttings from nursery seedlings) should be used, what size of seedling or stump is best, what is the best season for planting, how much, or rather how little soil working and weeding is necessary, and so on. A mistake in any one of these details may make all the difference between a successful plantation and an expensive failure. A recent example from teak plantation research illustrates this point. Experiments carried out over a period of 5 years in 4 or 5 different localities in the west coast districts of Madras showed that if "stumps" of teak of a certain range of size (0·4″—0·8″ diameter) were planted out six weeks before the monsoon, and a certain type of weeding by scraping was done, the resultant growth was so rapid and the gain in survival percentage so great that the total cost of formation was reduced by Rs. 5/- to Rs. 12/- per acre.

Suitable Trees for Plantations

Silvicultural research is constantly engaged in determining what species are suitable for different soils and climatic conditions. Whenever any species is found by the utilisation experts to be specially good for any particular industrial purpose (*e.g.*, matches, paper-making, plywood, tanning bark etc.), the silviculturists in the different provinces in India set to work to determine the silvicultural requirements

of the species and to work out the best plantation technique for it. Similarly any species for which a local demand exists or springs up is fully investigated by the silviculturists.

Afforestation Experiments

There are large areas of India where the soil is too poor or the climate too dry for any form of agriculture, or where, owing to destruction of the forest in the past locality conditions have changed for the worse. Instances are the "Bhur" and "Usar" areas of the United Provinces, the "Kallar" areas and the eroded areas of the Siwaliks in the Punjab, dry barren areas in parts of Bihar and Bombay, shifting windblown sands of the south of Madras and in Orissa, high-level grass-land in the Nilgiris, etc. Silvicultural research is constantly at work trying to find suitable species and suitable methods of afforesting such localities, and notable advances have been made in this direction in recent years.

Natural Regeneration Experiments

Where "natural regeneration" (*i.e.*, the regeneration of crops from natural seed-fall or sprouting of stumps with little or no planting) can be achieved it is generally cheaper than making artificial plantations. It is, at the same time, an operation requiring a considerable amount of skill and silvicultural knowledge, and involves such operations as manipulation of the forest canopy to the correct degree, burning or alternatively fire protection, grazing to keep down grass, or alternatively fencing to prevent browsing, weeding at critical periods and other operations for producing conditions favourable for the germination of the seed and the establishment of the seedlings. Experiments to ascertain the effects of the numerous controllable ecological factors in the forest on the recruitment and establishment of reproduction of desired species form an important part of the programmes of research of the silvicultural branches in the provinces, and have as their aim the development of a cheap and successful technique for regenerating the forests in question by natural methods.

Tending and Thinning Experiments

Tree crops once established have to be tended and thinned in such a way as to produce the maximum quantity of the desired form of produce—be it firewood, clean timber, bark for tanning, heartwood for extraction of valuable product, etc. Silvicultural experiments are in progress in crops of a great number of the more important economic species to determine the best intensity and periodicity of thinning, and the best type of thinning in each case.

Varietal Trials

Just as in agricultural crops, trees of one species may vary very considerably in their properties, and in such variations are often hereditary. For instance, Chir pine trees vary in their resin producing capacity and sometimes have badly twisted fibre. *Acacias* producing tan barks vary in the tannin content of the bark, teak trees of different origins vary in growth form, branchiness, fluting of the stem, rate of growth and in frost-tenderness, individual trees occur in many species which have valuable ornamental figure, or alternatively bad characters like interlocked grain. There is an enormous field for silvicultural research in determining to what extent desirable or undesirable characters are inherited or not and in isolating and breeding strains of trees having valuable properties and in eliminating strains which have undesirable ones. A considerable amount of work is already in progress with these objects in view.

Management Statistics

For the proper management of forests, so as to produce the highest sustained returns, detailed statistical knowledge of the growth of crops throughout their lifetime is fundamentally necessary. The determination of the most profitable age or size at which crops should be exploited and the calculation of the permissible yield that may be extracted annually from the forest without encroaching on the growing capital are dependent upon these statistics. In even-aged crops and plantations they are collected by the periodic remeasurement of small sample areas distributed over the full range of age classes and of soil and site quality classes. There are, at the moment, about 1,983 such sample plots under measurements, the data from which are all computed and compiled into yield tables in the statistical section of the Silvicultural Branch of the Forest Research Institute. Statistics for increment in irregular forests and in mixed crops are similarly collected, as well as data for determining the cubic contents of standing trees. These "volume tables" as they are termed are essential for the satisfactory organisation on exploitation work, and enable contractors to know what outturn of round logs or of sawn timber may be ex-

pected from the standing crops they have purchased. Bark percentage and heartwood percentage data are also utilised.

Statistical management studies are also made in other types of crops, a notable example being bamboos worked either for paper making or for supplying local markets. Here it is necessary to determine the best method of regulating cutting so as to obtain the maximum output of the required type of bamboo, and also to obtain statistics of the yield per acre of properly managed bamboo forest.

PROTECTION PROBLEMS

Forests suffer from numerous enemies, the greatest of which is mankind himself. Apart from insect pests and fungal diseases, which are dealt with by the *Entomologist* and the *Mycologist* respectively all other protection problems, such as prevention of damage by wild or domestic animals, protection from fire, the eradication of parasitic plants, weeds and pests such as Lantana and Eupatoreum, climbers etc., fall to the Silviculturist for solution, as also problems concerned with the maintenance or formation of forests for flood prevention and for checking erosion. Studies of grassland improvement and grazing management in connection with forestry have recently come within the sphere of the silviculturist's problem of work.

DOCUMENTATION AND SUPPLY OF INFORMATION

The field covered by silvicultural research has been indicated in the above very brief account. When it is realised that there are several hundreds of economic species in India under investigation at any one time, the wide scope of the work can be appreciated. The investigations, which have of necessity, mostly to be conducted in the forests themselves by local silvicultural research workers are co-ordinated through the Central Silviculturist at Dehra Dun, and all results of investigation as well as all other useful silvicultural information is systematically placed on record, and is available for replying to the numerous enquiries received from private individuals as well as from official sources, and from abroad as well as in India. The function of the silviculturist's office as an information bureau is an ever increasing one, and one which owing to shortage of staff, has not been able to expand sufficiently to meet all demands made on it.*

* Kindly communicated by the President of the Forest Research Institute, Dehra Dun.

Notes and News

Obituary

SIR JOCELYN FIELD THORPE died suddenly on June 10 last, at the White House, Sussex. Born in 1872, he was educated at King's College, London and at the Royal College of Science. He later took a Ph.D. degree working under Victor Meyer at Heidelberg. In 1895 he joined Owens College, Manchester as a Fellow and remained there for 15 years. He came under the influence of W. H. Perkin (Jr.) and jointly and alone published papers on subjects which served later as the foundation for many of the modern developments in organic chemistry. After the expansion of the Imperial College at South Kensington he was appointed a professor in 1914 where he remained until his retirement in 1930. Here he trained a large number of students and played no insignificant role in placing his country in the leading position in organic chemistry which it occupies today.

Thorpe had a passion for the advancement of chemistry on co-operative lines and he made a great effort to unite various chemical interests. He was a member of almost every chemical committee set up during the last 25 years and also served as president of both the Chemical Society and the Institute of Chemistry.

Monograph on Excavations at Harappa

A DETAILED account of discoveries made at Harappa, in the Punjab, has recently been published by the Archæological Survey of India in a sumptuously illustrated monograph on Excavations at Harappa. The excavations at Harappa were carried out first by the late Rai Bahadur Daya Ram Sahni and then by Mr M. S. Vats, Deputy Director General of Archæology, who has edited the publication. The present volumes together with the previously published 5 volumes on Mohenjo-daro by Sir John Marshall and Dr Mackay complete the official account of the large-scale excavations in the Indus Valley. The discoveries at Harappa range over a period of 20 years. We hope to publish a review of the monograph in a subsequent issue.

Harappa which has been known for over 100 years, is larger in extent and had a much longer span of life than Mohenjo-daro, and reveals phases which are definitely earlier as well as later. Amongst the earliest finds at Harappa are miniature seals and sealings dated to the second quarter of the 4th millennium B.C., a period not reached at Mohenjo-daro. These seals are generally of burnt steatite, less frequently of faience or paste and rarely of shell and are characterised by the absence of any knob, and also of the unicorn and other animals, (with the sole exception of the *gharial,*) found on the later stamp seals. The range of their inscriptions is limited, but the variety of their shapes is truly amazing, over 20 varieties having been traced out by now.

The cemetery at Harappa is unique in India, but it belongs to a distinctly later period. The cemetery contains two strata one above the other ; the upper one of pot-burials which contained human remains including skulls and a few bones, and the lower one of earth-burials consigned to graves in the ground and accompanied generally by grave furniture which the dead person was apparently believed to require. The burial pottery is of finer grain and the shapes are more highly developed and elegant than in the secular pottery found in the city sites. The paintings on the burial pottery show preference for animal and realistic motifs such as the goat, deer, bull and peacock, kites and fish, as well as for plants, trees, leaves and stars, while the paintings on the secular pottery show a bias in favour of geometrical and linear patterns. A study of the skulls by anthropologists has revealed that all the principal racial strains in India were represented in the population of those early days.

In the city site, a remarkable discovery is the Great Granary, the largest of the buildings left over from the old days. The Granary consists of two similar blocks separated from each other by an aisle 23 feet wide, which was once roofed over. Each block comprises six halls, alternating regularly with five corridors, in all cases the walls rising to a uniform height. The halls are each partitioned into

four narrow divisions by three equidistant full-length brick walls terminating in broader piers. The resulting aperture made their spanning by corbelling or timbering easy. This extraordinary complex measures 169 feet by 135 feet. The halls had no doubt timbered floors which rested on the partition walls below. Access to them could be had direct from the corridors, which probably sloped up to the entrance hall, or from the aisle side. In some of the Roman Forts in England there are structures remarkably like this Granary with the same narrow galleries and the same small apertures at the bottom of the end walls intended to allow circulation of air under the floor to prevent the grain becoming mildewed.

Another discovery at Harappa is what may be called the Workmen's Quarters, giving distinct evidence of careful planning far ahead of any contemporary attempt. Fourteen small houses built in two blocks of seven houses each, separated by a long narrow lane, with a similar lane at either end have so far been brought to light. The three lanes are regularly intersected by a series of six cross-lanes, having the effect of making each dwelling open on all sides. Each house is rectangular and consists of a courtyard and two rooms, *viz.*, a small room flanking an oblique entrance passage and a bigger room at the back of the courtyard. The entrance is so planned as to shut out a view of the courtyard from the outside. The houses bear a striking resemblance to the workmen's cottages at Tel-El-Amarna in Egypt (which date to a period at least 1200 years later), except that the cottages at Tel-El-Amarna being built in continuous rows, have no cross-lanes and are open on two sides only.

Among other important finds from Harappa mention may be made of two small nude male stone statuettes in the round of prehistoric origin. One of them is a torso, with frontal pose, in red sandstone and the other an ithyphallic dancer in dark grey stone. They are made in parts and are of high artistic merit with refined and wonderfully truthful modelling, incomparably superior to the statuary found at Mohenjo-daro. Their discovery has, in effect, revolutionised existing ideas about the origin of Indian art and its technique.

Jewellery and Crafts in Harappa

A REMARKABLE collection of jewellery consisting of gold, silver, stone, faience and shell objects, has been found below the foundation of a wall in the Workmen's Quarters. Those of gold comprise a hollow armlet and bangle, a conical ornament for the temple or forehead, a heart-shaped pendant inlaid with blue faience, a brooch with silver backing shaped like the number 8 and inlaid with two rows of tiny, cylindrical steatite beads, having gold ends, a necklace consisting of 240 beads in four strings, two wristlets of beads and two small conical bosses, and an assorted string of 27 beads. One broken silver bangle, numerous fragments of another, six necklaces consisting of pendants and other beads of gold, steatite, agate, jade, blood-stone and faience, three necklaces of cornelian and two each of steatite and faience and one of shell complete the lot.

Another important discovery is a medium-sized, round copper jar, sealed with a lid, which concealed a hoard of implements and utensils in excellent preservation, and a small copper chariot. The former contained as many as 70 weapons and implements and several hollow and solid bangles, ready as well as in the process of manufacture. A complete idea of the ancient carts, with its roof and driver is given by the models in copper, recovered from Harappa. The Harappa chariot is two-wheeled, open in front and back, but has a gabled roof which, with the side-walls, is relieved with simple linear decoration. The driver is seated in front on a raised seat, but the animal yoked to it (no doubt a bullock, as the horse was unknown), the poles, wheels and the axle are missing. These earliest Indian vehicles are, if anything, superior to the crude carts of rural Sind in the present day.

Evidence of a highly developed ceramic and metal industry is afforded by 16 small furnaces, more or less fragmentary, found at the place. One of these consists only of a round pottery jar; two of cylindrical pits dug in the ground, the pit in one case being brick lined; and thirteen pear-shaped pits,—eight with and five without brick lining—in some cases provided with a small rectangular pillar with an air passage for the circulation of heat, and in one case with a dividing wall.

The furnaces give indications of varying degrees of heat and of repeated use. From their small size and signs of intense vitrification the conclusion has been drawn that the furnaces were not used for firing ordinary pottery ware but were designed for the casting of metal objects, which, there is abundant evidence to show, were manufactured locally or for the firing of small faience objects such as miniature vessels, squirrels, rams, beads, sundries for inlay, jewellery of this material and stoneware bangles; as well as for glazing steatite seals, faience sealings, vessels, etc., for putting on bands of coloured frit on some faience vases; and for etching cornelian bead—processes which imply efficient arrangements for quickly reaching a very high

degree of heat and equally rapid cooling arrangement in order to keep the colours bright. To judge from the light weight of the ashes and the intensity of the fire, charcoal seems to have been used in most cases.

War Economy and Utilization of Waste

THE annual national expenditure of the British Government was £1200 million during the year before the outbreak of the present war. During the present year it has jumped up to £4000 million. Even increased war time effort can meet only a fraction of this increased expenditure so that the nation is exploring all means of practising strict economy and to avoid waste of any form. Waste household products which in ordinary times were consigned to flames or the rubbish heap are now going to be gathered up and utilised as raw materials for other valuable products. A special department of the Ministry of Supply—the salvage department—has already been set up to cope with the problem. Some figures will give an idea of what huge preventible wastes were going on in that country before the war. Over a million tons of paper and cardboard were thrown annually into Britain's dustbins and during the present year the monthly tonnage of waste paper collected rose to 9,000 tons. Cotton rags usually considered absolutely useless and worthless are used in the manufacture of high grade paper and the industry has flourished in West Riding of Yorkshire for a long time. The industry had to depend on imported supplies, but collection of old and long discarded clothes will now make a substantial increase in home supply.

Various uses have been found for different types of animal and vegetable refuse, *e.g.*, the household cooked bone had scarcely any value at all. One eighth of its weight is fat, one-eighth glue, and the remaining three quarters after treatment will now yield food for cattle or fertilizer for the soil. So much importance has been attached to the utilisation of wastes that the Ministry of Supply has now announced that all local authorities with populations of more than 10,000 will have to arrange efficient systems of salvage and householder in these areas will be obliged to co-operate in the collection of waste paper and cardboard, scrap metals and household bones and other materials which may be added to the list from time to time.

New Method of Rendering a Poisonous Snake Harmless

THE usual method of rendering a poisonous snake harmless by extracting its fangs disfigures the snake and sometimes even its habit seems to change. Recently an electro-coagulating device for rendering poisonous snakes harmless, has been perfected by Duval B. Jorxos, in which he employs a high frequency current of about one million cycles per second. The escape of the venom from the poison gland and its passage to the fang is prevented by the destruction of a portion of the duct. An account of how the operator can manage the entire operation without assistance and in safety has been given in *Zoologica* of March, 1940. Already a number of snakes ranging from eight inches to four feet were treated by the above method and were found to be thriving quite normally without being in any way disfigured or their habits having changed in any way. Observations continued over a year indicate that the result of the occlusion of the duct is permanent.

Energy Distribution in the Ultra-violet Solar Spectrum

A REPORT on the energy distribution in the ultra-violet solar spectrum has been published by E. Petit in *Astrophysical Journal* 91, 159, 1940. The report embodies five years' work at the Mount Wilson Observatory. The radiation from the centre of the sun's disc were used and the light was fed from an aluminized siderostat mirror through a double quartz monochromator on to a vacuum thermopile. The results, reduced to no atmosphere yields spectral energy curves showing intensity drops by 50 per cent. between 4000A and 3800A, remaining nearly constant to 3250A, and then again falling at a linear rate to a low value at 2920A. The effect of Fraunhofer line absorption was eliminated so far as possible by obtaining auxiliary energy curves with a 21 ft. grating monochromator and a photocell. Even then the curve showed most of the depressions noted by previous workers and is far removed from that of a black body. The absorption spectrum of ozone is not sufficient to account entirely for the form of the curve and its departures from the black body type seems to be real.

Large-Screen Television Projection

UP till now television has suffered from this disability that the pictures received are not comparable in size and brightness with those produced by the cinematograph. This can never be achieved until it is practicable to apply the principles of optical projection of the pictures using a standard form of light source of a suitable magnitude. Dr A. H. Rosenthal has developed an instrument, which he has termed 'Skiatron' which makes possible such projection without using any intermediate film on

which the picture is to be photographically recorded and then projected. The principle of the device is based upon the fact that certain materials like potassium chloride, normally transparent become coloured and more or less opaque when subjected to cathode ray bombardment. In the Skiatron the cathode ray receiving tube is replaced by a plate of potassium chloride crystals mounted between two transparent electrodes. As this plate is scanned by the electron beam an opaque deposit is produced, the density of which is everywhere proportional to the instantaneous intensity of the beam. The screen thus carries during each frame period of complete quasi-stationary picture, which may be projected optically like a cinematograph film. The opaque deposit may however be quickly removed by the application of an electric field between the electrodes placed on either side of the crystal. The speed of obliteration depends on the field strength and temperature of the crystal and in the instrument, these are so adjusted that the deposits are removed in the interval between successive scannings. One additional advantage over the usual cathode ray tube arrangement is that in the latter the picture projected on the fluorescent screen is continuously varying whereas in the Skiatron the picture is quasi-stationary and the picture repetition frequency used in the Skiatron can be reduced to a value just sufficient to avoid flicker. Dr Rosenthal has also devised an arrangement of using three of these tubes for reproduction of coloured pictures.

Aero-medical Research

SOME time ago Colonel Lindbergh emphasized the necessity of increasing the facilities for research in various fields connected with aviation and also pointed out that one of the fields very much neglected was that of aero-medical research. The effects of anoxemia (insufficiency of oxygen) at high altitude are known for a long time, but it is only within the last two or three years that any real advance has been made in perfecting the apparatus for administration of oxygen to pilots and passengers of air planes. Boothby and others have developed a type of apparatus which requires only one quarter as much oxygen per minute per individual of what was previously required. The other important problem is connected with the rapidity of ascent. At present a rate of ascent of one mile per minute has been reached. But how fast can the human body be decompressed from full nitrogen saturation at sea-level? Tables of decompression have been worked out for pressures higher than one atmosphere in the laboratory of the experimental diving unit but no data is available for pressure below one atmosphere. This problem needs immediate investigation and the Mayo Foundation has installed a pressure chamber for this purpose in the laboratory of metabolic investigation to study how fast the human body can be decompressed without injury both at high and low pressures. The Foundation also proposes to start other phases of aero-medical research connected with the transport of patients safely by air.

Award of Franklin Medals to L. H. Backeland and A. H. Compton

THIS year the Franklin Institute bestowed its highest award upon Leo Hendrik Backeland, the inventor of bakelite and Arthur Holly Compton whose work on X-ray and cosmic rays has won for him an international reputation as a physicist.

Dr Backeland though best known as the inventor of bakelite, has made important contributions in other fields. A native of Belgium, Dr Backeland came to U. S. A. in 1889 and was employed as a chemist in one of the largest photographic supply house in the country. Later in collaboration with L. Jacobin he started manufacturing photographic papers and chemicals and one of their products 'Velox' paper was considered as a distinct step forward in the art of photographic printing. Later they sold their manufacturing concern to Eastman Kodak Company and Backeland turned to chemical research. His most important work was the discovery of the chemical reaction between carbolic acid and formaldehyde. By heating the product of this reaction under pressure he obtained an insoluble solid with an appearance like amber or ivory, which was easy to mould, was resistant to moisture and to chemical reagents and which did not conduct electricity. This invention was the beginning of the modern plastic industry.

The award to Dr Compton was in recognition of his brilliant researches on X-rays, in particular for his discovery and theoretical treatment of the Compton Effect. Only ten years after his graduation from the College of Wooster in 1913, Dr Compton was appointed professor at the University of Chicago which position he still holds. He has been the recipient of many honours and awards including the Nobel prize in physics in 1927. Dr Compton's early work on the total reflection of X-rays incident upon a metallic surface at a very small angle led to a new method of measuring the wavelength of X-rays, the results of which are more exact that those obtained by the earlier Bragg method. In 1923 Dr Compton investigated the nature of X-rays which had been scattered by matter. His photographs showed the existence of scattered rays, a part of which showed no change of wavelength and another part showing a modified wavelength. Application of the quantum theory led to equations which were supported by experiment. Thus Compton not only discovered a new phenomenon but also gave it correct theoretical interpretation. In recent years his chief work has been in the field of cosmic rays.

Liaison in Scientific Work

PROFESSIONAL men in industries may be sometimes faced with problems about which they lack first hand experience and in times of emergency this handicap is likely to retard the speed and progress of work. To deal with such difficulties with regard to technical problems the Institute of Physics, London, has recently formed a panel of consultants out of which the physicists who are likely to offer immediate practical suggestions are put in touch with the enquirer. The priliminary contact is quite informal; subsequent arrangements are a matter for private agreement between the parties concerned. The subjects which are dealt with cover both pure and applied branches and include, for example, physical measurements and testing, the design and supply of scientific instruments for special purposes and the control of processes by physical means. This arrangement will help the solution of problems faced at one place by the application of knowledge gained at another and will avoid a great deal of loss of time and patience of the workers. Recently there was some difficulty in the process of measuring the flow of certain animal secretions. A physicist in the ink industry was found out who made use of a method for measuring such a flow of certain printing inks having complex physical properties similar to the animal secretions. When the contact was made, the solution of the difficulty came very quickly. It is desirable that in this country also where we have just began to harness science to the aid of industries a number of registers should be compiled on such lines as above for technical assistance by the different learned societies of the country.

Meteorological Department's Report for 1939-40

THE administration Report for 1939-40, of the India Meteorological Department, states that the most important advance during the year was the improvement of weather forecasting facilities for airmen. The forecasting office at Delhi has been re-opened at the Willingdon Air Station, and is in close touch with aviation interests and is in a positon effectively to meet their demand. Arrangements for removing the upper Air Office from Agra to Delhi are nearing completion. Duing the year, several new observatories were started to meet the needs of the Air Force, the Civil Aviation Department and of shipping. New "current-weather" stations were started temporarily in north-west India and Kashmir with part-time observers, whose duty it is to supply current weather reports for Air Force flights in that area.

During the year a scientific expedition for investigation into cosmic rays from the United States of America, headed by Dr R. A. Millikan, Chairman of the Executive Council of California Institute of Technology at Pasadena, was assisted by the Department's officers, especially by the staff of the Agra Observatory. The expedition made observations at Agra, Gwalior, Peshawar and Bangalore by means of large balloons, to which were attached recording instruments. A report of the activities of this expedition was published in this journal on pp. 413-14 of the January, 1940, issue of the last volume.

A new wireless station, attached to the Meteorological office at Poona was opened on April 15, 1939. This station, and the New Delhi forecasting office, completed the Meteorological Department's "Regional Synoptic Scheme." The observations collected at Poona, Calcutta, Delhi and Karachi from selected stations in their own regions, are broadcast at specific times daily as "Regional Synoptic" messages. In addition, Poona acts as an All-India centre and broadcasts "collective synoptics" from which skeleton weather charts for the whole of India can be drawn. These regional and collective types of broadcasts have allowed India to reciprocate weather data regularly with countries as far afield as Egypt and Malaya, which broadcast their weather data in a similar fashion.

The Agricultural Meteorology Section continued to develop its liaison with the Agricultural Departments in the different provinces and States in India, while at the same time maintaining its record of investigation in many types of problems, all with the aim of elucidating the effect of weather and climate on crops. A start was made on an investigation to evaluate the effect of topography on local climate. The so-called "precision" observations, designed to reveal the effect of weather on various crops, have yielded, in particular, a unique set of data on the growth of rice during six different seasons. This section, which has been financed for seven years by the Imperial Council of Agricultural Research, has now been taken over by the Central Government as a charge on Central Revenues for a further period of three years, from April 1, 1940.

Last year nearly 6,000 warning messages were issued to ports and more than 1,800 messages to

shipping at sea, including those in connection with disturbed weather over the seas. Warning messages of heavy rain, untimely rain, high winds and frost numbered 8,900. The number of weather forecasts issued to aircraft from different forecasting centres totalled 11,533. Besides these, about 16,000 upper wind reports and 34,000 reports of current weather, including warnings of adverse weather and improvements thereof, were supplied to pilots from different stations along the air routes.

The study of the structure of some of the depressions and storms in the Indian area has revealed the necessity for a large number of simultaneous sounding balloon ascents in the field of a tropical storm before, during and after its passage over a particular area, in order to obtain more precise information about its structure process of formation and movement. To achieve this end, a scheme for a swarm of sounding balloon ascents ("swarm-ascents") during a post-monsoon storm in the Bay of Bengal has been drawn up.

Announcements

MR G. B. LAL, Science editor of the *New York American* has been recently elected president of the National Association of Science Writers of America. While working with the *New York Times*, he was awarded jointly Pulitzer prize for his meritorious reporting of the Tercentenary celebrations of Harvard University.

A GENERAL headquarters to co-ordinate and stimulate researches and discoveries of scientific workers in all shpheres has been formed in Britain. The personnel will consist of internationally known scientific investigators like Sir William Bragg, Dr E. V. Appleton, Sir Edward Mellanby, Sir Edwin Butler, Professor A. V. Hill and Professor A. G. Egerton. The Chairman will be Lord Hankey who will convey the fruits of the new body's labours directly to the Lord Chancellor.

IN the United States also a National Defence Research Committee has been set up by the Council of National Defence to correlate and support scientific research with a view to improving the mechanisms and devices of warfare with the exception of those relating to aerial activities. The Committee will have the assistance of the National Academy of Sciences and National Research Council whose work will proceed independently. There will also be a close working relationship between the Committee and the newly created Inventors' Council. The Committee will take up those new ideas and inventions which will be appraised by the Army and Navy in collaboration with this Council and arrange for further scientific research to complete their development and ensure utility. The chairman of the Committee is Mr Vannevar Bush, President, Carnegie Institution of Washington ; and besides representatives of War and Navy Secretaries and the Commissioner of Patents the following are the members: Mr Richard C. Tolman, Dean of the Graduate School, California Institute of Technology ; Dr Karl T. Compton, President, Massachusetts Institute of Technology ; Mr James B. Conant, President, Harvard University ; Mr Frank B. Jewett, President, National Academy of Sciences.

THE following gentlemen have been elected fellows of the National Institute of Sciences of India at the meeting of the Council held on 3rd October last :—

Rai Bahadur Dr. K. N. Bagchi, B.Sc., M.B., D.T.M., F.I.C., Chemical Examiner to the Govt. of Bengal and Professor of Chemistry, Calcutta Medical College.

Dr K. Ahmad Chowdhury, B.A., B.Sc., M.S. (Syracuse, U.S.A.), D.Sc. (Edin.), Wood Technologist, Forest Research Institute, Dehra Dun.

Dr Mohammad Ishaq, M.Sc., Ph.D., Head of the Dept of Physics, Muslim University, Aligarh.

Prof. K. B. Madhava, M.A., Professor of Mathematical Economics and Statistics, Mysore University.

Dr D. N. Majumdar, M.A., Ph.D., F.R.A.I., Lecturer in Anthropology, Lucknow University.

Dr D. Naravanamurti, M.Sc., Dr. Ing., A.I.C., F.Inst.P., Officer in charge, Wood Preservation Section, Forest Research Institute, Dehra Dun.

Dr Vishwa Nath, M.Sc., Ph.D., F.R.M.S., Lecturer in Zoology, Government College, Lahore.

Dr S. C. Roy, D.Sc., Director of the Burma Meteorological Service.

Prof. S. K. Roy, Ph.D., Professor of Geology, Indian School of Mines, Dhanbad.

Prof. N. A. Yajnik, M.A., D.Sc., A.I.C., Professor of Chemistry, Forman Christian College and Reader in Chemistry, Punjab University, Lahore.

Sir Rickard Christophers, Kt., Bt-Col., C.I.E., O.B.E., F.R.S., I.M.S. (Retd.), has been elected a honorary fellow.

SCIENCE IN INDUSTRY

Size and Shape of Colloidal Carbon

COLLOIDAL carbon or carbon black is used for the reinforcement of rubber. With the aid of this toughening agent the life of the present tyres has been increased three times. Modern high-speed printing presses require inks which should produce clear instantaneous imprints and this is possible only by the use of colloidal carbon as their pigment. Protective films of black paints and lacquers owe their longer life to the reinforcing power of the colloidal carbon and its ability to screen out injurious actinic radiations.

The mechanism of this carbon reinforcement phenomenon was not properly understood and during the last 20 years many attempts have been made to explain it on the assumption of burr or feather-like surface structure. No convincing evidence could be available as the extreme fineness of subdivision so long defied optical resolution.

From photomicrographs taken with the two-stage electron microscope developed and perfected at the University of Toronto, the shape and size of ultimate carbon particles has recently been determined. Carbon black obtained from the luminous flames of natural gas was magnified to 102,000 diameters and was found to be spheroidal with non-serrated surfaces and having a mean diameter of 28 millimicrons (approximately 0.000001 inch). This is about one half the value previously accepted based on other methods of measurements.

Commercial carbon black consists of clusters or aggregates of these ultimate spheroidal particles. When used in inks, paints or rubber the clusters are dispersed to develop the maximum effectiveness of the carbon. Electro-photomicrographs of this dispersed carbon have revealed individual carbon particles ranging in diameter from less than 10 to about 60 millimicrons. From the above measurements and observations the reinforcement hypothesis based on serrated or reticular configurations has been abandoned, and instead a new conception of specific surface development has been advanced. The above researches may have far reaching influences on the future developments of carbon black and its industrial uses.

N. K. S. G.

Manufacture of Drugs

CHLOROFORM, calcium lactate and carbolic acid have now been produced by Indian firms and samples have been received by the Medical Stores Department for tests. Samples of carbolic acid and cresylic acid, a disinfectant, have been found satisfactory. A sample of saponified cresol is being tested at the Central Research Institute, Kasauli. The chloroform has been produced by a Bengal firm and the sample is being tested for quality at the Biochemical Standardisation Laboratory, Calcutta, which is also testing a sample of calcium lactate. Samples of anaesthetic ether prepared by a Bengal firm have been tested by the Medical Stores Department and found satisfactory. This item has been in production for two years by the Department. An Indian firm is making five to ten tons of acetic acid glacial per month and is able to increase it to 30 tons a month without additional plant. It has unfortunately raw materials sufficient for one year.

Protective Films on Tin-plate

RECENTLY a new process has been developed by the International Tin Research and Development Council for protecting the tin-plate in tin cans from the action of sulphur in preserved foods. The usual method up till now was to coat the interior of the container with a special sulphur resisting lacquer, but this operation is expensive when compared with the new process and in some cases the lacquer has been found to react unfavourably on the flavour of the food product. It is stated that the new protecting film is an oxide and it is so thin that it is invisible. The film protects the underlying tin from the actions of sulphur compounds, produced by a slight decomposition of the proteins contained in certain types of vegetables, meat and fish products as a result of the sterilisation process. This decomposition of the proteins may cause blue or black stains to appear on an

unprotected tin-plate surface, and this discolouration is not only bad to look at, but may, in extreme cases, affect the appearance of the contents. Moreover in the case of some vegetables the colour is affected, green being changed to an unpleasing yellow.

In the Council's Laboratories the oxide film was first produced on the tin by immersing the plated articles in a hot solution of chromic acid for 15 minutes. But it had some disadvantages as a film of palm oil was left on the tin plate from the hot-tinning operation. The process has been now modified by taking a hot alkaline solution containing sodium phosphate and a chromate. The alkaline bath produces the required oxide film and simultaneously removes the oil film. The time required for dipping is two minutes only. The film has been tested with various types of preserved foods. Tests with meats and fishes are promising. But tests with various kinds of fruits, however, have given poor results, as the film appears to be slowly dissolved by the citric acid present.

N. K. S. G.

Non-Tin Container for Food

A NEW type of container for packing food products has been developed in Germany, which dispenses altogether with the use of tin plate, according to a report from the American Consulate General at Frankfort-on-Main. Instead of tin for coating the iron, the base sheet for making the new type of cans is coated with a phosphate film by the Bonder phosphate rustproofing process. A thin, tight, and uniform phosphate film is placed upon the iron sheet in 2 or 3 minutes by immersion in a special phosphate bath. The entire production process requires 30 minutes. There is another novelty in the cans. Instead of being soldered, the can is welded, enabling a further saving of 2 per cent in can material. Special automatic machines have been developed for efficient welding.

N. K. S. G.

New Synthetic Rubber Manufactured by Goodrich

GOODRICH Rubber Co. of U. S. A. is now manufacturing tyres in which 50 to 100 per cent of natural rubber has been replaced by synthetic product, "Ameripol". The name Ameripol signifies a polymer made from American materials. From reports so far available it is known that the basic material is American petroleum from which butadene is separated. This is mixed with other ingredients prepared from natural gas and air and then made into a milky emulsion using soap produced from agricultural sources. Upon heating and agitation, these ingredients react to form an emulsion of synthetic rubber, which is similar to the latex from rubber producing trees. With this synthetic rubber, the process of manufacture is like that of natural rubber. A semi-commercial plant is already in operation and Goodrich is constructing a plant which will produce several tons of Ameripol daily.

N. K. S. G.

Industrial Reorganisation of Bombay

THE report of the Bombay Economic and Industrial Survey Committee which has just been published observes that the government have as yet spent very little on the problems of marketing, finance and research. The other government departments concerned with economic activity have not also had a well-formulated and vigorous programme of economic development, and they lack in industrial bias. There has been very little co-ordination between these different departments and there is no provision for periodic consultations with a view to industrial development among the heads of these "economic" agencies of the government, *viz.*, the Director of Agriculture, the Director of Industries, the Registrar of Co-operative Societies, the Chief Conservator of Forests, the Superintendent of Government Stationery and Printing Press and the Chief Engineer.

The Committee stresses the potentialities of semi-agricultural industries like poultry-keeping, bee-keeping and sericulture. There are, says the report, possibilities for establishing the aluminium industry in this province as bauxite deposits have been discovered at Tungar Hill near Thana; and a high class earthenware industry as clay suitable for high class potteries is stated to be available locally. Bakelite, electrical goods, raw films, radio sets, bicycles and automobiles are other commodities which offer scope for domestic manufacture. Fruit canning and the manufacture of other fruit products has great possibilities. Fibre resources should be more economically utilised. A good deal of agricultural produce which is being wasted at present could give rise to new industries. Forest products offer enormous scope for building up new industries. The fisheries resources can also be exploited on a very profitable scale. As a part of a policy for the economic betterment of the province, the Committee suggests that a programme of rapid road construction may be immediately undertaken and the new transport facilities will offer scope for rapid growth of trade and industry.

"It must be borne in mind", says the report, "that the structure, the composition and the pace of industrial development are very greatly dependent upon tariffs, transport and currency, none of which vital determinants of economic development are under the control of the provincial government; and without controlling these, it is difficult to carry out any industrial policy meant to result in speedy industrial development. Moreover, the implications of provincial action in the industrial sphere may extend far beyond the provincial boundaries and that, therefore, the reactions on the other provinces and the Indian States have to be constantly taken into account.

With regards to the question of the relation of large-scale and cottage industries, the Committee feels that there is a large non-competing field between the two as also scope for co-operation. The Committee suggests that the question of regulating their relations should be discussed at a special conference of the representatives of the provinces and the Central Government. Discussing the relation between small-scale and cottage industries, the Committee is of opinion that no regulation is necessary here except in the case of the textile industry where the growth of small power-loom factories needs to be restrained. Even here no action should be taken without obtaining the approval of the other Governments in India, as these units may be serving the economic interests of other provinces.

The difficulties of the cottage industrial workers are primarily in the field of marketing, and to meet this difficulty the Committee recommends that each district should have an industrial association in charge of a district industrial officer assisted by a local advisory committee. The district industrial association should supply raw materials to artisans and sell their products, give them improved tools on the hire-purchase system and organise demonstrations, etc. Membership of the association should be open to all whole-time cottage workers resident in the district. The industrial association should have attached to it a small museum displaying the raw materials of the district, the finished products that can be made from these raw materials, the industrial requirements of the district and the possible industrial substitutes for the non-district industrial goods now in use. It should also organise district industrial exhibitions every year. For financing the cottage worker, a special organisation should be set up which should not deal direct with the cottage workers but only with the industrial associations. In the alternative, the Government may place Rs. 25 lakhs at the disposal of the cottage industries section of the Industries Department.

The Committee recommends that there should be authoritative collection and compilation of commercial and industrial information, which should be made the special work of an officer attached to the Industries Department. He should also publish an industrial bulletin containing abstracts of important trade articles and items of research interest in the Government's laboratories.

For the formulation of a positive industrial policy, the creation of a Board of Economic Development is suggested, and this Board should draw up a time-table of industrialisation based on the details collected by an industrial census. The reorganisation of the Industries Department on the lines proposed in the report is estimated to cost approximately Rs. 25 lakhs.

Automobile Factory in Bombay*

THE question of the establishment of an automobile factory in Bombay was first mooted in the year 1934. The first step taken in this matter, after the Bombay meeting in April 1935, was to send Sir M. Visvesvaraya to visit foreign factories where the industry flourished in full vigour, to consult there recognised experts, and frame and submit a report to the promoters. In April 1936, a printed report embodying the results of the foreign tour and investigations was placed in the hands of all those business men in Bombay who had previously attended meetings or taken an interest in the project. Copies were also submitted to the authorities of both the Government of India and the Government of Bombay. In this journal on the basis of Sir M. Visvesvaraya's report were published two articles under the headings, 'The Automobile Industry in India' (Vol. 4. p. 258, 1938-39), and 'Manufacture of Motor Vehicles in India' (*loc. cit.* p. 401) and also a short note on page 512 of the same fourth volume referring to later developments. We would refer our readers to these pages, which will be of interest in the present connection.

By the time the report was ready, a wave of pessimism, due, it is believed, to adverse propaganda,

* Adapted from a note by Sir M. Visvesvaraya circulated with the purpose of answering enquiries which are frequently received about this project, and of explaining what progress has been made so far, and what further action or facilities are needed for an early start.

caught some of the influential Bombay friends who had originally encouraged the scheme. It must be remembered in this connection that since foreign interests are likely to be affected by the establishment of the proposed industry, some degree of hostility to the scheme is expected. Even to-day there is a tendency on the part of a minority in the trade to spread the misleading view that it is "better to buy than to build" motor vehicles in India.

INDIA GOVERNMENT'S ATTITUDE

However, sufficient public support being assured, representations were submitted both to the Government of India and the Government of Bombay for co-operation and help. The first representation to the heads of both these Governments was made on 7th May, 1936. The Government of India while expressing sympathy with the project stated that they adhered to the policy of discriminating protection for Indian industries enunciated by the Fiscal Commission of 1921-22 and could not go to the help of an industry that was not started. Neither could they commit themselves beforehand, that is, before a factory was actually in operation, to purchase any of the products ordinarily required for Government use. However, in view of the service which an automobile factory is likely to render for defence purposes, the Government of India have now been obliged to mobilise even the meagre assembly equipment in India of two American motor car companies.

A press message from Simla reported some time back that the two motor companies, General Motors and Ford, which possessed large assemblage and body building plants in India were co-operating with the Government in the production of vehicles for the Indian Army. Although it was not possible to state the numbers or types which were in production at these plants, it could be said that the present initial expansion of the Indian Forces involved an increase of between twenty and thirty thousand in the number of vehicles required by the Army. All these were divided into no less than 56 types. To assist in coping with these requirements, the American concerns had recently considerably extended certain sections of their works and these extensions would be specially devoted to urgent Government work. This message shows the quantity of large orders placed with the two prominent American automobile companies. A request for such orders was made to the Government of India four years ago but there was no response. No reason, save their adherence to the old policy of discriminating protection, was given for denying similar facilities to an indigenous enterprise.

PROGRESS OF THE PLAN

The Bombay Government, on the other hand, wanted, subject to certain conditions, a guarantee of 3 or 3½ per cent. interest on a capital issue of Rs. 150 lakhs for the industry for a period of ten years. Before the concession was finally sanctioned, the Congress Government went out of office; and the present Government of Bombay are yet to ratify the promise made by their predecessors. In the concession just referred to, one of the conditions was that the new factory should be run by a firm of Managing Agents, and as soon as the provisional promise of a concession by Government to guarantee 3 or 3½ per cent. interest on share capital for a term of ten years was received, Mr Walchand Hirachand of Bombay, one of the promoters who had warmly supported the proposal from the commencement, offered to start a firm of Managing Agents with himself and two other well-known industrialists, Mr Dharamsey Mulraj Khatau and Mr Tulsidar Kilachand, as partners.

Mr Walchand Hirachand lost no time in taking the next move. He obtained from the Government of Bombay the loan of the services of Mr P. B. Advani, Director of Industries, Bombay, for the purpose of arranging terms and entering into an agreement with one of the automobile firms of repute in England or America, and obtaining its active co-operation for starting the proposed factory in Bombay. Mr Advani, in close consultation with Mr Walchand, first discussed the proposals with the Ford Motor Company of Dearborn, U.S.A., and next with the Ford Motor Company of Canada. India came within the operations of the Canadian Ford Motor Company so far as supply of Fort motor vehicles was concerned, but that Company was not willing to co-operate with the promoters unless it was allowed to participate substantially in the capital of the Company by owning 51 per cent of it. The promoters expressed inability to agree to this, and as a result the negotiations with the Ford organisation had to be reluctantly abandoned.

Mr P. B. Advani next started negotiations with another large firm, the Chrysler Corporation of Detroit (U.S.A.) with which a definite agreement has been concluded for manufacturing their motor vehicles in India on a royalty basis, that is, without participation of American capital in the Indian Company. The promoters are also in correspondence with a leading British Motor Car Company for manufacturing in India, on a royalty basis, their low power cars. The British Company concerned has promised cordial co-operation, and negotiations are proceeding satisfactorily.

Both the manufacture of medium power vehicles under license of the Chrysler Corporation and of low-power cars under license of the British Company referred to could be undertaken if Government help is available at least for the first few years.

PROSPECTS OF THE INDUSTRY

Sir M. Visvesvaraya's original report was issued in 1936, there has since been an appreciable change in the public demand in India from medium power to economical low-power cars. When the scheme in its present form as outlined by Mr Advani is completed and brought into operation, the number of vehicles manufactured yearly is expected to be 11,000 instead of 12,000 and the total capital outlay required for the factory will be the same as in the original scheme, namely, Rs. 2¼ crores. But the same machinery and plant will, with small additions, be able to manufacture even upto 20,000 units whenever demand arises for so many.

The value of the products manufactured yearly at recent normal rates will probably be as under:—

	Rs. lakhs
3,000 medium power cars at Rs. 3,500	105
5,000 trucks at Rs. 3,000 ...	150
3,000 low-power cars at Rs. 2,000 ...	60
Total Rs.	315 lakhs.

This will be the approximate yearly value of motor vehicles which a factory constructed at a cost of Rs. 2¼ crores in this country would be able to manufacture at the outset.

Authoritative statements have been prepared and published in the United States of America which show that the price of a motor car to the consumer in a foreign country like India is about 2½ times the actual cost, *ex* works in America. A car which costs, say Rs. 1,400 in a factory in Detroit would be sold for about Rs. 3,500 in Bombay. The difference of Rs. 2,100 is at present spent on inland freight in America, ocean freight, sea insurance, loading and unloading charges in Bombay, import duty, dealer's commission and a few other minor items. The bulk of these charges will be saved if vehicles are made in India.

In the case of a car manufactured in India, the only heavy expenditure to be incurred outside the factory would be the import duty on special parts if no concession is secured from Government and the dealer's commission or profit. A liberal estimate of outlay on these two items will probably be Rs. 750. Taking the price prevailing in normal times, the saving per car would be Rs. 2,100 − Rs. 750 = Rs. 1,350. Assuming that the working of the Indian factory will not be as economical as in America and saving not as high as Rs. 1,350 but only Rs. 500 per unit, or one-seventh of the normal price of a completed car, the total clear profit would be one-seventh of the sum of Rs. 315 lakhs or Rs. 45 lakhs. This will mean, under favourable conditions, a profit of 20 per cent. on the initial capital outlay. The profit will vary with changing market conditions but the rough calculations here given should leave no doubt in the mind of the reader that the prospects of the industry are very promising.

MANUFACTURE SIMPLIFIED BY AUTOMATIC MACHINERY

A good many people, even among industrialists, are obsessed by the fear that the manufacture of motor vehicles is a very complicated and difficult matter and the Indian workman is not yet trained for this delicate work. But such fears are groundless. The machinery used in the manufacture of parts is to a considerable extent standardised and its action is largely automatic. The thought and skill required in manufacture has been transferred from the workman to the machine and "although the motor vehicle is a most delicate and finely adjusted machine, the human labour and human intervention utilised in its manufacture is reduced to a minimum." The experience of automobile assembly plants of which there are a number working in India shows that the Indian workman is quite capable of handling this class of machinery and of producing articles of the required quality, strength and finish.

MOTOR VEHICLES MANUFACTURED IN THE PRINCIPAL COUNTRIES OF THE WORLD

The manufacture or production of motor vehicles in the leading countries in the years 1938 or 1939 was as under:—

Country.	Year.	Motor Vehicles produced.
United States	1939	3,577,058
Canada	1939	155,316
Great Britain	1938	477,561
France	1938	220,343
Germany	1938	328,000
Italy	1938	70,388
Russia (U.S.S.R.)	1938	215,000
Japan	1938	30,000
India	.....	*Nil.*

The maximum yearly production in some of the countries is much higher. In the United States of America, for instance, the vehicles manufactured in 1929 was 5,359,090. The above information, which shows the production to be much in excess of that in the past years, should dispel any doubt about the Indian factory reaching its saturation point within a few years of the start.

Mainly for export purposes, several leading manufacturers in America have established branch factories in Canada. For instance, the Ford Manufacturing Company of Detroit, U. S. A., has an associated factory in Windsor (Canada), and this Canadian factory supplies Ford vehicles of the type manufactured in Detroit to all parts of the British Empire. The Canadian Ford Company has the exclusive right to supply such cars to India. But Ford cars including the low-power ones manufactured at Dagenham, England, come direct to this country from England.

SUPPORT GIVEN TO THE INDUSTRY IN FOREIGN COUNTRIES

Before the War there were over 40 factories in France, manufacturing automobiles or their parts, and which were maintained in slack times by orders for armaments and defence machinery given by the French Government. Without such support the factories could not have possibly existed.

Germany being unable to compete with America put up a prohibitive duty. Herr Hitler encouraged the industry in several ways, one of which was to exempt people who purchased German-made cars from paying certain taxes for a term of years. As a result of this encouragement and other facilities given, the industry which produced only 52,000 vehicles in 1932, increased production to 243,000 in 1935, and to 328,000 in 1938.

Russia started the manufacture of motor vehicles some eight years ago. The Soviet Government opened an office in New York and stationed a number of Russian engineers there to export machinery and parts for manufacture in Russia. This, they did, in close co-operation with the Ford Motor Company of Dearborn, U.S.A. In the first year, they took all the parts to Russia and assembled them and completed the car. In this way they made 5,000 cars. In the second year, they purchased 50 per cent. of the parts and made 10,000 cars. In the third year, 25 per cent. of the parts were purchased and 20,000 cars were made ; and in the fourth year, they manufactured 40,000 cars. As a result of the activities of her Government, Russia which manufactured only about 40,000 vehicles in 1935, increased production to 215,000 vehicles by 1938.

NOTABLE ENCOURAGEMENT IN AUSTRALIA

The support promised under similar circumstances by the Commonwealth Government of Australia to a local Company, *before it proceeded to make the necessary arrangements to establish the industry in Australia,* is the latest and the most significant instance of the helpful attitude of modern Governments towards this industry.

On December 19th, 1939, the Commonwealth Government entered into an agreement with a local Company, the Australian Consolidated Industries, Ltd. The agreement stated that a Motor Vehicle Engine Bounty Act had been passed in the Australian Parliament which provided for the payment of a bounty of £1,500,000 for the first 60,000 motor vehicle engines manufactured by the Company.

Some of the other principal provisions in the agreement are :—

(*a*) Two-thirds of the paid-up value of shares should be owned by subjects resident in Australia.

(*b*) The Commonwealth Government will safeguard the interests of the Australian Company against the establishment of rival manufacturing foreign Companies.

(*c*) Government will use its power of import control to counteract any foreign trading methods by oversea interests in selling competitive vehicles in Australia.

(*d*) For five years from commencement of manufacture, the Commonwealth Government will purchase a substantial portion of its requirements from the proposed Factory.

(*e*) Government will admit free of import duty such machinery as cannot be conveniently manufactured at the outset within a reasonable time.

(*f*) The Commonwealth Government will be prepared to examine upon request the measure of tariff or other assistance needed for import of any special automobile parts.

HELP EXPECTED FROM OUR GOVERNMENT

The support expected *from the Government of Bombay* is the confirmation of the guarantee of 3½ per cent. interest on capital outlay, provisionally promised by the Premier of the previous Congress

Government. This support will be in conformity with the declared policy of the Government of Bombay to grant assistance, specially to new and nascent industries.

The support expected *from the Government of India* according to the latest appeal is reduced to three items :—

(1) The factory may be treated as a War measure since it will be able to manufacture and supply Army trucks, armoured cars, and if necessary also armaments. At a few weeks' notice the factory equipment can be transformed into an armament plant ; and, with small additions to the plant, the factory will be sufficiently equipped to manufacture aeroplane engines when required. In view of this prospect, the grant of dollar exchange and import permits for purchases made for the projected factory should take precedence over civil requirements for other purposes.

(2) It is understood, that the Government of India have a programme to purchase annually 5,000 new motor trucks for the mechanisation of the army. It would not be out of place for Government to promise a substantial part of this order to the projected local factory since its arrangements with the Chrysler Corporation of Detroit, as explained before, ensure that vehicles of the highest quality obtainable anywhere in the world can be supplied.

(3) Reasonable tariff concessions may be granted in connection with imports of parts and raw materials required for the local manufacture of motor vehicles, to the extent commonly done in European countries and in Canada.

IMPORTANCE OF THE INDUSTRY

The projected Indian factory will from the very commencement be a manufacturing concern and not a mere assembly plant. Since the outbreak of the War, prices of motor vehicles have risen, and high prices will continue to rule for two or three years after the War. If the factory is started now, it will not only be providing trucks for War purposes and for the Indian Army within some eight months, but it will also be profiting itself and materially benefiting the country as a War time industry.

As explained before, there has been some amount of propaganda carried on, apparently by interested parties, to mislead the public that the industry is not wanted here. While small States like Belgium, Australia and Norway with populations numbering 8, 7 and 3 millions, respectively, are establishing motor car factories, it cannot be said that one such factory will be a superfluity in this sub-continent of ours with its 375 million population.

Two of the largest automobile Corporations in the world have after investigation concurred in the size, scope and estimated cost of the Bombay project as outlined in 1936. We have seen that a leading American Company was willing to put some of its own money into the concern if allowed. Another leading Corporation has actually entered into a working arrangement with the promoters of the Indian project for manufacturing their motor vehicles in Bombay on a royalty basis. The former would not have offered to participate in the capital of the scheme ; nor the latter entered into an agreement, unless the prospects of the industry were distinctly bright.

It is evident from this, that the proposals which have been before the business public for the past five years, and before the Central Government and the Government of Bombay for at least four years, are sound from every point of view. Had the industry been started when the project was first mooted in the year 1936, it would have been in successful operation by now, and of special value for War purposes in the present emergency.

With the starting of the factory, a number of subsidiary industries would be springing up and thousands of people will get employment. Local industries of this importance have a legitimate claim on the revenues of the country and on active Government encouragement and support. To neglect the industry under present world conditions would be a discouragement to economic enterprise, a hindrance to progress, and a danger to the country's safety.

Production of Clean Milk in an Indian Household

M. R. MADHOK
Agricultural Bacteriologist, Punjab.
S. L. KAPOOR
Punjab Agricultural College, Lyallpur.

THE production of milk in the West has now become a scientific art whereby milk is produced under controlled conditions and graded according to definite bacteriological standards before it is put in the market. More recent advancements have brought forth such specialized products as Irradiated milk, Vitamin 'D' milk and the Acidophilus milk.

Compared with this, the art of milk production in India remains as primitive as ever. Co-operative dairying is practically unknown and the few dairies that are working in India are mostly patronized by the European or high class Indian gentry. In rural areas farmers mostly produce their own milk supply while in towns and cities the milk supply is mainly controlled by *gowalas* who are addicted to innumerable malpractices.

Most of our producers do not realize the importance of hygienic precautions in milk production and the educated few, who do, often consider them unnecessary since milk in India is mostly consumed after boiling or simmering. The argument is, however, faulty firstly because during the hot weather when conditions for the growth of bacteria are the most favourable, milk is often consumed raw and secondly because our experiments, reported elsewhere (1940) have shown that simmered milk when exposed to contaminants is more suitable for the growth of bacteria than even the raw milk.

About 89% of the total population in India lives in villages where milch cattle are kept under most insanitary conditions; the cattle yards are littered with dung and manure, and no precautions whatever are taken in milking. Conditions in towns and cities are still worse. The milch cattle are kept in dingy closed rooms or in narrow lanes over the sewage drains. The hygienic value of milk produced under such conditions cannot but be questionable.

Milk is a complete food not only for children and adults but also for bacteria. Special attempts have therefore to be made to prevent its becoming a source of disease.

The value of cleanliness in milk production is fully illustrated by the advance made in other countries but very little direct work has been done on the subject in India, mainly because our scientific workers have taken for granted what holds good in the West. This we think is not the right attitude because our climatic, economic and social conditions are entirely different from those of the West. A study of the various factors as affecting milk production under our conditions, therefore, seems very desirable.

With this object in view a series of experiments was conducted at Lyallpur to determine the worth of some simple precautions regarding the production of milk. In making these trials the fact that our farmers and city milk producers are generally poor and illiterate and that they have to be convinced by some simple yet direct and inexpensive means before they can be persuaded to adopt improved practices, has all along been kept in view.

EXPERIMENTAL DETAILS

Cows of identical breed at nearly the same stage of lactation were selected for the experiments. A preliminary examination of milk was made in each case to spot out any abnormality in the animal.

The trials were at first conducted in the college dairy and subsequently repeated in a *gowala's* house so as to make the conditions more nearly identical with those of an average household. Since calf-suckling is usually practised, all the precautionary treatments in a *gowala's* house, were carried out after this operation was over.

The effect of the following procedures on the quality of milk produced was studied:—

I. Unsterilized pail, tail untied, foremilk not removed.

II. Sterilized pail, tail tied, foremilk removed.

III. Sterilized pail, tail tied, foremilk removed, udder and hands washed with water.

IV. Sterilized pail, tail tied, foremilk removed, udder and hands washed with potassium permanganate solution (1 : 2000).

V. Pail cleaned with mud, tail tied, foremilk removed, udder and hands washed with potassium permanganate.

VI. Pail cleaned with ash, tail tied, foremilk removed, udder and hands washed with potassium permanganate (1 : 2000).

VII. Pail cleaned with ash and kept in the sun (8 hours, maximum temperature 130°F) tail tied, foremilk removed, udder and hands washed with potassium permanganate (1 : 2000).

*VIII. Pail cleaned with ash and kept in shade, tail tied, foremilk removed, udder and hands washed with potassium permanganate (1 : 2000).

The standards used to judge the effectiveness of such precautions were: (*i*) the number of bacteria present in a millilitre of milk by the plate method, and (*ii*) the reduction time as indicated by the methylene-blue reductase test. For purposes of comparison trials were made with two different types of pail that are most commonly used in the Punjab (Fig. I).



Balti (Galvanized iron) *Dohnā* (Brass ware)

Fig. 1. Showing different types of pail used in the Experiments.

For counts of the numbers of bacteria, platings were done on skim milk agar of the following composition:

Skim milk	...	... 2%
Bacto peptone	...	... 0·5%
Beef extract	...	... 0·1%
Glucose	...	... 0·1%
Agar	...	... 1·5%

The reductase test was carried out according to a recent modification by Thornton (1937) whereby milk tubes containing the standard methylene-blue solution are shaken every half an hour. In order to determine the comparative worth of different treatments several repetitions were made in each case but results of only typical observations are presented here.

RESULTS

Tables I-VI being sufficiently explanatory only a brief account of the experimental results is given below:

Results given in table I indicate that milk produced without precautions gives the highest

TABLE I

Showing the effect of different precautions on bacterial numbers and keeping quality of milk

Treatments	College dairy samples.		*Gowala* samples.	
	Bact. per c.c.	Reduction time.*	Bact. per c.c.	Reduction time.
1. Unsterilized pail, tail untied, foremilk not removed.	10150	7 hrs.	19100	6 hrs.
2. Sterilized pail, tail tied, foremilk removed.	1450	12 ,,	3150	8 ,,
3. Sterilized pail, tail tied, foremilk removed, udder and hands washed with water	530	15 ,,	1250	10 ,,
4. Sterilized pail, tail tied, foremilk removed, udder and hands washed with $KMnO_4$	110	more than 18 hrs.	700	more than 15 hrs.

* The quality of milk produced in all cases was fairly good because real bad milk reduces the colour of methylene-blue within 2 hours.

* This treatment is essentially similar to treatment VI but a separate trial on these lines had to be conducted side by side with treatment VII for comparative purposes.

bacterial counts, while the numbers are very much reduced when the pail is sterilized, foremilk is discarded and the tail is tied. Still better results are obtained if, in addition, the milker's hands and the cow's udder are washed with potassium permanganate solution. Within the scope of these trials treatment 4, gives the best quality of milk.

Marked differences in bacterial numbers and the reduction time of methylene-blue are found when the pails are either cleaned with mud or cowdung ash (Table II). Ash with its relatively low bacterial content and better germicidal property is found to be a much better material for cleaning the pails.

TABLE II

Showing the effect of cleaning milk pails with mud or ash on bacterial numbers in milk.

Treatments	College dairy samples.		*Gowala* samples.	
	Bact. per c.c.	Reduction time.	Bact. per c.c.	Reduction time.
1. *Balti* cleaned with mud	2600	10 hrs.	4800	8 hrs.
2. *Dohna* cleaned with mud	8400	8 ,,	6500	8 ,,
3. *Balti* cleaned with ash	1300	14 ,,	2200	7 ,,
4. *Dohna* cleaned with ash	1500	14 ,,	2300	7 ,,

N.B.—To prevent interference from other causes a few drops of pure milk were removed and the udder and hands washed with $KMnO_4$ (1 :200), in every case.

If the pails after cleaning with ash are kept inverted in the sun for a few hours the number of bacteria is very much reduced, *viz.*, 3-6 per ml., practically approaching the sterilized pails (Table III). Milk drawn in such pails with proper precautions (*cf.* Treatment No. VII) also shows much lower counts of bacteria (Table IV).

TABLE III

Showing relative bacterial counts in pails cleaned with ash and kept in the sun and in shade.

Treatments	Bacteria per c.c.	
	College dairy samples.	*Gowala* samples.
1. *Balti* kept in sun ...	6	18
2. *Dohna* kept in sun ...	3	8
3. *Balti* kept in shade ...	120	230
4. *Dohna* kept in shade ...	180	380

N.B.—200 c.c. of sterilized water were used for rinsing each pail.

TABLE IV

Showing the effect of pails cleaned with ash and kept in the sun (8 hours, maximum temperature 130°F) and in shade, on bacterial counts in milk.

Treatments	College dairy samples.		*Gowala* samples.	
	Bact. per c.c.	Reduction time.	Bact. per c.c.	Reduction time.
1. *Balti* kept in sun	70	14 hrs. over 18 hrs.	840	9 hrs.
2. *Dohna* kept in sun	75		760	9 ,,
3. *Balti* kept in shade	5100	10-12 hrs.	2200	7 ,,
4. *Dohna* kept in shade	6000	10-12 ,,	2300	7 ,,

N.B.—To prevent interference from other causes, a few drops of foremilk were discarded and the udder and hands washed with $KMnO_4$ (1 :2000), in every case.

Bacterial counts in *gowala's* samples are relatively higher than those in the dairy milk, apparently due to differences in the sanitary conditions of the two places. The general trend of results is however much the same in both the cases.

In order to determine the degree of effectiveness of such treatments the essential data were subjected to a critical statistical test and the analysis of variance worked out as shown in table V.

TABLE V

Analysis of Variance

Due to.	Degree of freedom.	Sum of squares.	Mean square.	Ratio of variance.
Replications ...	5	2128·6	425·720	...
Treatments ...	6	155491·2	25915·200	97·08
Error ...	30	8007·8	226·926	...
Total ...	41	165627·6	...	...

It is observed that the results are highly significant even at one per cent level. This would indicate that the differences are not mere chance variations but are actual expressions of the precautions taken. Furthermore to evaluate the relative significance of different treatments, critical difference has been calculated and the bacterial counts (actual numbers per c.c. have been divided by 100, to simplify the calculations) arranged in the order of the effects produced (*cf.* Table VI).

It is evident that treatments I, V and II are highly unhygienic. While a marked variation is apparent in the bacterial counts of milk under treatments IV, VII, III and VI, the differences are insignificant statistically.

TABLE VI

Treatments arranged in order of the effects produced.
Critical difference = 19·2.

Treatments.	IV	VII	III	VI	II	V	I
Bacterial Nos. per c.c./100	7	8	12·5	23	31·5	65	191

Economic depression together with ignorance of precise precautions has greatly impeded the hygienic production of milk in this country. Since elaborate devices for steaming and disinfection as advocated by foreign workers are not practicable in India, such simple and cheap precautions as the washing of milker's hands and the cow's udder with clean water or potassium permanganate solution discarding a few drops of the foremilk and cleaning the pails with ash and exposing these to the sun, etc., should prove very helpful in the production of clean milk. Since *gowala's* house depicted more closely the conditions of an Indian house-hold, statistical analysis has only been restricted to this set of experiments.

In fact these simple trials were conducted more for the purpose of providing figures that would appeal to an absolute novice than for scientific interest. On the basis of the experimental results it is claimed that if our *gowalas* and farmers could be persuaded to adopt these simple precautions, the production of high quality milk is possible in everyday practice even under our conditions of extremes of climate and of social and economic backwardness.

References.

1 *Proceedings*, (1940) Ind. Sc. Cong., 1940.
2 Thornton, H. R. (1937), *Jour. Dairy Sci., 20,* 693.

FORCING WATER INTO HUMAN BODY

A jet of water under pressure of 15,000 pounds per square inch, issuing from a tiny hole, may become part of cancer treatment in the future. This method of painlessly forcing water through the skin instead of using a hypodermic needle injection was reported by Drs G. Failla and T. R. Folsom.

Cancer yields more readily to X-ray treatment when distilled water has been injected to drown the cancer, as it were, after X-ray bombardment.

The idea of using a very fine, high-pressure jet of water came from reports of the injuries suffered by workers with high-pressure oils. The injuries were at a considerable depth from the surface of the body. The oil, emerging in a fine stream from a tiny hole, penetrated the body without the worker being aware of it. The method may be used, Dr Failla suggested, not only for getting distilled water into tumors in conjunction with X-ray treatment but also for injecting radioactive substances into the tissues.

The water jets penetrate the skin an inch or more, preliminary tests have shown. Skin offers considerable resistance to the jet as compared with other substances. The jet can penetrate raw potatoes, for example, to a depth of three or more inches.

Although the water jet can be used to introduce liquids into human tissues, Dr Failla says no "distinct superiority of the jet over the needle method" has appeared.

—*Science Digest.*

MEDICINE & PUBLIC HEALTH

Some Economic Features of Japanese Food

JAPANESE diet plays an important part in the economics of the people. The Japanese obtain the three essential constituents of food, namely, protein, carbohydrate and fat, from a dietary quite different from what is a rule in Europe or America. The sources and proportions, for instance, of protein as taken by the Japanese people may be seen from the table below, in comparison with those of the same substance as obtained by the Europeans from their daily dietary. The figures in the table are constructed with the normal human requirement of protein as 100.

JAPANESE.		EUROPEANS.	
Cereals and potatoes	44·9	Cereals and potatoes	42·3
Fish	18·5	Meat	22·1
Beans	18·3	Milk & dairy products	19·0
Others	18·3	Others	16·6
Total	100·0	*Total*	100·0

From the above, it will be seen that while the Europeans obtain protein chiefly from meat, milk, butter and cheese, the Japanese find the same food essential in fish and beans, protein in the latter's case being represented by soya beans in a predominant proportion.

In order to obtain a given amount of meat, milk and other dairy products one must give to the animals seven times as much quantity of protein of vegetable origin. The growing of livestock feed, therefore, is an important part of agricultural work in most European countries. One half and, sometimes even two-thirds, of the tillable acreage is placed under fodder and crops for animals. But fish and beans on which the Japanese people mainly depend for supply of one of the essential constituents of diet are grown by nature. Fish grow up in the sea. The soya beans happen to be one of the species which require no nitrogenous manure. The bacteria in their roots absorb nitrogen to produce one of the richest vegetable foods. As for fat the Japanese obtain it chiefly from vegetable articles of diet, and the amount taken is much beyond the biological requirements. The Europeans seek fat in foods of animal origin, and the amount they take generally far exceeds the amount really required for physical purposes. Living under one and the same price level, the Japanese spend 60 per cent less on their daily diet than the Europeans.

Operation in Blood Bath

A CAREFUL surgeon would no more neglect to drain off escaped blood while operating in the peritoneal cavity than he would operate with unsterilized instruments. Careful drainage helps to keep the cavity clean, and lessens risk of peritonitis, though instances are available of its developing after "dry" operations. A modification in this practice of surgery has been suggested as a result of manipulating a rush of patients for such an operation. During the Arab-Jewish riots of 1936 in Jerusalem, Dr Edward G. Joseph of Hadassah Hospital had many patients whose abdomens were badly shot up. Dr Joseph had not enough time to resort to drainage, and he operated in a blood bath, stitched up his patients' intestines, closed their abdomens without further ado. The victims recovered with no hint of peritonitis and the success suggested that free outpouring of blood in the peritoneal cavity might be of help rather than harmful. Dr Joseph has tried out his theory on dogs and rabbits, then further on humans. When he soiled the peritoneum without allowing bleeding, during an operation on the colon, eleven out of twelve animals developed peritonitis. When fresh blood was injected into the cavity, only one in four became infected and adhesions were notably few. On human patients 200 c.c. of blood run through a tube into the abdominal cavity at the end of the operation produced favourable recoveries. These findings are summarised in the July issue of *Lancet*.

Home Treatment for Syphilis

WITH the progress of medical research the chemical means to cure syphilis are available now but for its real conquest there is the problem of lining up the patients. Standard syphilis-destroyer is arsphenamine, the drug salvarsan ("606"), which Germany's Paul Ehrlich prepared 30 years ago.

Mercury and bismuth compounds are also useful. But all these drugs must be injected regularly over a long period (18 months to 2 years) and many patients dislike injections and monotonous visits to the doctor. When their gross symptoms disappear, they often abandon treatment forthwith, still harbouring the pale lurking spirochetes. A sensational new drip treatment which enables patients to assimilate massive doses of arsenicals a drop at a time through their veins provides a quick cure of early syphilis in some cases. An account of this was published on p. 47 of the July, 1940 issue of this journal. But in this method a patient must co-operate by staying in a hospital for five days.

Doctors have long wanted a syphilis antidote which can be taken (according to their instructions) by mouth, at home. *Time* reports the development of such a home treatment. The preventive value of bismuth for syphilis was made clear in the 1920's by Dr M. E. Sonnenberg of Poland, who gave bismuth injections to prostitutes for five years, and obtained 95% protection. For the past ten years, Dr Paul John Hanzlik and his co-workers at Stanford University have been working to put bismuth into practical anti-syphilis pills. Recently they settled on a soluble sodium bismuthate compound which they called "sobisminol". In most patients, two capsules of sobisminol taken with a glass of water three times a day for several weeks healed the surface disturbances and freed them of spirochetes. It also passed into the blood stream and attacked the spirochetes in the blood and tissues. Sobisminol also works as a prophylactic. Taken daily for at least three weeks, it protects against syphilitic infection after the first week. But Dr Hanzlik does not promise complete cures on the basis of sobisminol alone. He and other investigators believe its role for the present to shorten and minimize the course of injections.

Maternal Mortality in India

VERY little information was available regarding the causes of maternal morbidity and mortality in India. During the past few years under the auspices of the Indian Research Fund Association maternal mortality enquiries have been carried out in Calcutta and Bombay and another was in progress in 1939 in certain of the urban and rural areas of Delhi Province. As in other countries, puerperal sepsis appears to rank as the highest among the causes of maternal mortality.

Anaemia associated with pregnancy ranks as the next highest. In regard to eclampsia and toxaemias of pregnancy, their incidence appears to differ geographically. For instance, they are relatively rarer in north-eastern India than in the southern and eastern parts of the country. On the other hand, osteomalacia, producing conditions causing difficult labour, appears to have a definitely higher incidence in the Punjab, Kashmir and north-western India generally. Other investigations relating to maternal morbidity included a study of the toxaemias of pregnancy at the Seth G. S. Medical College, Bombay, enquiries into the anaemia of women in Assam and in Calcutta, and a study of the biochemical and dietetic factors concerned in the toxaemias of pregnancy at the King Edward Medical College, Lahore.

Tracing the Cause of Epidemic Dropsy

EPIDEMIC dropsy is a disease which is widely prevalent in north-eastern India, for instance, in Assam, Bengal, Bihar, Orissa and the eastern parts of the United Provinces. The cause of the disease was for long a mystery in spite of considerable research done on the subject.

It has been shown through epidemiological studies and the results of human feeding experiments, that the accidental contamination of mustard seed with the seed of a weed, *Argemone mexica*, (known as *sialkanta* in Bengal) which grows wild in the fields where the mustard plant is grown, seems to cause epidemic dropsy. The presence of argemone oil in mustard oil can be demonstrated by a colour change following the addition of nitric acid to the suspected oil, the intensity of colour giving an indication of the proportion of argemone to mustard oil in the mixture. Thus, from the point of view of epidemic dropsy as a public health problem, a considerable advance appears to have been made, because suspected oils can easily be tested and prevented from being sold to the public.

Further, it has been shown by experiments on animals that when argemone oil is heated till it "fumes" well, the toxicity of the oil becomes reduced to that of bland oils, like olive oil or liquid paraffin, although the heated oil still gives the positive nitric test. If these results obtained on animals are confirmed by observations in man, then the heating of the oil till it "fumes" would be a simple method of controlling the disease. This is particularly important in view of the custom prevalent in Bengal of using raw untreated oil in food and for anointing the body.

Endemic Fluorosis in Madras

IN Madras Presidency, a disease is widely prevalent characterised by stiffness and pain in the spinal

region and in the various joints. It has been shown to be be one of chronic fluorine intoxication resulting from the continued use of water containing fluorides. The problem of combating it is two-fold, namely, the prevalence of a comparatively wide geographical area of a dental condition, commonly known as "mottled enamel", and the occurrence in a restricted area, of severe manifestations of chronic fluorine intoxication involving the spine, joints and ligaments to which the name of endemic fluorosis has been given. Work is in progress to de-limit the fluoride areas in the province. The presence of mottled enamel in children has suggested a wide distribution of fluorides in drinking water supplies. As regards dietetic factors, in the prevention of this disease it has been observed that even with a high fluoride content of the water used for drinking and cooking, the incidence and severity of chronic fluorine intoxication is greatly influenced for the better by a well-balanced diet. With a comparatively lower fluorine content in the water, an insufficiency of vitamin C and a high calcium value in the diet results in a higher and more severe incidence of fluorine intoxication, even the younger adult age groups becoming affected; and in the absence of fluorides in the water, these dietetic deficiencies produce neither mottling of enamel nor bone manifestations.

Laboratory experiments on monkeys have confirmed these findings of the field survey. Two factors therefore appear to be important in the production of fluorine intoxication, *viz.*, the presence of fluorides in toxic doses and an unbalanced diet with a pronounced deficiency of vitamin C.

Research work at the King Institute, Guindy on the removal of fluorides from water has not been successful in evolving a cheap method for removing the salts for application under rural conditions. An attempt was then made to see whether a fluoride-free water could be obtained at depths greater than 30 to 35 feet, the normal depth of fluoride-bearing water in Nellore district. A borehole carried to a depth of 300 feet yielded water having a high fluoride content of 3·5 parts per million. The practical solution of the problem of endemic fluorosis should therefore with the present knowledge be sought by remedying the nutritional defects of the population.

Public Health as a Social Service*

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THE address in orienting public health as a social service traces the origin and evolution of the social services as such, particularly as exemplified in England; which, as the home of the Industrial Revolution and of Herbert Spencer, saw the birth of these services that now are world-wide. The Political and Economic Planning (PEP) *Report on British Social Services* (1937) defines social services as: "those services provided or financially assisted by a public authority which have as their object the enhancement of the personal welfare of the individual citizen." The definition of 'public health' to include social scope was first enunciated by Winslow (1920) and has since been modified as follows:—

> "*Public Health* is the science and art of social utilisation of scientific knowledge for medical protection by maintaining health, preventing disease, and curing disease *through organised community* for (*a*) the hygiene of the environment; (*b*) the control of community disease; (*c*) the organisation of medical and nursing service for the early diagnosis and preventive treatment of disease in the individual; (*d*) the education of the individual in principles of personal hygiene and of preventive medicine; and (*e*) the development of the social machinery which will ensure to every individual in the community a standard of living adequate for the maintenance of health As such, public health becomes social medicine and is primarily a field of social service, applying practically every basic science directed towards a comprehensive programme of community welfare."

Public health activities 30 years ago were actuated by either or both fear of epidemics and humanitarianism, with limitation of scope largely to control of environmental hygiene and of communicable diseases. Social service became assured in governmental function only in this century and largely since 1914-18. The justification of social service is economic.

The specific question explored in the address is whether public health, in addition to its previous epidemic and humanitarian motives, possesses a social economic basis and, if so, what is the present orientation; and, particularly, whether it has reached the stage of evolution as either a discipline

* Adapted from Dr John B. Grant's Basanta Lecture delivered on September 26 and 27, 1940, at Calcutta University and published with the permission of the University.

or an art to permit postulating principles upon which depends successful administration? The percentage decrease in the death rate from tuberculosis in England and Wales from 1851-1938 was one of the illustrations taken to show the inter-relationship between and dependence of public health upon other social fields than the medical. In England tuberculosis regulations and the community medical machinery for tuberculosis control did not come into effect until 1912 while the decrease in the death rate was proportionately greater between 1851 and 1911 due to improvement in the social-economic condition than after specific anti-tuberculosis measures were begun.

Modern sociology is defined as the 'science' of the origin, growth, structure and function of society. It is on the verge of becoming the art and practice of the collective will of society to procure the fullest potentialities of life from the application of knowledge of the natural sciences through the administrative channels of social services. But as yet only an empirical and ineffective stage of government has been reached and thus corroborating the conclusion that society represents an organism of low degree or a stage of development at which in the animal world the germs of an intellectual faculty are just perceptible. It is universally acknowledged that the immediate and pressing social problem confronting the welfare of the world is to overtake the lag between modern knowledge and its community utilisation. However in spite of the lag in the theoretical desiderata, there has been a relatively significant beginning of social services and without which there could not be the present expression of dissatisfaction with the progress made in terms of that desired. The lag in public health is ascribed to five causes. The outstanding cause of the lag is the absence of scientific *investigation of methods* to apply the results of pure research to groups of population. The four other causes of the lag are: the absence of a public opinion educated in the maintenance of health and the prevention of disease; inadequate economic considerations in planning of administration; the lack of adherence to six essential administrative principles; and finally, the absence of personnel trained in community application of the methodology resulting from scientific investigation. The address amplified the five causes of the lag through detailed exemplifications and indicated steps being undertaken internationally in solution of their causes.

The main point brought out in the address is the unscientific nature of present public health administration as a social service. General principles enunciated by Bernal and Huxley were quoted as to steps necessary for the social services to become scientific, particularly Huxley's requirement for experimentation in methodology based upon determined principles. The address then, in terms of these general requirements and of experience in public health itself, lays down six postulates for public health administration as a science. These are the interdependence of social services; the achievement of maintenance of health only through the people being themselves possessed of adequate education in and practice of knowledge; the necessity for the administration of special functions being undertaken only by a single governing body; the necessity for compromise in social progress but in terms of the whole design being before the mind; the requirement that administrative procedure must be based upon sound economic consideration and practicable financial budgetting; and, the requirement of personnel trained in administrative methods scientifically derived. This initial enunciaton of postulates for any social service administration continues through elaborating each of the postulates.

No single field of social welfare can independently function effectively. This first principle of horizontal articulation is based upon experience of results of social planning. Society is composed of population with a biological heritage, natural resources or the physical heritage, and technical arts or the cultural heritage. Not only must the planned society integrate these three factors but social service implies the correlation of the technical arts themselves. The progress of each is mutually dependent on the average level of progress of all other social fields. Public health cannot progress beyond the effectiveness of education; agriculture beyond communications. The organisation of medicine is inseparable from the social-economic organisation of the community in which it functions. Interdependence of social services is the *first* postulate.

The second fact of medical social service administration is that successful community utilisation of knowledge for medical protection is dependent upon the two fundamental factors: economic-political and education. The development of economic-political is not discussed being beyond the scope of the address.

The *second* postulate is that the final positive goal of maintenance of health can only be achieved by the people themselves through being possessed of adequate education in and practice of health knowledge. The address gave details of the manner in which compulsory education in the United States and England was orienting rapidly towards positive education for citizenship participation, together with

illustrations of the resultant abilities for maintenance of health.

The British Ministry of Reconstruction (1919) called attention in the following words to the defects that had grown up over 70 years in the English Administration:

> "It has been the vice of our organisation of the machinery of government that the separate provinces of government activity have been carved out, or permitted to develop, not to fulfil a special purpose for all sections of the population, but to fulfil all purposes for a special section. It is not surprising, in view of the fundamental importance of the national health in all relations of life, that, for each special section of the population in turn, progress in Government activity should discover the necessity for action in matters of health. In the absence of a Ministry of Health, the Departments concerned with each special section retained and developed their own responsibility by means of independent and water-tight machinery; while in every such section the specialised health provision thus established rapidly became full of duplication and overlapping."

The foregoing was formulated by Sir Arthur Newsholme into the following *third* postulate; "Good administration requires that when a special function is to be undertaken it should be undertaken by one governing body for the whole community needing the service, and not for different sections of the community by several governing bodies."

This necessity for co-ordination and unity of purpose under one administration will be successful in proportion to fulfilment of certain secondary administrative requirement. Organisation must be in graded units from the polyvalent primary units at the periphery to the base at the top providing specialized function and supervision. Specialised supervision is the key to successful polyvalent peripheral activities. Methodology must be scientifically derived and administered by personnel who are trained through self-participation in the methodology to be administered, and with opportunity for regular periods of refresher training. Administration itself must be checked periodically for efficiency by routine use of appraisals. Centralized direction and decentralized activity is the basis of sound administration upon the principle that too great decentralization limits competence while too great centralization results in ultimate weakness.

An inexorable law is that social change never unfortunately takes place through planned comprehensive schemes but piecemeal, here and there, now and then, by trial-and-error and opportunistically. The necessity for administrative acknowledgement of compromise constitutes the *fourth* postulate. This principle is so essential to the initiation of new activities but so little, if ever, appreciated by academic theorists inexperienced in bringing new community machinery into existence that, for their benefit, the statement of fact must be supported by authority. The principle has been lucidly expressed by Lord Lytton who, after his return from the viceroyalty of India in 1882 wrote the following:

> "The basis of all government, whatever the form of it, and the object of all statesmanship, whatever the direction of it, must always be *expediency*, and expediency alone—nothing more and nothing less—what is expedient, in other words what is good for the entire community, with which a Government is concerned. All that is inexpedient for the community, regarded in all its parts and all its interests, *prospective* as well as present, is bad in government and false in politics. The test of right or wrong is not truth or falsehood, but good or evil. All political action is good or bad, right or wrong, according to its consistency not with theory but with *circumstance*. For circumstances are the only things which Government has to deal with."

> "Those human circumstances are not simple, uniform and consistent but infinitely various, fluctuating and divergent. We cannot apply to courses of political action or administrative work the methods which are applicable to trains of reasoning or research; the object of these latter is to arrive at abstract truth, of the former to bring about good of a particular multitude of human beings, whose condition is extremely composite and whose interests are rarely identical."

> "Divine right of royal or other ruling powers *or* the doctrine of the Rights of Man and Equality of all classes are equally untrue. Government is neither more nor less than the trustee and guardian of the collective interests of a State . . . institutions are not made, they grow; not logical, simple or symmetrical, but various, intricate and full of salutary anomalies."

It is only the academic theorist who projects whole schemes with the expectation of their immediate community fulfilment. Shaw has said the same thing in "Nothing is ever done and much is prevented by people who do not realize they cannot do everything at once". Lord Lytton's experience is resolved by Sir George Newman in *Building of a Nation's Health* (1939), into the following specific recommendations

to the medical social service administrator, of which three are pertinent to the point in question:—

(*i*) Every scheme should express a standard of objective and workmanship which constitutes something in the nature of a national minimum of what is both necessary and practicable in all areas, rather than what might be ideal or desirable if carried out by the most enlightened and competent Local Authorities; such public and representative bodies prefer to feel that there is ample room left for local volition and elasticity;

(*ii*) The undertaking only of what is immediately practical and obviously beneficial or advantageous, rather than the adoption of a medical system of higher scientific value and statistical accuracy but less prompt in returns and less obviously ameliorative or remedial in purpose;

(*iii*) In health statecraft, central or local, medicine takes not an incidental but an essential share, but it is not always para-remedial in purpose;

This fourth principle of the necessity in social progress for compromise between theory and practicability of application results in two ancillary facts to be borne in mind. More immediate progress can be assured through the successful community demonstration of a quarter of one principle than through the abstract enunciation of 100 principles. And, compromise can be successfully entered upon only provided that in so doing the whole design is before the mind.

The results of social service administration are proportionate to the economic soundness of expenditure planning and consequent varying methodology of technical implementation. Much of the ineffectiveness of administration is the result of violation of this principle. It is obvious that there can be no results if a medical service for school health in India, with its annual per capital income of Rs. 65, is planned on the same administrative basis as for England—a country with an annual per capita income of £76 (1931) and where the medical service alone costs 7*s*. per capita of school population per annum. The consequent methodology problem must first be solved in India before there can be a significant school health programme. The solution lies in the development of methodology whereby the facilities purchased at a cost elsewhere of 7*s*. per capita, can be applied locally within economic practicability. This can and has been done in countries of relatively low economic standard. This principle is so significant that it justifies illustration. This is taken from China.

The community teaching field established under the Medical College in Peking developed methodology of school health on two economic standards. An 'A' service to demonstrate technical measures common in the West was provided entirely through cash purchase at a cost of Chinese dollars 2·41 per school child per annum (1934). This, however, was impracticable of extension under Chinese economic conditions. Consequently, a 'B' service was developed at 64 cent per capita per annum, which was economically practicable. The latter programme was developed on the basis that the essential measures should be undertaken by voluntary effort of the teachers and the pupils themselves and that cash purchase should be limited to provision of supplies and of technical supervision by the medical officer and the school nurse. This applied to each of the three administrative sections, *viz.*, sanitation, medical service, and health education. The practical essentials are water and sanitary toilets in sanitation; routine appraisal measures of the individual pupil's health and prophylactic vaccinations under medical service, together with correction of acute remedial defects; and, the integration of healthful living and of health knowledge with actual living of the pupil in health education. It was shown that responsibility for the bulk of routines of the school health service could be placed upon the teachers and the pupils provided two essentials were adhered to. These were to train the teachers and to provide adequate supervision of the established routines by the medical officer and the nurse. Teachers appointed in each school in charge of health were designated for special training in a special session during vacations. These summer 'institutes' had practice schools attached with demonstration of health services in the latter, which were also provided in the 'institutes' for the teachers themselves. Teachers were thus given opportunity to instruct themselves in the measures of school health through self-participation as well as being provided with theoretical instruction. The result was provision to the schools of persons competent to be responsible for the categories of measures indicated above. This applied not only to the sanitation of the school environment but the teacher could vaccinate as well as undertake the routines of simple treatments including trachoma; and, he supervised the pupils in their practice of health habits, periodical weighing etc., that the latter undertook themselves through a system of health monitor-ships. Supervision was provided through either the school nurse or the medical officer visiting the school weekly, except when special measures had to be undertaken beyond the capacity of the teacher or the students. This description is sufficient to illustrate that the bulk of the essentials of a school health service can be

discharged through local voluntary efforts rather than through cash purchase, freeing the latter for making available the required technical supervision and medical supplies. In this manner the fundamentals of a service at a cost of Chinese dollars 2·41 and dependent entirely upon purchase was provided for 64 cents through utilisation of trained voluntary effort under technical supervision. But a different administrative methodology had to be devised upon the amount of available cash and which differed greatly in detail, although not in principle, from administration of the school health service provided entirely through cash purchase. Also, utilization of this principle requires that the administrative area is large enough to be self-contained. Obviously a summer institute for teachers would not be justifiable for ten schools only.

The *fifth* postulate is that administrative procedure must be based upon sound economic budgeting. The corollary is that public health administration becomes successful in proportion to the extent of self-participation, directly or indirectly, by the citizen. This fact increases in importance with the lesser economic ability of the community to make cash purchase of medical protection. Control of malaria in Panama is effectively undertaken solely through cash purchase, which is entirely impracticable in Bengal. The social complexity in industrially advanced communities necessitates specialization and cash purchase which however can be substituted through 'self-help' or voluntary effort in the relative simplicity of agricultural communities.

Finally, the *sixth* postulate is that administration will be effective to the extent that methodology has been developed inductively through controlled experimental communities and is administered by personnel trained specifically in the methods. Failure in this principle constitutes the single most important factor for the lag between development of knowledge in the natural sciences and the community utilisation of such knowledge. The reasons for this are elaborated elsewhere.

The purpose of the development of methodology is to assure practicability and fullest efficiency of community utilisation of the results of *pure* research. Utilisation of methodology implies personnel trained in the successful methods. Social administration is effective in proportion to the extent that there is planned correlation and co-ordination between academic research and training and administration.

Training in public health is the most emergent branch of medical education as should be expected from the fluid picture of practice reported in this address. The function of investigation and instruction in public health is the demonstration of the most efficient and practicable METHODS of scientific medical protection through organised community effort and the provision of opportunity for students *to train themselves in* the principles and application of these principles and methods. Both the investigative and the training functions demand the provision of controlled community areas of a size sufficient to permit exemplification of self-contained administrative methods, and to provide quality and quantitative facilities for students' self-participation.

Social background and its relation to public health and disease constitutes no part of medical education as yet although it is now obvious they should be as much as bacteriology or surgery. Perusal of the dicta in the past two decades emanating from such organisations as the General Medical Council of Great Britain, or the Association of American Medical Colleges, reveals that the major recommendation is the necessity for incorporation in the medical curriculum of the preventive and public health aspects of medical knowledge. So far the results of these recommendations are nominal not only because of the vested interests of the older-established subjects but because the recommendations have almost entirely ignored suggestions for the specific means for their implementation. This failure is due to the absence of social experience on the part of the present 'elder statesman' of medical education, who have reached their present senior positions without opportunity for personal experience in undertaking the principle they are recommending, although they can now see its importance. However, this failure seems inexplicable in the light of the prescription by the same body of adequate self-participative facilities for instruction in the pre-clinical and clinical branches of medicine. In fact, today such facilities have almost reached standardisation of what is deemed satisfactory provision. Yet, educators have not seen that adequate facilities for instruction in public health to either the undergraduate or graduate student can be assured only on the same principle as that already followed in pre-clinical and clinical instruction through the provision of opportunity for self-participative instruction in community fields under control of the teachers.

The address concludes with the significant statement that the efficacy of national health administration in assuring medical protection must be in proportion to its fulfilment of the six postulates enumerated; thereby providing a yardstick to measure the soundness of any local administrative policy.

Diet Surveys in India

In a note prepared for the meeting of the Nutrition Advisory Committee of the Indian Research Fund Association in December, 1939, Dr W. R. Aykroyd, M.D., D.Sc., Director of the Nutrition Research Laboratories, I.R.F.A., Coonoor, summarised the results of over 50 surveys carried out in different parts of India. The Committee recommended that the existing information about the foodstuff composition of diets should be made available for agricultural and animal husbandry departments and utilised as a guide to agricultural policy. Further information on rice diets is available from the Government of India *Health Bulletin* No. 28, summarised from the *Indian Medical Research Memoir* No. 32, recently published (1940).

The surveys included a careful quantitative investigation of all the foods consumed by a group of families—usually about 20—and each survey lasted for a period of 10 to 20 days. This involved daily house to house visits in which all foodstuffs were weighed. At some places surveys were repeated at different seasons. Intake per consumption unit (*i.e.*, per adult man value) of calories, protein, various mineral elements and vitamins have been worked out and, in addition, the average composition of the diets as regards actual foodstuffs determined. It is the latter which is of the greatest value in connection with agricultural policy.

The information already available does however provide a picture of dietary habits over a large part of India. Most of the families investigated belonged to the poorer classes and their diet is typical of that consumed throughout the year by millions in the areas in which the surveys were carried out. While the kinds of pulses, vegetables, etc., taken by the people naturally differ from place to place, in general the nutritive value of different varieties coming under the various headings is fairly similar. Thus, leafy vegetables as a group are rich in vitamin A and calcium, and all vegetable fats and oils consumed in India are devoid of vitamin A activity, and so on. Any differences in the nutritive value of different varieties of the supplementary foodstuffs, which are usually included in the diet in very small quantities, are important in relation to the diet as a whole.

RICE DIET

The majority of surveys have been carried out in rice-eating areas. The important fact emerges that the diet of the poor rice-eater is very similar all over India. He consumes, in addition to his staple cereal which supplies 80-90 per cent of total calories, very small quantities of other foods such as pulses, vegetables, fruits and meat. Milk and milk products are taken in negligible quantities or not at all.

The "actual" diet of the poor rice-eater in India is represented semi-diagrammatically in Table 1. A well-balanced diet, resembling diets recommended by the Laboratories, is included for purposes of comparison.

TABLE 1.

THE "ACTUAL" DIET OF THE RICE-EATER AND A "WELL-BALANCED" DIET.

(Ozs. per consumption unit per day).

Food.	*"Actual" diet.*	*"Well-balanced" diet.*
Rice	15·25	15
Pulses	0·5-1·5	3
Milk	None or negligible amounts	8
Leafy vegetables ...	0·5-1·0	3·4
Non-leafy vegetables ...	2·0-5·0	6
Fruit	negligible	2
Vegetable fats & oils ...	Less than 1·0	2
Fish, meat and eggs ...	0·5-1·0	3 (when milk is absent from the diet or taken in negligible quantities).

(with condiments and spicees in small quantities.)

Rice: If the composition of the "actual" diet is worked out in terms of protein, minerals and vitamins, and the results compared with the standards suggested by the League of Nations Technical Commission on Nutrition and other standards drawn up by physiologists, it is found that the rice-eater's diet falls short of such standards in almost every important constituent. Rice however supplies 80-90 per cent of total calories, and the nutritive value of the diet as a whole is in certain respects dependent on that of the main ingredient. Improvement in the nutritive value of rice is therefore desirable. How can this be accomplished? Certain workers consider that the development, cultivation and popularisation of strains of high nutritive value constitute a promising line of attack. Results so far achieved in this direction do not, however, suggest that any striking success is likely to be obtained by this

method of approach. No amount of selective ingenuity could produce a rice which was a rich source of calcium and vitamin A in relation to human requirements. Rice must always be defective in certain essential food elements whatever be the botanical variety or method of cultivation. This question has been fully discussed in an I.R.F.A. *memoir* published from the Laboratories, entitled *The Rice Problem in India*. Sir John Russell, in his report on agriculture in India has remarked, "In dealing with food crops intended for home consumption the agriculturist should aim at securing the largest and healthiest crops possible, but he need not concern himself with trying to change their composition. The amount of alteration possible is too small to justify the expenditure of time and resources that can better be spent in other ways".

On the other hand, the content of rice in certain important food factors, is greatly affected by milling, washing and cooking. The easiest way of raising the nutritive value of rice as consumed is by minimising the losses brought about by these processes. Parboiled rice, which retains certain vitamins in considerable quantities even when highly milled, is to be preferred to raw rice. The task of ensuring that rice loses as little nutritive value as possible during preparation concerns public health and educational rather than agricultural authorities. It has been fully considered in the *memoir* referred to. Whole wheat and the various millets have a higher nutritive value than milled rice, and the partial substitution of rice by one or other of these foods improves poor rice diets. This has been demonstrated by animal experiments. It is therefore desirable that the consumption of wheat and millet should be encouraged in rice-eating areas. As regards agricultural policy, this presumably means that special attention should be given to increasing the yields and extending the production of these cereals. The cultivation of wheat in India is limited by climatic conditions but the millets are grown all over the country. They tend however to be regarded as secondary in importance to rice, and are often considered to be an inferior type of food. "Grow and eat more millet" would be a slogan very acceptable to the nutrition worker.

Pulses: The rice-eater's intake of pulses falls short of what is desirable in the circumstances. Pulses supply some of the food factors in which rice is deficient, and constitute a valuable supplement when the diet is based largely on raw milled rice. Agricultural departments in rice-eating provinces should aim at increasing the cultivation of pulses by developing improved varieties, etc. The type of pulse is not of particular importance, since there is not much difference in the nutritive value of the various species.

Milk: In the majority of the rice-eating groups investigated, the intake of milk, which of all foods, most effectively supplements the poor rice-eater's diet, was negligible, and in striking contrast to the suggested standard of 8 ozs. daily. Wright in his report on dairy improvement has estimated the total milk production of India as amounting to 8 ozs. per capita daily. This figure may however give a false impression of the amount of milk consumed in many parts of the country. For practical purposes the poor rice-eater consumes no milk at all.

Leafy vegetables: Leafy vegetables are particularly valuable supplements to poor rice diets since they are rich in vitamins A and C and calcium. The surveys have shown that intake is everywhere far below the desirable level. Agricultural departments should therefore take up the study of leafy vegetables and endeavour to increase their production. The commonest and cheapest varieties are usually as valuable as the more expensive.

Non-leafy vegetables: Intake of non-leafy vegetables showed considerable variation in the different provinces. In some it almost reached the standard recommended ; in the majority, however it was well below this level. While the value of leafy vegetables must be particularly emphasised, there is no doubt that a greater consumption of vegetables of any kind would improve standards of nutrition in India. On this point the Russell Report may be quoted: "Much more work should be done on the cultivation of green leafy vegetables and demonstration fruit and vegetable gardens should be set up adjacent to the villages where they can receive manure and water. A marked extension of vegetable growing is very desirable."

"Special emphasis may be laid on the development of kitchen gardens in villages. The latter has been strongly recommended by the Nutrition Research Laboratories and is now part of the programme of Health Units, etc., working among village populations. In some places considerable successes have been achieved. The villager in many parts of India is not interested in growing vegetables even when land and water for this purpose are available. Education and propaganda are required to teach him the value of vegetables as food and to persuade him to grow these for his own use when circumstances permit. More attention might be given to vegetable growing by agricultural research workers and departments."

Fruits: Consumption of fruit was in general negligible in the groups investigated. Fruits are

rich in various vitamins which are present in insufficient quantities in the poor rice-eater's diet. Mangoes, papaws, tomatoes and oranges are of particular value. Emphasis may be placed on the tomato, a cheap food of high nutritive quality which is being successfully popularised in certain parts of India.

Vegetable oils and fats: The rice-eater's diet is normally very poor in fat and intake is often below 20 grammes daily. This is far below the standards of fat intake usually recommended. While it is not clear whether a low consumption of fat tends *per se* to produce ill effects on the body, it is reasonable to suggest that intake of vegetable fats and oils could with advantage be raised. An increased production of oil seeds by selective and other methods is therefore desirable.

Fish, eggs and meat: In general fish is a food of considerable value in supplementing poor rice diets. Fish muscle can supply various important food factors and small fish, when eaten whole, are particularly valuable because they are rich in calcium. The fishing industry in India is in a very backward condition and a large potential source of good food remains untapped. The yield is a mere fraction of that which could be obtained if efficient methods such as those followed in Europe and Japan were applied. The industry is handicapped by the fact that it is almost wholly in the hands of poverty-stricken fishermen who are unable because of ignorance and lack of capital to take advantage of new and improved methods. Problems of transport, refrigeration, marketing, etc., require a great deal of investigation. It is a pity that at present so little attention is being paid to the development of fisheries because a greater intake of fish would unquestionably do something to improve standards of nutrition in India. Eggs have a nutritive value roughly similar to that of milk and an increase in production is to be recommended for the same reasons. Meat forms a very small part of typical Indian diets and in the existing economic circumstances there is little prospect of a material increase in meat supply.

Sugar and Jaggery: The sugar intake of most of the rural rice-eating groups was nil or negligible. The industrial groups in Bihar consumed sugar under 1 oz. a day. The intake of the families in Delhi province and of the Bombay workers was a little above this level. In South India consumption of sugar and jaggery in general is very small. These figures suggest that the recent increase in sugar production in India has not yet been reflected in a substantial intake of sugar on the part of the poorer classes. Sugar is a useful food in that it is a concentrated source of energy ; it is, however, pure carbohydrate and does not contain the food factors which are most needed to supplement Indian diets. An increase in sugar intake is no doubt desirable, but it cannot be regarded as highly important from the standpoint of nutrition.

MILLET DIET

So far only one millet-eating group in Mysore has been surveyed. Ragi (*Eleusine coracana*) was the type of millet consumed. A study of diet, which is probably typical of millet diets throughout India, shows that its composition, apart from the staple cereal, is similar to that of typical rice diets. While millet diets are of higher nutritive value than rice diets because of the superiority of the staple itself, the former can be improved by supplementary foods in sufficient quantities in much the same way as rice diets. The recommendations with regard to milk, vegetables, fruit, etc., thus apply equally to millet diets.

WHEAT DIET

A relatively high intake of milk and milk products and pulses was characteristic of the groups whose chief cereal was wheat. Whole wheat itself is of higher nutritive value than rice as ordinarily consumed, and wheat diets in India are more satisfactory as regards general composition than rice diets. The amount of vegetables and fruit included in the wheat diet was however too low. If these diets can be regarded as typical of wheat-eating areas in general, it is clear that a greater production of vegetables and fruit should be one of the chief aims of agricultural policy in such areas. The low consumption of vegetable oil and meat is offset by the fairly high consumption of milk and ghee, which nevertheless fall short of the standard recommended in certain of the groups.

TAPIOCA DIET

Tapioca is consumed as a staple food only in Travancore. One survey has been carried out in this State. It was found that the diet of a typical village group was based on both tapioca and rice, the former being consumed in greater quantities. Tapioca has a very low protein content, and in tapioca-eating areas there is a special need for foods rich in proteins of high biological value, such as

milk, fish or meat. Intake of vegetables and fruit was found to be satisfactory in the area surveyed. A diet based largely on tapioca should be supplemented by at least 3 ozs. of pulses daily ; this quantity was not consumed by the group studied. Most of the tapioca-eating areas are adjacent to the coast and advantage should be taken of this to increase fish intake in these areas.

The investigations reported in this note are in line with the following recommendation in the Russell Report :

"The first need in my view is to make a nutrition survey in each province so as to discover what are the chief deficiencies in dietary ; the medical authorities should then meet the agricultural experts to decide what crops, including fruits and vegetables, should be grown to supply the missing elements. The approximate quantities needed should be indicated, and the agricultural staffs acting along with the rural development authorities should then encourage by all means in their power the growth of these crops".

Let us hope that the programme outlined above should be soon carried out by the proper government agencies.

EFFECT OF SMOKE POLLUTION ON HEALTH

Measurements of daylight in the industrial areas has shown that a considerable amount of visible light as well as a large part of the ultra-violet light is effectively cut off by the smoke clouds in the atmosphere. It is mainly the loss of the ultra-violet light, which sometimes amounts to about 90 per cent, that is injurious to health. Lime is not deposited in sufficient quantities in bones, when there is not enough ultra-violet light falling on human bodies. Children who do not get sufficient amount of ultra-violet light develop rickets. The loss of ultra-violet light also brings about a deficiency of vitamins in the blood, which are so much necessary for the building up of the nerve tissues of our bodies and the stimulation of our blood-cells.

The lack of ultra-violet light affects the vegetation as well as the animals. The clogging of the stomata by the deposit of dark coloured sooty matter further reduces the poor ultra-violet light reaching the leaf tissues. Cows fed on this vegetation yield milk poor in lime salts and children fed on this milk again are deprived of the nourishing matter, lime.

—*Journal of the Gujarat Research Society.*

Research Notes

Inhibition of the "Succinoxidase System" with Extracts of Tumours and Normal Tissues

THE "succinoxidase" system has been found to play a fundamental rôle in cellular respiration. Various investigations have been made to study the distribution of "succinoxidase" in normal and pathological tissues. The succinoxidase activity of certain tumour was found to be very low. R. A. C. Elliott (*Biochem. Jour., 34,* 1134, 1940) has recently made some interesting investigations to explain this low activity. It has been found that the oxidation of succinate by liver suspension was rapidly and almost completely inhibited by the presence of suspensions or extracts of Walker 256 Carcinoma and Philadelphia No. 1 Sarcoma and less actively by Jensen Sarcoma. The inhibitory effect was also shown by some normal tissues, especially pancreas and spleen. Commercial trypsin also inhibits to some extent. The inhibitor is thermolabile and non-dialysable. It acts on the "succinoxidase" system in a progressive manner, the inhibiton increasing with time.

It is now generally accepted that the "succinoxidase" consists of at least three components, dehydrogenase, cytochrome and cytochrome oxidase. The dehydrogenase causes succinate to reduce cytochrome and the reduced cytochrome is reoxidised by cytochrome oxidase. The succinic dehydrogenase and the cytochrome oxidase are both inhibited by tumour extracts. But this is not strong enough to account for the total inhibitory effect on the "succinoxidase" system of liver. Cytochrome c is unaffected. It is thus concluded that the inhibitor acts on some other component, possibly cytochrome b. The "succinoxidase" activity of brain, muscle and kidney is affected similarly to liver suspensions. But the "succinoxidase" activity of heart suspensions is not at all affected and tumour extracts accelerate the succinate oxidation with heart suspensions in presense of added cytochrome c.

P. K. S.

Thiamine (vitamin B_1) in Citric Acid Metabolism

KREBS and others have shown that citric acid plays an important rôle in the metabolism of carbohydrate. This cycle involves two oxidative decarboxylation processes. The first is involved in the synthesis of citric acid from pyruvic acid and 4-carbon dicarboxylic acid and the other is required for the conversion of ketoglutaric acid and succinic acid. It is already known that pyruvic acid is one of the most reactive intermediates in carbohydrate metabolism and co-carboxylase (thiamine pyrophosphate) is essential for the oxidation of pyruvic acid, but no conclusive evidence has yet been furnished to show that co-carboxylase is essential for the synthesis of citric acid. Recently Sober, Lipton and Elvehjem (*J. Biol. Chem. 134,* 605; 1940) have made an attempt to show that perhaps thiamine is essential for the synthesis of citric acid. The evidences furnished by these investigators show that during vitamin B_1 deficiency in rats, urinary excretion of citric acid is appreciably decreased. Further, this citric acid excretion is independent of the inanition accompanying the deficiency. It has also been observed that rats suffering from thiamine deficiency show a decreased ability to synthesise citric acid from injected succinic acid. A 10-fold rise in citric acid excretion in rats has been observed by these workers when thiamine was administered to deficient rats. These results suggest the possibility that co-carboxylase functions in the metabolism of citric acid in the body.

B. G.

Iron-Porphyrin Compounds and Haemocyanin

THE theory of cellular respiration states that oxygen after being activated by the respiratory ferment, cytochrome system, reacts with hydrogen atoms of the metabolites which have been activated by substrates, specific dehydrogenase systems. The latter process consists in the transfer of hydrogen atoms from the substrates to pyridine co-enzymes

under the influence of catalytically active proteins. The actual oxidising agent in cellular respiration is not molecular oxygen but the ferric iron of the Warburg-Keilin system and the function of oxygen consists in the re-oxidation of the ferrous iron formed by the reaction with hydrogen. Now, the iron of the Warburg-Keilin system belongs to iron-porphyrin nucleus which possesses the interesting property of forming three sorts of compounds each of them playing a fundamental part in cellular respiration. Iron-porphyrin may unite with (*i*) a protein and thus combine reversibly with molecular oxygen without electron exchange (haemoglobin, myoglobin etc.), or may combine with (*ii*) a protein forming a sluggish oxidation-reduction system, non-autoxidisable (cytochrome *c* and possibly other cytochromes) or, with (*iii*) nitrogenous compounds giving autoxidisable electro-active systems (haemochromogens, Keilin's 'cytochrome oxidase'). Thus iron-porphyrin compounds may act as mediators between activated substrates and electro-active systems and as final mediators with molecular oxygen.

Ball and Meyerhof in a very interesting paper on the occurrence of iron-porphyrin compounds and succinic dehydrogenase in marine organisms possessing the copper-containing blood pigment, hemocyanin, (*J. Biol. Chem. 134*, 483, 1940) have shown that this pigment also functions in a manner similar to the iron blood pigment. This copper blood pigment has not yet been observed to play any part in the process of oxygen utilization by mammalian tissues which proceeds through a chain of iron-porphyrin compounds composed of a haemoglobin, myoglobin, cytochrome a, b, and c.

Of the marine animals studied, four (*Limulus polyphemus*, *Busycon canaliculatum*, *Homarus americanus* and *Loligo pealii*) possess hemocyanin as blood pigment. They also contain such iron-porphyrin compounds as myoglobin and cytochrome. Cytochrome oxidase and the three cytochromes are present in the heart and some body muscles of all these organisms. All tissues of these animals possessing the cytochrome system are also found to be rich in succinic dehydrogenase which is intimately bound up with it and the general respiratory cycle of mammalian tissues. It is therefore concluded that the process of oxygen utilisation in these organisms is similar to that in mammals except for the substitution of haemocyanin for haemoglobin. The reason for the utilisation of copper instead of iron by these organisms to form their blood pigment cannot be ascribed to the inability of these animals to utilise iron or to synthesise the porphyrin prosthetic group characteristic of the iron blood pigments. Why animals like *Busycon* should employ haemocyanin for a blood pigment and yet possess muscles rich in the pigment myoglobin, which is very much akin to haemoglobin, is indeed of profound interest and requires to be further elucidated.

S. R.

Factors Influencing the Absorption of Iron and Copper From the Alimentary Tract

ALTHOUGH the importance of iron regarding haemoglobin formation and regeneration has long been recognised, the actual form in which it is present in food-stuffs and the exact mechanism in which it is absorbed by the system have given rise to considerable speculation. Some suggest that ferric iron as such is not absorbed by the system but must first be reduced to the ferrous state in the intestine which contains easily oxidisable materials and has a low oxygen tension. Other workers believe that ferric Fe can be absorbed as easily as ferrous Fe and produces as good a haemoglobin regeneration as ferrous iron.

Tompsett (*Biochem. Jour., 34*, 961, 1940) states that as the ferric iron becomes non-dialysable and nonextractable with trichloroacetic acid due to the formation of complexes with phosphatide and phosphoproteins present in the food-stuff, it is probable that it is not absorbed as such. Before absorption the ferric iron is first reduced to the ferrous state and this reduction takes place in the stomach by a vitamin like ascorbic acid or by protein. According to the author, as the reduction takes place in acid medium, the gastric acidity of the stomach plays a very important role in the absorption of Fe.

Absorption of copper on the other hand is not inhibited by the presence of phosphoproteins and phosphatides in the diet. From the results obtained by the author it is clear, that the absorption of Cu and Fe is higher on a low calcium diet than on a high calcium diet and is increased by the addition of acid to the diet.

K. C. S.

LETTERS TO THE EDITOR

Socio-Biological Causes of the Fall of France

In recent months the world has had the misfortune of witnessing the fall of the Great French Empire to the Germanic hordes and its slow capitulation under the iron heel of the Nazi. We have been told that the French were taken unawares by being outflanked from the Belgian side where there was no Maginot Line, that the German forces were superior to the French forces in man-power and machinery and that there was treachery on account of the existence of the fifth-columnists in their midst. More than any others it is perhaps the last item that is the most noteworthy.

If we look back into the Hall of History, we can find many nations that have crumpled like a pack of cards before the onslaught of invaders, more virile, energetic and determined to carry through a certain objective. Assyrian, Babylonian, Iranian, Greek and Roman civilizations have all gone back to roost. They have all fallen because of the destruction of homogeneity of their race.

Similar thing has happened with France. For the last 100 years or so she has recorded a falling birth-rate and today she stands the lowest on the list. She is a country that is fast aging, *i.e.*, in a given population there are more aged persons than the young, more young than children. Six decades ago French birth-rate was 23·9 per mille, in 1929 it was 17·7. In the beginning of 1939 it was perhaps much less and now after the war and loss of the pick of manhood it will be further depressed in the years to come. In 1929 German birth-rate was about 18 and since 1933 it has been going up. In spite of falling birth-rate there has been some slight increase in the French population as shown by the country's decennial censuses but that has been found to be mostly due to immigrating foreigners. Taking only those foreigners who are the enemies of the French people today, *viz.*, the Germanic races and the Italians we find that in 1931 there were as many as 148000 of the former and 808000 of the latter. Taking total immigration of all nationalities and ages during 1920-30 it has been computed that nearly 2 million persons had entered France. Now, any country whose natural population has been falling and whose neighbours are casting wistful eyes on her stands in a permanent danger of being swamped out. On the top of all these it was at one time found that there were as many as 400,000 illegal, criminal abortions, etc, thus depriving the country of a natural increase of her population. Perhaps most of the foreigners may have taken French nationality. But after all one has to take into account the culture that is brought into an alien country by the immigrant. There is principally a wide gulf between the native culture and the imported one, and the acquisition of a country's nationality can in no way divest an immigrant from the cultural modes of the parent-country saturated in his bones. Besides this there is another factor, that of racial mixture, accentuated by the constant fall in birth-rate. Although the children born of such a miscegenation may be of the same nationality as the immigrant-receiving country there is that diversity of culture and cultural ideas which are homogeneous in the other children. These form a direct menace to the country of their birth since in abnormal times, such as the present war, they may become potential fifth-columnists for the invading country or countries if they happen to be the ones from which they come. Apart from the factor of superior man-power and machinery, this is the major factor that has played its part in the present fall of France. It had its beginning nearly 70 years ago when records show that emigrants from other countries began to invade the French territory. Today that invasion has been consummated.

Perhaps the only country in the world that has sought to fight the immigration menace from diverse countries and nations is the U.S.A. She has enacted laws which are now being rigorously put into practice. But the menace still remains since there are millions who may have by now acquired American nationality and most of whom may be reckoned as potential fifth-columnists. The only course left open to America today is to help

Great Britain in its resolve to crush the German plans of invasion and hegemony, and thus nip the danger in the bud. She can then set about putting her house in order in the light of French analogy.

Bombay,

S. F. Desai.

23-9-1940.

Action of Some Quinoline, Benziminazole and Pyrazolone Derivatives on Paramoecia

The action of quinoline and some of its derivatives on paramoecia has been studied by Grethe[1], Tappeiner[2], Niederehe[3] and others. Brahmachari[4], *et al* made an interesting observation that, although 6-aminoquinoline and 8-aminoquinoline have no action on paramoecia in strength of 1 : 4000, the introduction of OH-group into these quinoline derivatives raises their toxic action on paramoecia to a remarkable degree.

The effect on paramoecia of some quinoline, benziminazole and pyrazolone derivatives, synthesised[5] and sent for examination by me, has been kindly studied in the Department of Pharmacology, School of Tropical Medicine, Calcutta. A summary of the results obtained is presented below.

Compound.	*Concentration.*	*Effect on Paramoecia.*
(A) Sodium derivative of 1-phenyl-3-methyl-pyrazoline-4 :5 (2′ :3′)-4′-hydroxy-quinoline.	1 : 5,000 1 : 10,000 1 : 20,000	Death after 10 minutes Death in 25 minutes No effect
(B) Hydrochloride of 4-hydroxythiophen-2 :3 (3′ :4′)-2′-hydroxyquinoline-sulphonic acid.	1 : 5,000 1 : 10,000	Death in 13 minutes No effect
(C) Hydrochloride of 1-phenyl-3-methyl-4-(2′)-benzimin-azolylpyrazolone.	1 : 5,000 1 : 10,000 1 : 20,000	Death after 1 minute Death after 2 minutes No effect
(D) Hydrochloride of 2-hydroxy-3-(2′)-benziminazolyl-4-methyl-quinoline-sulphonic acid.	1 : 5,000 1 : 10,000 1 : 20,000	Instantaneous death Death after 2 minutes No effect
(E) Hydrochloride of 2 :4-dimethyl-3-(2′)-benziminazolyl-quinoline.	1 : 5,000 1 : 10,000 1 : 20,000 1 : 50,000 1 : 100,000	Instantaneous death Instantaneous death Death after 10 minutes Death after 18 minutes Death within 45 mins.
(F) Hydrochloride of 2 :4-dimethyl-3-(2′)-benziminazolyl-6 :7-benzo-1 :8-heptadiazine.	1 : 5,000	No effect

From the accompanying table it is evident that the compounds (A, B, C and D) are moderately toxic to paramoecia, whereas the compound (E) is highly toxic to paramoecia—so much so that its antiseptic properties compare very favourably with an equivalent dilution of quinine. So far as the compounds (D and E) are concerned, it is found that the toxicity for paramoecia is considerably enhanced by the replacement of the hydroxy-group in 2-position by methyl (provided the sulphonic acid group does not interfere with the action).

My grateful thanks are due to Bt.-Col. R. N. Chopra for kindly permitting me to publish the above results.

Tejendra Nath Ghosh.

Department of Pure and Applied Chemistry,
Indian Institute of Science,
Bangalore, 24-9-1940.

[1] *Deutsch. Arch. Klin. Med.*, *56*, 189, 1895.
[2] *Ibid.*, *56*, 369, 1895.
[3] *Z. ges. Expil. Med.*, *6*, 350, 1918.
[4] *J. Pharm. Expil. Therap.*, *39*, 413, 1930; *41*, 255, 1931; *44*, 445, 1932.
[5] T. N. Ghosh, *Jour. Ind. Chem. Soc.*, *14*, 123, 713, 1937; *15*, 89, 1938.

On the Effect of Thoria-ceria, Alumina and Manganese Oxide upon a Nickel Catalyst

The highly active particles on a catalyst surface are liable to be easily sintered by heat. Hence these particles lose activity very quickly while catalysing an exothermic reaction. Such particles, however, are likely to possess high chemical reactivity as well. This can be easily measured by the action of acids in the case of metallic catalysts and provides a means for studying the comparative concentration of the active particles. Dilute acetic and hydrochloric acids have been found to dissolve nickel catalyst. The action starts earlier in the case of simple nickel catalyst in comparison with a preparation which contains thoria-ceria in addition. When allowed to be oxidised in a very limited supply of air the latter remains practically unaffected while the former is considerably oxidised. These facts show that particles of comparatively higher activity are present in nickel catalyst prepared without thoria-ceria. The reduction rate of the catalyst is however accelerated in the presence of thoria-ceria. This and the steadiness of Ni-thoria-ceria catalyst are most probably due to the anti-sintering effect of thoria-ceria. The action of alumina is more or less similar but the oxides of manganese act by producing highly active particles which, however, cannot prevent sintering.

Chemical Laboratory, K. M. Chakravarty.
Dacca University,
Dacca, 20-9-1940.

The Source of Energy in a White Dwarf Star.

A white dwarf star has for its mass a much smaller luminosity than other stars. For Sirius B, the most accurately known white dwarf, the rate of energy generation (L/M) is 0·007 erg. per gram per sec., and thus during its life-time of 3×10^9 years the energy radiated per gram will be $10^{14\cdot7}$ erg.*

A white dwarf ultimately becomes a 'black dwarf' (a term originally due to Fowler) when it has completely cooled down. It is of some interest to examine the possibility that the star's radiation is all maintained by the very small gravitational contraction which takes place as the white dwarf sinks into the black dwarf stage.** This is done in the present note.

The pressure of ionised matter† at temperature T and density ρ such that the free electrons constitute a degenerate gas and the atomic nuclei (of average atomic number Z) a non-degenerate gas is to a first approximation‡ given by

$$p = \frac{K\rho^{5/3}}{\mu^{5/3}} + \frac{k\rho T}{Z\mu m_H}, \quad \ldots \quad (1)$$

where the degeneracy-constant K is

$$K = \frac{8\pi h^2}{15m}\left(\frac{3}{8\pi m_H}\right)^{5/3}. \quad \ldots \quad (2)$$

μ is the mean-molecular weight per free electron *i.e.*, the free electron concentration is $\rho/\mu m_H$. For ionised hydrogen $\mu = 1$, and for any other completely ionised element of atomic number Z and atomic weight A, $\mu = A/Z \doteqdot 2$. m denotes the mass of the electron, m_H the mass of the proton, k Boltzmann's constant and h is Planck's constant. Equation (1) can be rewritten in the form

$$p = \frac{K'\rho^{5/3}}{\mu^{5/3}}, \quad \ldots \quad (3)$$

where

$$K' = K\left[1 + \frac{kT}{Zm_HK}\left(\frac{\mu}{\rho}\right)^{2/3}\right]$$
$$= K\left[1 + \frac{5}{Z}\left(\frac{2}{9\pi}\right)^{\frac{1}{3}}\frac{1}{A_0^{2/3}}\right], \quad \ldots \quad (4)$$

and the degeneracy discriminant A_0 is

$$A_0 = \frac{h^3}{2(2\pi mkT)^{3/2}}\frac{\rho}{\mu m_H}. \quad \ldots \quad (5)$$

As the electron gas is degenerate $A_0 \gg 1$.

If we assume (for the sake of an exact treatment) that the distribution of temperature inside the star is such that A_0 remains constant throughout the degenerate stellar core*, then we can treat K′ as a constant. The equation of mechanical equilibrium for the star would then reduce to Emden's equation of index 3/2, and, therefore, replacing K in the usual theory[1] by K′ we have for the radius R of the star,

$$R = R_0\left[1 + \frac{kT_0}{Zm_HK}\left(\frac{\mu}{\rho_0}\right)^{\frac{1}{3}}\right]$$
$$= R_0\left[1 + \frac{5}{Z}\left(\frac{2}{9\pi}\right)^{\frac{1}{3}}\frac{1}{A_0^{2/3}}\right], \quad \ldots \quad (6)$$

where R_0 is

$$R_0 = \frac{5^{\circ}\,(\omega^{\circ}_{3/2})^{1/3}K}{2^{7/3}\pi^{1/3}G\mu^{1/3}}\frac{1}{M_{3/1}} \doteqdot \frac{2\cdot79 \times 10^9}{\mu^{5/3}}\left(\frac{\odot}{M}\right)^{\frac{1}{3}} \text{cm.}\dagger \quad (7)$$

$\omega^{\circ}_{3/2} = 132\cdot4$ is a number defining the Emden-Solution of index 3/2, G is the gravitational constant, and ρ_0 and T_0 denote the central density and temperature respectively. The central density is related to the mean density ρ_m by the equation

$$\frac{\rho_0}{\rho_m} = \frac{(\sigma_{3/2})^{3/2}}{3\omega^{2}_{3/2}} \doteqdot 5\cdot99. \quad \ldots \quad (8)$$

$\sigma_{3/2} = 178\cdot2$ is constant characteristic of Emden's Solution of index 3/2.

The virial theorem requires that

$$2W_k + W_G = 0, \text{ or } E = (W_k + W_G) = \frac{W_G}{2}, \quad \ldots \quad (9)$$

where W_k is the total kinetic energy of the particles

* The luminosity is assumed to be constant during the life of the star.

** If we assume that the star's radiation is maintained by a conversion of hydrogen into helium, then the amount of hydrogen required per gram of the white dwarf material would be $10^{-4\cdot1}$ gram, for, one gram of hydrogen on conversion to helium generates $10^{18\cdot8}$ erg. However, the rate of energy generation for this exceedingly small concentration of hydrogen comes out on the Bethe-Critchfield formula to be much smaller than the present rate of 0·007 erg per sec. per gram, and thus a larger concentration of hydrogen will have to be assumed. Whether the high-temperature stage that very likely precedes the white dwarf stage would leave this requisite hydrogen-concentration, it is difficult to say, but if it did, the "life" of the star would be much greater than the time-scale of 3×10^9 years.

† The material in the interior of a white dwarf is completely ionised due to pressure-ionisation.

‡ Terms of power higher than one in T are omitted.

* For a white dwarf the core composed of degenerate electron gas contains practically the whole mass of the star.

† $\odot$ is the mass of the Sun.

in the star, W_G is gravitational energy and E the total energy of the star. The gravitational energy for a polytrope of index n is

$$-W_G = \frac{3}{5-n}\frac{GM^2}{R}. \quad . \quad . \quad . \quad (10)$$

Substituting for R from (6), we have from (9) and (10),

$$E = -\frac{3GM^2}{7R_c}\left[1 - \frac{kT_c}{Zm_HK}\left(\frac{\mu}{\rho_c}\right)^{2/3}\right]$$

$$= -\frac{3GM^2}{7R^\circ}\left[1 - \frac{5}{Z}\left(\frac{2}{9\pi}\right)^{\frac{1}{3}}\frac{1}{A_0^{2/3}}\right]. \quad . \quad (11)$$

Therefore, the energy available for the star to radiate is

$$\triangle E = \frac{3GM^2}{7R_c}\frac{kT_c}{Zm_HK}\left(\frac{\mu}{\rho_c}\right)^{\frac{2}{3}}$$

and, using (6) and (8) we obtain after a little reduction

$$\frac{\triangle E}{M} = \frac{5}{7}\frac{\omega^\circ_{3/2}}{\sigma_{3/2}}\left(\frac{3}{2}\frac{kT_c}{Am_H}\right) \doteq 0{\cdot}53\left(\frac{3}{2}\frac{kT_c}{Am_H}\right), \quad (12)$$

where the expression in the brackets is the thermal energy of the nuclei per gram of matter at the centre of the star.

The energy radiated during the life-time of Sirius B is $10^{14\cdot7}$ erg. and if all this is to be provided by gravitational contraction, then, assuming the stellar material to be helium, we have

$$0{\cdot}53\left(\frac{3}{2}\frac{kT_c}{4m_H}\right) = 10^{14\cdot7}, \text{ or } T_c = 3{\cdot}0 \times 10^7 \text{ degrees,}$$

which is a reasonable value for the central temperature of the stellar core. Because of the large thermal conductivity of degenerate matter the core is almost isothermal. The assumption, $p/T^{1\cdot5} = \text{const}$ made in the calculation of T_c, therefore, leads to an appreciably higher* value of T_c.

If we take the core to be *isothermal and of uniform density*, then, an easy calculation gives

$$\frac{\triangle E}{M} = \frac{3}{2}\frac{kT}{Am_H},$$

and putting $\frac{\triangle E}{M} = 10^{14\cdot7}$ e.g., we have $T = 1{\cdot}6 \times 10^7$ degrees.

It is not difficult to estimate roughly the thermal conductivity of dense degenerate matter, and knowing this the temperature of the core can be determined. Calculations[2] for a model white dwarf ($L = 10^{31}$ erg., $M = 10^{33}$ gram) gave $1{\cdot}4 \times 10^7$ degrees for the central temperature of the core and $1{\cdot}2 \times 10^7$ degrees for the surface of the core, and these values are in reasonable accord with the core temperature that is required if the star's radiation is to be maintained by gravitational contraction alone.

Physics Department, D. S. Kothari
University of Delhi.
Delhi, 29-9-1940.

* In fact, higher by a factor comparable to 3.

[1] Milne, *Monthly Notices R.A.S.*, *92*, 610, 1932.
Kothari, *ibid.*, *93*, 61, 1932.
[2] Kothari, *loc. cit.*

SCIENCE AND CULTURE

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Right Thinking*

ON the portals of the University of Uppsala, is to be found an inscription attributed to the philosopher and mystic Schwedenborg—"Free thinking is good, but right thinking is better". It sounds a noble maxim, but like all pious sentiments the difficulty begins as soon as one tries to apply it to practical problems; for in all matters which excite human passions, it has not yet been found possible to attach any *objective* sense to "Right Thinking", and in this respect, the moderns are no better than the ancients.

Only three decades ago, the arrogant modern nations used to look down upon the ancients rather superciliously on account of their many irrational actions and ways of thought. How irrational were these ancients, they argued, when the gods of one nation used to be regarded as devils by the neighbouring ones, while to the objective mind of the moderns, no distinction could be discerned between the rival brands of divinity. How wrong was it for a certain people to regard itself as the chosen of god, while others, equally accomplished in arts, crafts and literature were to be regarded as barbarians!

But the events of the last thirty years have shown that in this respect the moderns are no better. During the last World War, which according to the victorious side was fought to make the world safe for democracy, each side used to consider itself the sole possessor of righteousness, and God Almighty was asked to help the Righteous Cause. So ponderous were the arguments brought forward, not only by politicians and churchmen, but sometimes even by scientific men, in favour of the particular brand of righteousness, that the All-Highest must have found himself as uncomfortable as a High Court judge pitched between two clever lawyers in an obscure case. When after the War, Clemenceau, the French premier, visited the Pyramids, he made some rather arrogant remarks about the vanity of ancient Egyptian Pharaohs who built up an artificial mountain only to house their carcase! He was reminded by an Egyptian paper the next day that probably two hundred years later, the Treaty of Versailles, of which Clemenceau was one of the authors, would be considered as a far worse monument of folly than the Pyramids.

The gods of ancient times have, at the present time, given place to creeds of various designation—Nationalism, Imperialism, Socialism, Marxism, Fascism and Nazism—and wars are being fought over these rival creeds with as much ferocity and ruthlessness as between any two barbaric nations of the past! Who is to find out, in this perplexing plethora of "isms", which is the right one! The saying of the philosopher Hegel, that there is scarcely any human struggle between the absolute right and the absolute wrong, but the struggle is rather between two conflicting views of the right, is after all a counsel of despair!

* A lecture delivered by Prof. M. N. Saha at the Milanee Club, Calcutta, on 16 November, 1940.

But though in matters of politics, sociology and economics, it has been hitherto found difficult, if not altogether impossible, to define 'right thinking', it does not appear to be so in the intellectual field, particularly in subjects which do not excite human passion. But even this was not the case in medieval times, when the steps by which progress had been achieved were completely forgotten and, by the false teachings of religion and tradition, people were rendered psychologically impotent to do any right thinking even in the intellectual field. All knowledge which had been previously built by the patient labours of preceding generations, was supposed to be contained in scriptures and in certain books affiliated to the scriptural authority, and it was universally believed that these were revealed to some prophet or sage. Much of the information about material phenomena was apparently absurd, but if anybody dared to express his opinion freely, he would be visited by excommunications and persecutions in this world and hell-fire of several brands in the next!

Some progressive human minds in Western Europe revolted against this mode of irrational thinking in the 15th century, and approached Nature first hand—by observations, experimentation and rational interpretation of facts. It is usual to ascribe the emergence of 'right thinking' in the intellectual field as a revival of the spirit of the Greeks, who, from 500 B. C. to the beginning of the Christian era were bold enough to dissociate completely the cultivation of knowledge from the cult of gods.* There have been other periods of intellectual revival but the Renaissance is singled out because it is nearest to us in time; it covered wide areas, continued for longer time and acected all fields of knowledge hitherto neglected or cultivated as a secret lore by the priestly class, namely chemistry, physics, astronomy, biology, medicine, geography, ancient history and geology.

The Renaissance spirit has worked now for over 400 years in Europe in the intellectual and technical field leading not only to undreamt-of increase in human knowledge but also to the birth of new crafts and arts which have entirely revolutionised the older modes of living. Though, originally it was to some extent shy of politics, sociology and religion, its influence gradually came to undermine the established order in these fields. So great was the success achieved by the Renaissance type of human mind that the French in course of their great Revolution decided to discard their old religion and set up a Goddess of Reason, in itself another irrational act. Right thinking has however not yet been extended in a marked degree to politics, sociology and religion, and this has led to the greatest of human tragedies of the present times, namely colonial exploitation of the less fortunate people by the Europeans as also to the tragedies of the last and the present World War.

Is it not possible to extend the spirit of right thinking to subjects vital to the stability and progress of human society? Unfortunately on account of the false teaching of history the present generation appears to be psychologically unfit to take a broad view of these matters. But probably a philosopher, a few centuries hence, will find the present conflicts to be as irrational as their ancient prototypes. The last war was in effect one for the capture of privileges by the most advanced nations of the world but the present one is claimed to be one between two rival ideologies. But if one surveys the different political doctrines, from the extreme form of imperialistic exploitation to extreme Marxism, it will be found that none is absolutely wicked or absolutely right. As a matter of fact, Russia starting from extreme Marxism is finding that some features of the old order have to be adopted faced as she is with a capitalist world, whereas even the citadels of capitalism find it necessary to introduce varying doses of government control of industry and commerce and of private property. The technique of government is tending to become similar in countries widely different in material prosperity and historical tradition, and certain controversial doctrines which are supposed to form the essential elements are not found to be so after the experience of a few decades. Both Nazism and Fascism are based upon ideas of race superiority and prescription of a lower standard of life for inferior people. These doctrines are largely sentimental and may be discarded when political ambitions are satisfied. The great democracies of the world have apparently condemned ideas of race superiority, but there is a vast difference between their professions and practices. For example, the great democracy of America has got within its borders 15 millions of coloured people whose only representatives in the House of Representatives are a few janitors. The

* Modern research has shown that every people who have achieved a certain amount of greatness had a 'period of rationality' when the seeds of their future were sown, *e.g.*, the reign of the first few dynasties of ancient Egypt, the period of Sumerian City States in the Near East and the period following Upanishadic and Buddhistic thought in India.

British Empire has been proclaimed to be more liberal than its Roman counterpart of ancient times, but it has still to pass a law like the edict of Caracalla which conferred Roman citizenship on all people within the Empire of Rome. So when we are given lectures on the advantages of democracy by the so-called advanced nations of the world, it is probably only meant for local consumption, and, for the less fortunate races, such slogans are simply misleading. History has shown us again and again however that those who are guided by false ideas of racial superiority have sooner or later suffered for it.

In this country unfortunately there is no right thinking even in the field of knowledge, not to speak of politics, sociology and economics. An objective mind looking at the present welter of conflicting ideologies in India may justly compare the different parties and communities to so many swarms of fish struggling in a net, each pulling in a different direction. For a short time there was a spirit of unity due to a sense of collective injustice, but as soon as the chance appeared that some of this injustice may disappear, the old prejudices and mental barriers which have been inherited from a false teaching of history start doing their nefarious business. There can be no escape from this state of affairs unless the problems are approached in a spirit of true and impartial enquiry.

Some might argue that it is quite impossible to discuss matters involving politics, society and religion in an objective way. This has not been the experience of some of us who had the privilege of taking part in the deliberations of the National Planning Committee. The members of this Committee represented all shades of opinion—from capitalists to professed communists—industrial and academic men and probably there were as many shades of political opinion as the number of members. In the personnel of the 29 sub-committees which were formed for discussing particular subjects there were all kinds of divergent opinion and the subjects themselves,—industries, labour, control of currency and banking, industrial policy etc.—were such as usually excite the bitterest controversies. Yet it has been the experience of the members of the sub-committees and the National Planning Committee that when the problems in each of these subjects were properly studied and analysed in an objective manner, the solutions practically took the same shape in everybody's mind, and it was possible to reach a very large measure of agreement even on the most debatable points. It therefore does not appear impossible to apply the principle of right thinking even to political and economic problems. But the present generation of political leaders are to a great extent psychologically unfit to approach the problems in such an objective way. A new type of mind must be created for this purpose. It however remains a moot question whether, even when scientific solutions of political, economic and social problems are obtained, they can be put into practice without a bitter struggle.

A Greek historian, Polybius, who spent a number of years in Rome as a hostage and had the privilege of making the acquaintance of the most eminent Roman statesmen, asked himself this question: Why in politics were the Greeks utter failures, while the Romans, who were only their pupils and had very little pretensions to originality, attained unique success? He considered that the explanation lay in the judicious blending of monarchical, aristocratic and democratic elements in their constitution. In other words, the Greeks were guided by abstract reasoning in framing their constitution, while the Romans built up the fabric of their State by the experience gained in long and arduous struggles, choosing the better course in all their vicissitudes. The constitution was not a product of one man, but of many, and had been perfected not in a single lifetime but in the course of several ages and generations.

If a proper political and economic constitution is to emerge out of the present chaos, it can only happen if the problems are approached in an objective manner and if the real lessons of history are remembered and properly utilised in the interest of the entire community.

Recent Technical Development in Wireless and Broadcasting in Great Britain

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(*Continued from the last issue*)

THE BRITISH BROADCASTING CORPORATION

THE next important establishment visited by the author was the British Broadcasting Corporation. This is the biggest broadcasting organization in the British Empire and is one of the largest in the world. The B. B. C. was founded in 1922 as a limited liability concern and on 1st January, 1927, became a public corporation working for national interest. The whole organization is broadly divided into four main sections: Engineering, Programmes, Public Relations, and Administration.

The author was primarily interested in the engineering section which is sub-divided into seven departments—Overseas and Engineering Information, Maintenance, Station Design, Lines, Equipment, Civil Engineering and Research. The Overseas and Engineering Information department collects information about the reception of B.B.C. programmes at home and abroad and gives technical advice to listeners. The Maintenance department, as the name implies, is responsible for the proper maintenance of all the transmitters, studios, aerials and control room equipments of the B. B. C. stations. The Station Design department is mainly concerned with the design and testing of transmitters and other relevant equipments. The Lines department is in charge of all the ordinary and "music" telephone lines rented by the B. B. C. from the British Post Office for broadcasting purposes. The Equipment department is concerned with designing and constructing all low frequency apparatus and switching equipments in control rooms. The Civil Engineers' department looks after the planning and maintenance of all the B. B. C. buildings and transmitting aerial masts. The Research department is responsible for the development of the technical equipments of the B. B. C. and works in co-operation with other Engineering departments and with manufacturing companies.

Through the Overseas and Engineering Information department the author had the opportunity of studying the technical details of the following typical long- and medium-wave B. B. C. transmitters.

(*a*) *The National Transmitter at Droitwich:* This transmitter is tuning-fork controlled and the wavelength of radiation 1500 metres. The aerial system is of the T-type supported by two 700 ft. masts and the aerial power is 150 Kw. Series modulation in the penultimate stage has been adopted in the transmitter. The penultimate stage thus consists of two distinct and separate sections connected in series, one audio frequency and the other radio frequency, each running with 10 Kv on the anodes, the total H. T. supply being 20 Kv. The audio frequency section has got four 10 Kw. water-cooled valves connected in parallel and the radio frequency section four 15 Kw. water-cooled valves.

The output stage is a balanced push-pull modulated-high-frequency stage using six water-cooled valves each capable of a maximum output of 50 Kw. Two of the valves, one on each side of the push-pull, are kept as spare. With two 50 Kw. valves on each side, therefore, the required output power of 150 Kw. is obtainable without running the valves at their full load rating.

A special precaution has been taken in the design of the transmitter for getting good fidelity. The output of the final push-pull stage passes through a "transducer" and thence to the transmission lines connecting the main station building to the Aerial-transformer house. The transducer unit contains specially designed h. f. circuits, the main function

of which is to reduce the attenuation of the higher audio frequency sidebands, thus enabling the long-wave transmitter to have a fairly uniform frequency response up to about 9 Kc/sec.

(*b*) *The Regional Transmitter at Start Point:* This transmitter has been opened in 1939 and has an aerial power of 100 Kw on 285·7 metres. In common with all recent B. B. C. transmitters, high-level "Class B" modulation has been used. Further, negative feed-back has been applied to the modulator system to reduce the total harmonic content. It may be remarked that with the general increase in power of transmitters, the cost of the power to run a station becomes a major item in the operating costs. The Class B high-level gives a good overall efficiency and is now being universally used by the B. B. C.

The aerial system at Start Point is of particular interest and is of a type not before used by the B. B. C. The location of this station is responsible for this. Sea being to the south, the aerial system was designed to increase radiation to the East and the West and to reduce it to the South. The aerials are in the form of two mast radiators 450 feet high and spaced 350 ft. apart (about $\frac{3}{8}\lambda$). One mast is excited directly and the other through a phase-shifting network adjusted to produce the required polar diagram. Each mast rests on porcelain insulators and is stayed by three groups of stays, each stay being in turn broken up by insulators. The aerials are fed by concentric feeder lines leading into two aerial coupling circuits which are contained in two small buildings immediately next to the bases of the masts. The building nearer the transmitter contains also the phase-shifting network.

(*c*) *The Receiving and Frequency Checking Station at Tatsfield, Surrey:* This station is attached to the Overseas and Engineering Information department. Here some of the B. B. C.'s receiving work for relay of important foreign broadcast programmes is done. For important relays, however, the B. B. C. usually rely on the single-side-band receiving system of the British Post Office, which has been referred to in our last article. At Tatsfield, the frequencies of all B. B. C. transmitters are measured carefully and any deviation is at once reported to the station concerned.

The system of reception at Tatsfield is of the Diversity type using horizontal rhombic aerials. Usually two rhombics are used in conjunction with two receivers, the rhombics being separated by about 6λ for the mean working wavelength. It may be noted that reception at Tatsfield for relay purposes is mainly of broadcasts from U. S. A. As the angle of incidence of these downcoming short waves varies within a certain limited range, the two rhombics are of two different dimensions so designed as to cover, on the average, the entire range, the optimum workings being at 18° and 22° respectively. These values are chosen because the variation of the angle lies between 16 and 24 degrees with the horizontal. The one designed for 18° satisfactorily covers signals varying between 16° and 20° and the other between 20° and 24°.

The audio outputs of the two receivers are paralleled through volume control potentiometers and phase reversing keys. There are also controls by means of which the receivers may be used independently of one another, *i.e.*, the output of only one may be fed to the line.

The coupling of rhombic to the concentric feeder leading to receiver is also of special interest. The input impedance of a properly terminated rhombic is about 800 ohms. An 800-ohm line is, however, somewhat unmanageable. A concentric feeder which has a special advantage because of its very low noise pick up voltage is therefore used, though its impedance is considerably less than that of the input impedance of the aerial. The system of coupling is shown in Fig. 3.

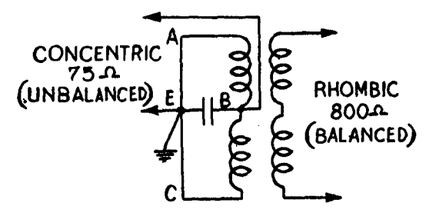


FIG. 3

It will be noticed that at any instant if A is positive with respect to B, C is also positive with respect to B because of the opposite senses of winding of the sections AB and BC. The current through the coaxial load due to both the halves AB and CB of the coupling coil is in the same direction at any particular instant.

The Empire Station at Daventry: Towards the end of 1927 the B. B. C. inaugurated experiments on long distance short-wave broadcasting after the manner of the American and Dutch stations. It soon

became obvious that there was a great demand throughout the Empire overseas for B. B. C. programmes and on 19 December, 1932, a regular service to serve the whole British Empire was started by the B. B. C. from two short-wave transmitters at Daventry. Various experiments have since been carried out to improve and expand the service. The original aerial systems and the two transmitters with which the service started are no longer used and have been replaced by more efficient ones of latest design. Initially, the duration of service was 10 hours a day ; now it is 18 hours with a range of wavelength from 13 to 50 metres. There are now six periods of transmission which are so arranged that each corresponds to an evening period (which is most convenient for listening) in some part of the Empire for which that particular transmission is intended. The wavelength and aerial system are changed to suit each particular transmission and, in general, four transmitters on different wavelengths radiate simultaneously during each Empire transmission. This makes reception more reliable for, out of these four, there is always at least one which is best suited for reception, either on account of its wavelength or due to the special disposition of the corresponding aerial system.

There are at present in service 8 transmitters, two having output of 10 to 15 Kw., one 20 Kw., and the remaining five about 100 Kw. These last five, however, normally operate at an output of about 50 Kw.

From the very early days of the Daventry station various experiments have been carried out to determine the best type of aerial system for a particular service. Obviously, omni-directional aerials involving unnecessary loss of energy in the undesired directions should be avoided for Empire service. The transmissions from the aerials at Daventry are not, however, what may be called "beam" transmission, because each transmission covers a horizontal sector subtending 36° at the aerial, the central "line" of which is directed towards the country to be served. The propagation conditions in the vertical plane are variable and the corresponding polar diagrams are to be adjusted to suit these varying conditions. The variations in the ionosphere with the time of the day and the season of the year necessitate adjustments of the angle of radiation and the width of the main lobe in the vertical plane to suit the particular transmission. At the present imperfect state of our knowledge of the ionosphere, the design of these aerial systems is still more or less of an experimental nature. According to tests which have so far been carried out by the B. B. C., aerial systems with stacked horizontal dipoles seem to be better than vertical aerials. It has also been found that about four horizontal elements in the vertical plane are sufficient for a good transmission. Further, for satisfactory results the best average height, above ground, of the bottom element has been found to be about one wavelength and the separation between elements $\frac{1}{2}\lambda$. Nearly all the aerials are provided with reflectors—this not only increases the radiation in the forward direction but also greatly reduces any back echo at the distant receiver. The reflectors are all parasitically excited, the distance between radiator and reflector curtains being $\frac{1}{4}\lambda$. The designs of the radiator and reflector elements are identical and there is provision for interchanging the two curtains so that the direction of radiation may be reversed.

A few notes on the feeder lines and their matching as in use at Daventry may be of some interest here. From various considerations balanced open-wire type feeders are almost universally used. Matching is mainly done in three stages :—Firstly, the extreme end of the feeder line is stub-matched at the array terminal (points A, Fig. 4). The main line

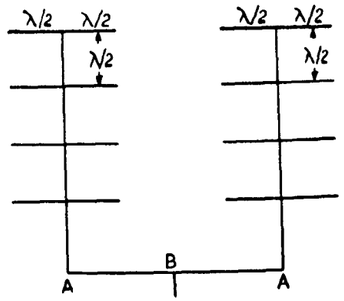


FIG. 4

is then matched at point B. After this, the whole transmission line is checked and any mismatching or standing wave due to irregularity in the line is remedied either by short lengths of lines or line-matching condensers which consist of insulator rods (spacers), with corona rings or discs. The final matching is done at the beginning of the line just after the switching system which connects any transmitter to the desired aerial. Here too, stub-matching is adopted ; as far as possible short-circuited stub-matching is used because of its easy manipulation.

In the latest transmitters the B. B. C. are using four-wire lines between transmitter and the switching system connecting the transmitter to the desired array. It may be noted that this portion (about 75 metres) of line has to carry currents of different frequencies to suit the particular array used. But, as a matching (after switching system) made at one frequency may not hold for other frequencies, there is possibility of standing waves being formed in this portion of the line with consequent chance of flash-over.

The surge impedance of a four-wire line (two in parallel, with spacing in-between, as one wire of a twin line) varies with the spacing between the two conductors of each line. Obviously as the spacing is decreased, the surge impedance gradually approaches the value for a twin wire line as shown in Fig. 5.

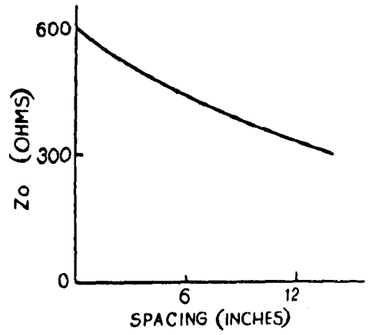


FIG. 5

No. 6 hard-drawn copper wires with 12″ spacing between any two consecutive conductors are used by B. B. C. and such a line has surge impedance of about 320 ohms.

The B. B. C. have lately adopted a different system of feeding high power arrays. The advantages of the new system will be easily understood if we compare Figs. 6(a) and 6(b). It may be recalled that the standing waves on the interstack feeder (Fig. 6a) impose a limitation on the power that can be used. In the new system (Fig. 6b) the power in the interstack feeder is halved. It is obvious that if an even number of dipoles is used in each vertical stack then the feeders are still balanced. For example, if the end-impedance of a $\lambda/2$ radiator is roughly 2,000 ohms, then the impedance between A and B (Fig. 6b) looking into the array is 2,000 ohms, there being 1,000 ohms load (two 2,000 ohms in parallel) on each wire of the twin-wire feeder. This system of feeding, therefore, equally divides the total power in the two interstack feeders. It has the further advantage that the single bay of push-pull

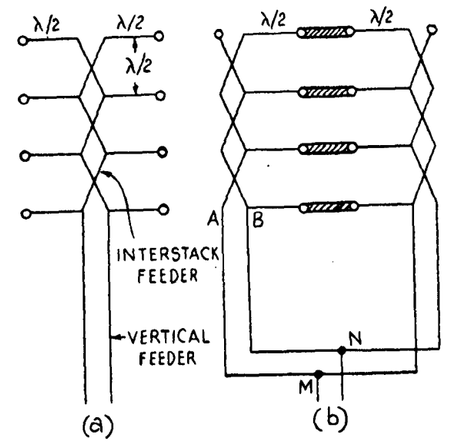


FIG. 6

dipoles can be slowed for rotating the direction of the transmitted beam. This is not possible when a single bay is fed in the normal way by a single feeder.

Filtration of harmonics. The B. B. C. take special care to prevent the harmonics, generated by the high-efficiency amplifiers, from reaching the radiating system. The second harmonic is filtered out by means of $\lambda/4$ (quarter wavelength on fundamental) short-circuited lines. Such a line behaves as an infinite reactance on fundamental but as a short-circuit on the second harmonic. The ideal place of such a filter would be directly at the transmitter output but as each B. B. C. transmitter is required to operate on a number of spot wavelengths, the filter is located after the switching system connecting a particular transmitter to the line leading to the desired array system. As a further precaution against second harmonics, the downcoming feeders from each vertical stack of push-pull dipoles are anchored firmly to the ground by means of short-circuited $\lambda/4$ lines, the short-circuited end being earthed. This arrangement not only acts as a second-harmonic filter, but also as an earth connection for lightning discharges.

No special precaution is taken for filtering out the third harmonic because the tuned coupling to the

feeder definitely discourages any third harmonic being present in the output.

SOME SPECIAL FEATURES OF DAVENTRY TRANSMITTERS

Of the five high power transmitters of recent design two have been supplied by the Standard Telephones and Cables Limited and the other three by the Marconi's Wireless Telegraph Company Limited.

(i) The Standard Transmitters:—These use Class-B high level modulation and the transmitters are designed for four spot frequencies. The most interesting feature is the design of the final r.f. power amplifier in which, contrary to usual practice, the grids are earthed and the filaments are at r.f. potentials. Such amplifiers are called "series-connected" or "inverted". The schematic arrangement and the equivalent circuit (for only one valve of the push-pull) are shown in Figs. 7 (a) and (b).

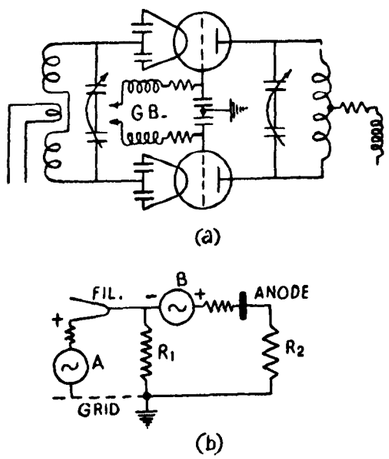


FIG. 7

It will be observed that the earthed grid between the anode and filament eliminates or minimizes direct transference of energy, through the valve, between the input and output circuits. Moreover, this earthed grid means inherent negative feed-back in the amplifier and, for stability, balancing condensers are either not required at all or they are of extremely low values. Leaving stray capacity out of account, the anode-to-anode output circuit capacity due to the valves themselves is equal to one half of the anode-grid capacity (Cag) of one valve. This is to be compared with double this value, *i.e.*, equal to Cag, for the case of the classical neutralized amplifier. Consequently this is a great advantage in high power short wave transmitter design because larger valves can be used before the limits imposed by excessive inter-electrode capacity are reached.

From the equivalent circuit it is obvious that the exciter (A) supplies power to the grid circuit (R_1) as well as directly to the output load (R_2), since, so far as R_2 is concerned, the exciter (A) and the equivalent anode circuit e.m.f. (B) are operating in series and in phase. Thus the exciter stage for an inverted amplifier has got to supply more power than for a normal amplifier. The extra power is, however, directly transferred to the output load and usefully employed there. In many practical cases, it is very advantageous to be able to draw power from the exciter and use it to augment the power delivered by the final stage. Such is the case when it is desired to obtain the highest possible output on short waves without paralleling output valves. When limitation due to size of valve is reached, the inverted amplifier gives further increase of output because of the power from the exciter. It may be remarked in this connection that since the exciter and the final stage supply power to the output load, both these stages are simultaneously modulated.

The efficiency of this system, expressed as the ratio of the output power to input power to the anodes of the two stages is, of course, not greater than the efficiency of a normal amplifier but in practice, for the same degree of stability, the inverted amplifier gives greater effective efficiency. In the normal case it is in general necessary to incorporate some damping resistance across the grids of the amplifier valves. This resistance absorbs power from the exciter which, in the inverted system, would be transferred to the output load.

The elimination of large anode-to-grid balancing condensers greatly reduces the tendency of parasitic oscillations. This advantage is of special importance in the design of high power short wave transmitters because as the size of the valves is increased with resulting increase of inter-electrode capacity, the resonant frequency of balancing condenser circuits becomes nearer and nearer to the operating frequency which makes selective damping of the parasites more and more difficult—almost impracticable.

The elimination of anode-to-grid balancing condensers is very advantageous in transmitters designed

to operate on a number of spot frequencies. The change over from one frequency to another can then be effected very quickly because the balancing condensers do not require accurate adjustment for each frequency. In a practical inverted amplifier, however, a certain adjustment which varies with frequency is necessary, but the adjustment is not at all critical. This adjustment is due to the unavoidable inductance in the connections between grids and earth, due partly to the connections themselves and partly to the grid leads inside the valves; this inductance is, in effect, a coupling impedance between input and output circuits giving undesirable reaction. To avoid this the inductance is neutralized by series tuning capacities, the values of which have obviously to be altered with frequency, though not very critically.

Since the filaments of inverted amplifier are at r.f. potentials, they are heated by A. C. supplied through special shielded transformers having low capacity between the secondary and the grounded shield between the windings.

(ii) The Marconi Transmitters:—Of the three Marconi transmitters, one incorporates Series modulation and the other two, which are the latest, Class B—all high level. The first one employs a method of modulation control which may be understood from the simplified scheme shown in Fig. 8. The filaments

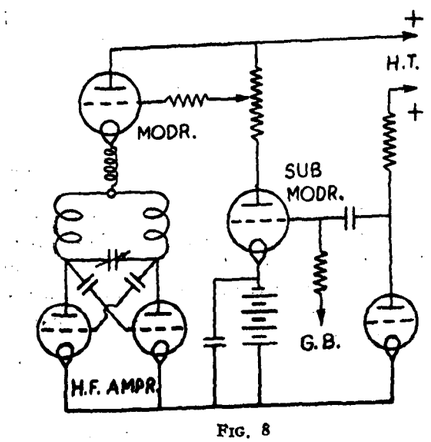


FIG. 8

of the h.f. amplifier valves are earthed and connected to H.T. negative. The h.f. circuit is of the usual centre-tapped tuned-anode type and the modulator valve is connected between the H.T. positive and the tap. This arrangement simplifies the design of the h.f. circuits but simultaneously introduces difficulties in feeding the audio input and supplying grid bias for the modulator. A special sub-modulator system has therefore to be designed for this. The sub-modulator valve including a series anode resistance is arranged in shunt across the H.T. supply and a tapping on this resistance is taken through a squegger resistance to the grid of the main modulator. The tapping is so adjusted that the modulator grid takes up the correct potential relative to its filament and anode. Such an arrangement would not give 100% modulation owing to the fact that when the main modulator acquires its maximum positive grid swing, *i.e.*, when the sub-modulator is 'cut-off', the voltage across the modulator cannot fall to zero. In consequence an additional bias voltage (actually a D. C. generator) has been used in series with the sub-modulator cathode and this enables 100% modulation to be obtained.

Another feature of this type of modulation is that the circuit arrangement lends itself without much alteration to a "floating carrier" system by which the strength of the carrier is made to depend on the modulation depth. By this means a large amount of power can be saved during periods of weak modulation. Although the designers have made provision for this floating carrier the B. B. C. do not use this method of carrier control because in such a case, receivers fitted with A. V. C. would give greater noise during silent periods and periods of low modulation.

Research Department:—The Research Department of the B. B. C. is located at Nightingale Square, a suburb of London. This department is entrusted with the experimental development of the transmitters, aerials, studios and other equipments used by the B. B. C. It deals with all the technical problems and difficulties of the B. B. C. and acts in close co-operation with other engineering departments and various manufacturing concerns.

Of the problems which were being handled during the author's visit, special mention may be made of the development of a new type of high-efficiency system for broadcast work. The earliest of the so-called high-efficiency system is the out-phasing-modulation system of Chireix (1935). The next one was the high-efficiency power amplifier for modulated waves due to Doherty (1936). Terman

also developed a high-efficiency grid-modulated amplifier (1938). Very recently (1939) Vance has also developed a high-efficiency modulating system.

At the time of the author's visit the B. B. C. Research Department was busy developing and improving upon the Fortescue method of amplification of modulated h.f. which should also have high efficiency when the unmodulated carrier alone is present. In previous systems of this type the practice had been to use two amplifier valves in the output and to feed each valve with input power modulated to a wave form identical with the modulated envelope required at the load. One valve, however, is biassed beyond cut-off so that it only comes into operation when the input envelope exceeds the carrier value.

The B. B. C. are using a pair of amplifiers connected to a load and impedance inverting network in the form of a mutual inductance. Neither amplifier, however, has abnormal bias and both have input A. C. envelopes in which the modulation depths differ from that required at the load. In the special case, actually used by the B. B. C., the input to one is pure carrier and that to the other contains the side bands together with some modulated wave. By suitable adjustments the system works very satisfactorily ; the distortion measured at 100% modulation is only about 3.5%. Regarding efficiency it may be noted that the first output valve dealing with carrier only, operates at an efficiency of about 75%. The second valve is run as a linear (with respect to the h.f. envelope) amplifier and takes practically no current in the carrier state. The overall efficiency of the pair is thus about 70% and is practically the same as that of an amplifier for unmodulated carrier.

The Research Department is also developing a new type of anti-fading aerial system. Normally half-wave radiators are used for this purpose but considering broadcasting on medium waves, it is very costly to erect such masts. The most important factor which the B. B. C. have to consider is that in the vicinity of a big city like London, the Air Ministry would not allow the erection of such high masts because of danger to Air navigation. In 1938 Hansen and his associates in America showed analytically that an aerial system consisting of a ring of vertical radiating elements would radiate mostly along the ground and that these elements need not be very high. In 1939 they further showed that a single ring is better than a multiple ring. The B. B. C. are carrying on experiments, for the first time in England, with the object of using such an aerial system at their London Transmitter at Brookman's Park.

The Research Department is also making various experiments in connection with studio design. It is needless to emphasize that the quality of a broadcast programme depends to a very great extent upon the acoustic properties of the studio. It may be mentioned that even after long practical experience of many years the B. B. C. have not yet been able to come to any definite specification or formula regarding the proper treatment of studios. Usually they distinguish between four types of studios—talk, production, orchestral music and dance music. The average size of their talk studio is $13' \times 16' \times 10'$ (height) and the reverberation time is about 0.3 to 0.4 second which, for good performance, should be practically constant over the audio range, *i.e.*, from 50 to 8,000 cycles/sec. It is desirable to have the time rather decreasing with decrease of frequency in this range. The reverberation time for a production studio of 50,000 to 100,000 c.ft. should be about 1 sec. This studio is usually divided into two compartments resulting in an acoustic coupled circuit. For orchestral music studio of size 10,000 c.ft. the reverberation time should be about 0.9 second and for 100,000 c.ft. about 1.7 second. In this case an increase of reverberation time with decrease of frequency between 100 cycles and 50 cycles is sometimes desirable. For dance music the average size is 30,000 c.ft. and reverberation time about 0.7 seconds. Some distinction is also made between the ceiling and the walls of a room for their acoustic treatment. The ceiling is covered with intermittent patches of Rock wool with a total surface area of about one-fourth of the ceiling. For the walls, about one-third of the height just above the floor is covered with wood panels ; one-sixth just below the ceiling is covered with Rock wool and the remaining intermediate portion is covered alternately with patches of Rock wool and Newtonite. Celotex is not usually employed because it absorbs moisture and soon loses much of its sound absorbing property. Rock wool is not much affected by moisture.

THE STANDARD TELEPHONES AND CABLES, LIMITED

The last important establishment visited by the author was that of Standard Telephones and Cables, Limited, at New Southgate, London. The Standards are one of the biggest manufacturers of Wireless

transmitters of all varieties, special receivers and telephone equipments.

The main laboratories of this company in England are at Woolwych and New Southgate, both suburbs of London. The Woolwych laboratories are mainly concerned with the design, development and manufacture of valves and low-frequency and telephone equipments. The radio laboratories are centralized at New Southgate under direct control of the chief engineer Mr. C. E. Strong. The author being primarily interested in the design and testing of broadcast transmitters, concentrated his work in these laboratories. The activities of the Transmitter section of the Development Department are subdivided into four divisions—high power, medium power, low power and aircraft. Each division contains workers specialized in the job and there is close co-operation between the different divisions.

It will not be possible to describe here the activities of the different sections but a brief analysis of some work with high power tetrodes, which the author closely followed, may be of interest. The investigations were carried out in connection with the development of the penultimate stage for a 150 Kw. shortwave broadcast transmitter (B. B. C. order). The final stage was intended to work on the inverted principle and it was estimated that about 20 Kw. would be required out of this penultimate stage. This stage was therefore designed to work with four VLS 413 (Standard) tetrodes in parallel-push-pull (Max. anode dissn. 15 Kw., Sc. grid dissn. 800 watts, Max. anode voltage 11 Kv., $\mu=300$, $g=5$ mA/v, $V_f=21V$, $I_f=70A$, Total emission 10A.).

The circuit scheme was normal. The exciter output (72 metres, crystal controlled) was led in by means of a concentric feeder and was magnetically coupled to the grid circuit. This was first tuned with ordinary condenser but it was found that the grid feeds were unbalanced. The grid tuning condenser was then changed into the split-stator type and the unbalance was practically removed. The load was inductively coupled to the anode tank circuit and consisted of a *line* with heavy dissipation and terminated in a bank of lamps. With the exciter "on", the anode and *line* circuits were next tuned in the "cold" state, *i.e.*, without any H.T. Finally, with the different circuits properly tuned, the drive was cut-off and H.T. applied. By swinging the anode circuit through resonance it was found that the system was quite stable. The tests were repeated a number of times and the stability on 72 metres was confirmed.

Stability and modulation tests on 55 metres :— The wavelength of operation was then changed to 55 metres. The amplifier seemed stable but on very careful tuning throughout the range of grid and plate tuning condensers, the 10A. H.T. fuse blew off. The violence indicated parasitic oscillation and was completely eliminated by using 50 ohms resistance in place of the h.f. choke in the H.T. lead. The amplifier was next "driven" and from the input and output figures, the anode efficiency came out to be rather high (75.6%) and overall efficiency 70%. It was suspected that the assumed *line* impedance (365 ohms) was not correct, and it became therefore necessary to measure the peak volts across the line to get a better estimate of the output. The line being of the balanced two-wire type, two peak voltmeters in series were used across the line. One voltmeter gave 1.47 Kv. and the other 1.35 Kv. The total peak voltage across the line was thus 2.8 Kv. The line current was 6.4 A in one arm and 7.2 A in the other, giving an average of 6.8 A. This gave the actual output as 13.6 Kw. and a line impedance of 300 ohms roughly.

The H.T. used was 9 Kv. and it was suspected that the system may not be stable at higher voltages during modulation because the exciter for an inverted amplifier has also to be modulated simultaneously with the output stage. To check this, modulation tests were made and the distortion produced was also measured. The distortion at 75% modulation indicated the stability during modulation. The amplifier valves being tetrodes higher percentages of modulation could not be secured easily by modulating the anodes only.

Stability tests on 30 metres :—The grid, anode and line circuits were next adjusted for 30 metres. Self oscillations occurred with four valves and an output of 20 Kw. was obtained. Two valves were taken out and the circuits tuned again—self oscillation still persisted. Two 2000 ohms resistances were next connected in series between grid-to-grid to provide grid damping and the system was found to be stable with two valves. It is important to note that for stability tests under actual working conditions some resistance between grid-to-grid must be used because, when driven properly, the grids consume power from the grid tuned circuit and provide the damping. When testing stability without drive, this damping should be provided by some extra resistance.

It was anticipated that when the valves will be "driven", the amplifier should be stable without the extra damping resistance. Actual tests proved the validity of the anticipation. Calculations and measurements showed that the total power consumed from the grid tuned circuit was 500 watts; the grid-to-grid peak voltage was 1800 volts, giving effective grid damping of 3,240 ohms. This compares favourably with the grid damping resistance 2000 + 2000 ohms during stability test.

From two valves an output of only 12.8 Kw. was obtained on 30 metres. This being far below the requirement (20 Kw.), stability tests with four valves were therefore continued.

Stability with negative feed back:—The scheme shown in Fig. 9 was adopted. It is obvious that the

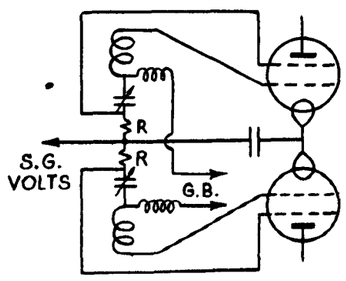


FIG. 9

oscillatory current flowing via the anode-screen grid capacity through R would introduce the necessary negative feed back. The R's were of course non-inductive "Givrite" carbon rod resistances. On 30 metres it was found that a value of 4 ohms for R was sufficient for stabilising four valves. On closer inspection, however, it was found that this type of feed-back would necessitate a tremendous loss of energy. The anode-screen grid capacity of the valve being about 30 $\mu\mu$f, it was easily calculated that at 30 metres the loss (H.T. being 9 Kv.) would be about 5 Kw. The idea of such a system of feed-back was therefore given up.

Various values of feed-back resistances up to 400 ohms between centre-to-centre of filaments were next tried. The circuit used for this purpose is really interesting (Fig. 10). The quarter-wave line for filament heating insulates the filaments from h.f. leakage. This was tested by means of a neon lamp whose glow was maximum near the filament end of the line and zero at the "shorted" end of the $\lambda/4$ line.

There was, however, no sign of any definite improvement. It was then realized that the major portion of the inter-electrode h.f. current from the anode tank circuit flowed via the anode-screen grid capacity and therefore very little in the cathode circuit. This was why the filament-to-filament feed-back resistance produced no effect.

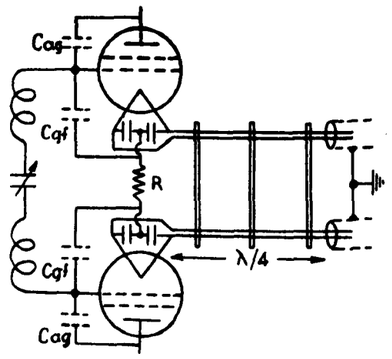


FIG. 10

The Inverted Amplifier:—All normal straightforward means for stabilising having failed it was next decided to try "Inversion". In this the grid is tied to ground and the filament is at r.f. potential. The filament heating current was supplied via the quarter-wave network as described above and the input rearranged according to the new requirements. The system was found quite stable on fundamental but there was very strong parasitic oscillation which latter was easily suppressed by introducing further damping resistance across grid "leads".

Further tests on the Inverted amplifier were discontinued specially because this stage was intended to drive a 200 Kw. stage which latter would be inverted. As it is very much complicated to manage two consecutive inverted stages it was decided to make further attempts for securing stability under normal amplifier conditions.

Neutralizing Power Tetrodes:—The difficulty in neutralizing tetrodes will be appreciated if we bear in mind the fact that in the usual bridge type of neutralization of a push-pull amplifier, the value of each neutralizing condenser is the same as that of the anode-control grid capacity. In the case of tetrodes this capacity is extremely small, (0.6 $\mu\mu$f in the present case), and it needs no emphasis that in high power circuits where components of large size are used, the reactance of the leads makes it extremely difficult, if not impossible, to adjust neutralizing condensers of such small values. Neutralization was carefully tried, bearing all these points in view, but oscillations could not be controlled in any way.

It is unfortunate to record that the present European War broke out at this stage and further work in this line had to be discontinued.

IONOSPHERIC RESEARCH IN ENGLAND

The ionized regions of the upper atmosphere which are responsible for guiding radio waves over long distances are collectively known as the Ionosphere. It has now been established that the ionosphere has several layers of maximum ionization; recently the existence of definite ionized layers in the lower atmosphere has been proved by observations made at Calcutta and has been verified by other workers abroad.

The study of the ionosphere is of very great importance both from the practical as also from the theoretical point of view. The tendency in recent years has been to use short waves for long distance communication because of their many advantages. The propagation of the short waves being dependent on conditions of the ionosphere, it is obvious that a knowledge of the nature and the variations of this connecting link between transmitter and receiver is extremely important to the practical radio engineer. The choice, for instance, of the optimum wavelength of transmission between any two places depends on ionospheric conditions, with the time of the day and the season of the year. A detailed study of these and various other associated subjects is thus very necessary for maintenance and development of radio communication systems between widely separated countries.

Further, the source of ionization in the upper atmosphere, the causes of its temporal and other erratic variations are of profound scientific interest and have attracted the attention of investigators of various countries. Work in this line in India was started first in Calcutta in 1930 and is now being carried on at some other Universities and Institutions also.

The principal centres of ionospheric investigations in England are the National Physical Laboratory, the Marconi Research Department, Cavendish Laboratory and Imperial College of Science and Technology. The British Post Office and the B. B. C. also take great interest in these works but do not carry out directly any researches. They utilise, so far as the development of their communication systems is concerned, the results of observations made by other establishments.

The *National Physical Laboratory* maintains a Radio Research Station at Slough, about 20 miles from London. Dr. R. L. Smith Rose is the Superintendent of the Radio Division of the National Physical Laboratory which includes the Slough Station. The locality being rural and the Station having large open fields, it is eminently suitable for field work. Amongst the ionospheric works carried on here mention may be made of the following:—

(*i*) *Automatic recording of the variation of equivalent height.* A system of automatically recording the variation of equivalent height (P′) of the ionospheric layer (or layers) with time or with the frequency of the exploring radio waves has been developed. The tuning arrangements at the transmitter and receiver are electrically linked in such a way that the oscillator frequency of the superheterodyne receiver is automatically maintained at the correct level above the transmitter frequency throughout the tuning range. Routine observations of these so-called (P′-t) and (P′-f) curves are made daily with vertically incident waves. Vertical rhombic aerials are being used both for transmission and reception, the peak output of the transmitter being about 0·5 Kw.

(*ii*) *Direction finding on short waves.* Some time ago a longer-short wave (30 to 70 m.) direction finding equipment, using spaced aerials of the Adcock type, was developed at the station. Very recently special short wave (down to about 5 metres) super-heterodyne receivers have been developed which permit of very careful matching. A cathode ray oscillograph (high vacuum type) is used as the visual and direct indicator. The system can also be used for aural reception.

(*iii*) *Polarization of radio waves.* A cathode ray comparator was first developed for this purpose. Recently the equipment has been modified for studying the polarization of short-duration pulses of radio waves.

(*iv*) *Measurement of the angle of incidence of downcoming waves.* In designing short wave antenna systems for long distance transmission it is extremely important to know this angle. The cathode ray comparator is very suitable for this work and is being so used at Slough in conjunction with two horizontal aerials spaced a known distance apart.

(*v*) *Development of a new time-base circuit.* In many ionospheric investigations a high speed of the cathode ray spot on the screen is desirable for greater resolution. For this purpose a novel time base circuit is being developed at Slough. The time base period remains 1/50 second, which is convenient for the purpose of synchronization with the A.C. mains frequency, but during this period the motion of the spot is made discontinuous and may be said to consist of three parts. The spot moves very rapidly from the beginning to the end of the sweep, remains steady for some time and then sweeps back to its initial position. The time for the first part of the motion may be controlled and made a small fraction of the total period to obtain greater resolution.

The *Marconi Research Department* also maintains a section for ionospheric research under the guidance of Mr T. L. Eckersley, F.R.S. The maintenance of such a section by a purely commercial organization is in itself a proof of the great practical importance of such investigations. The Research Department was shifted early in 1939 from Chelmsford to Baddow, a few miles west of Chelmsford. The site at Baddow is also clear and level and the open fields are most favourable for ionospheric field work. The pulse transmitter for these investigations is still at the Marconi Works at Chelmsford. The Department also maintains a Receiving station at Broomfield about a mile to the east of Chelmsford.

At Broomfield regular routine observations of (P′-f) curves are taken. The wavelength of the transmitter at Chelmsford is controlled from Broomfield by means of special telephone lines reserved for this purpose. About 10 minutes are required for a complete (P′-f) curve for the Region F and usually three observers are required at the receiver and one at the transmitter.

Investigations on the scattering of wireless waves in the ionosphere are also carried on partly at Broomfield. These are done mainly with special high-power (40 Kw) pulse transmissions from the Marconi Beam Station at Ongar, 12 miles from Broomfield. Observations are also made with omni-transmissions (16 Kw.) from another transmitter at Ongar.

The work at Broomfield consists chiefly of studying the retardation and general nature of the scattered radiation with a cathode ray oscillograph using the normal pulse technique. Observations are made with frequencies both above and below the critical penetration frequency for normal reflection of radio waves from the Region F. The cathode ray equipment at Broomfield which has been lately developed incorporates a time-base of the type being developed at Slough and described above. The mode of operation is, however, entirely different. At Slough the spot movements are controlled by electrostatic forces, while at Broomfield this is done by magnetic forces with the help of a pair of coils.

The pulse transmitter at Chelmsford consists of a push-pull balanced oscillator with series modulation. The radiating system is composed of four vertical rhombic aerials fed in phase. The termination of each rhombic (1,000 ohms) is shunted by a coil of suitable magnitude, whereby on long waves the rhombic is equivalent to an ordinary loop aerial. On short waves, however, the impedance of this coil is large and the termination makes it a real rhombic.

The main ionospheric investigations carried on at Baddow are :—

(*i*) *Polarization of downcoming waves.* A pair of loop aerials fixed at right angles to each other and rotatable round a common vertical support are connected by slip rings to the field coils of a radiogoniometer. Each loop is detuned from resonance, one 45° forward and the other 45° backward. By rotating the loops so that their planes are along the axes of the polarization ellipse (as projected on the surface of the earth) and by setting the search coil at an angle whose tangent is the ratio of these axes, a zero can be found. By using the pulse method the ordinary and extraordinary components may be separated and each studied separately.

Some very interesting experiments are being made for determining the limiting polarization of medium waves reflected from the Region E, the main object being to decide whether the polarization term in the magneto-ionic formula should be retained or not.

(*ii*) *Direction finding by means of spaced frame aerials.* Two aperiodic frames are located 20 metres apart and are fed by twin-wire screened cables to a central unit in the receiving hut. The relative input phases of the signals from the two frames can be changed and measured and the relative input amplitudes can also be altered so as to balance the inputs to the two matched receivers. The outputs from these are, as usual, applied to the deflecting plates of a cathode ray oscillograph. The phase and amplitude adjustments necessary in the central unit to get a linear 45° trace on the oscillograph screen, gives the relative phase and amplitude of the signals induced in the two frames.

The spaced frames are also used to measure the angle of inclination of downcoming waves from the ionosphere.

(*iii*) *Direction finding by spaced vertical aerials of the Adcock type.* The operation is practically the same as that used at Slough. Incidentally it may be mentioned that the spaced frame aerial type of direction finder has been found to give better results.

(*iv*) *Scattering of radio waves.* A long series of experiments is being carried on for the last few years on this subject. The direction, apparent equivalent heights of reflection, polarization and such other characteristics of the scattered radiation have been studied thoroughly with both directional and omni-transmitters. It has been definitely proved that the scattering always occurs in Region E. In the case of beam transmission there are two definite scattering centres. These are located where the beam strikes Region E, first when going up penetrating this region and secondly when coming down (after being reflected from Region F).

Ionospheric Work at Cambridge is being carried on at the Cavendish Field Laboratory by Mr. Ratcliffe and his co-workers. Part of the equipments, specially the transmitters, is located in the grounds of the Solar Physics Observatory and part in the neighbouring grounds of the old Rifle Range. The researches received a strong impetus when Prof. Appleton was appointed Jacksonian Professor of Natural Philosophy at Cambridge University in 1936. Early in 1939, however, Prof. Appleton had to leave Cambridge on his being appointed Secretary to the Committee of the Privy Council for Scientific and Industrial Research.

A series of important experimental works on the polarization of radio waves returned from the ionosphere and on the reflection coefficients of ionospheric regions have been carried out at Cambridge. Several interesting developments in the technique of such measurements have also been made.

During the author's visit some regular observations on long wave propagation through the ionosphere were being carried on. Already a number of interesting results have been obtained regarding the reflection height, polarization and intensities of the downcoming waves and their changes due to magnetic storms, sunspots, aurorae and such other disturbing causes of the ionosphere.

Recently some experiments are being carried on to measure the velocity of wireless waves over the earth's surface. The underlying principle is an adaptation of the pulse technique for ionospheric investigations. A pair of pulse transmitters and receivers are set up at some distance from each other. The pulses sent out from one transmitter are received at the second station which is thereby made to radiate pulses instantaneously. The time interval between pulse emission at the first station and the reception of the back pulse from the second is measured on a cathode ray oscillograph and the velocity of the waves calculated therefrom. It may be noted in this connection that the Cambridge measurements give, for the waves travelling along the ground, a velocity equal to that of light, whereas similar measurements previously made in U.S.A. gave velocities sometimes as low as half that of light.

At Cambridge an apparatus, called the Electric Differentiator, has been developed with which the order of accuracy of height measurement is claimed to be 0·5 Km. This apparatus has been used to study the variation of equivalent height of Region E with solar altitude. The same apparatus is being utilized for detecting the presence, if any, of atmospheric oscillations in Region E due to lunar tides. Some important results have been obtained and the observations are being continued.

The pulse transmitters at Cambridge are grid modulated in contrast with the series modulation system at Slough and Chelmsford. The transmitting aerial is, however, of the vertical rhombic type as is used at Slough and Chelmsford.

At the *Imperial College of Science and Technology*, London, various theoretical investigations connected with the ionosphere are being carried on by Prof. S. Chapman and his co-workers. It may be recalled that the first theory of the nature of

formation of an ionized layer in the upper atmosphere by absorption of monochromatic solar radiation was given by Chapman. Very recently he has remodelled this theory on the basis of band absorption. Problems of upper atmospheric oscillations, of variations of upper atmospheric ionization due to sunspots and due to charged and uncharged particles emanating from the sun and their correlation with terrestrial magnetic variations are also being investigated in great detail. At the time of the author's visit Prof. Chapman was engaged in completing his book on *'Geomagnetism'*.

CONCLUSION

It is futile to compare the conditions regarding teaching, research and industrial development of radio in this country with those of a highly industrialized and wealthy country like England. Nevertheless it is the opinion of the author that even in the existing conditions in this country, a great deal of improvement can be made with a little more of effort and determination. Much advance in research is possible if there be co-operation between the universities on the one hand and the Government departments on the other. With more financial help from the Government and the university, the teaching of Radio could be remodelled for imparting to the students a thorough knowledge of its theory and practice. There is, of course, the difficulty in the absence of industries, to provide, at present, for that special type of training which only a close co-operation between the industries on the one hand and the teaching institutions on the other can afford. Nevertheless, we would only be moving in a vicious circle if we allow ourselves to be deterred by this difficulty. On the contrary, improvement and advancement in teaching and research will have a stimulating effect on the radio industry which is bound to develop with the industrialization of the country in the wake of the war. Men and money are of course needed for the purpose. But in the opinion of the author any increased expenditure on this head will be amply repaid because our trained students will render indispensable help to the growing industries.

In conclusion the author would like to draw the attention of the readers to some of the important features of the teaching institutions as also of the manufacturing concerns which impressed him most.

In the teaching institutions, the most important thing which he observed was the close association which the institutions maintained with the manufacturing organizations. He further found that great importance was attached to frequent meetings of the senior students and the staff for discussions of various topics. The research organizations receive help from the industries through the Board of Scientific and Industrial Research. These organizations are invariably run by a highly specialised staff. When a particular problem is to be tackled, the principal research worker plans the mode of attack and distributes the various aspects of the problem to the respective specialists. The result is that no time is wasted over subsidiary investigations. The data are quickly collected and the work is speedily brought to a successful conclusion. In the industries also there is intense specialisation and this, in the opinion of the author, is one of the principal factors for the maintenance of the high quality of British products.

The author would finally like to take the opportunity of thanking all those who gave him facilities for his studies. It would have been impossible for him to visit and stay at so many places within the short time at his disposal but for the kind and courteous help which was accorded to him everywhere.

Limnological Investigation and Improvement of Villages

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IN my article on Water-hyacinth published in the *Bengal Weekly* of the 13th March, 1939, I dealt briefly with the life-history of this powerful plant-pest. Attempts were made and are being continued with zeal to remove this pest by manual labour and mechanical means. The methods were first advocated by my revered teacher, the late Prof. P. Brühl about 20 years ago, after having carried out prolonged experiments on this plant and on the different chemicals supposed to be capable of killing the plant. Following Professor Brühl, Griffith, Parija and others carried on investigations. The present author as a result of his studies has arrived at the same conclusion as that of Brühl in regard to the method of eradicating this pest. In his several articles he has emphasised the adopting of mechanised methods and more organised labour to fight successfully for the total extermination of this plant. This enemy of ours belonging to the plant kingdom invaded Bengal first, and by its rapid vegetative growth spread like wild fire all over the water expanses of this and the adjacent provinces during the last quarter of a century. The eradication of the pest has thus become a complicated problem and a gigantic task and it is baffling the attempts of the scientists, the State authorities and the public at large for a fairly long time.

It is indeed gratifying that during the last water-hyacinth campaign by the Bengal Government sufficient public interest has been aroused in the matter of eradication of this pest. The cultivators have realised the great economic loss this pest is causing by encroaching on their rice-fields and waterways. Water-hyacinth is now interfering with the progress of irrigation, cultivation, public health, sanitation, pisciculture and water supply in the villages, particularly in the eastern and lower parts of Bengal. It is expected that by more efficient organisation and with the help of suitable machinery an unceasing war will be carried on against this pest, particularly in the affected villages from the beginning of the autumn to the end of the hot season year after year. This task will require the co-operation of the district officers and the rural reconstruction department and should have the solid support not only of our Ministers but also of our public leaders.

There is another set of aquatic vegetation in addition to this pest. Anyone, even a casual rambler, walking along the side of a lake, a jhil, a tank, a pond, or a puddle, and observing plants and animals floating, swaying, dancing and playing in the water in their natural beauty, cannot but wonder at the marvels of pond-life, and will find in them "complete expression of the will of God in things created". This is good for a biologist and a philosopher but if we look from the standpoint of human welfare, the problem of tackling the dense masses of water plants, which often choke up the various types of water in this province, demands, by no means, less serious thought for their control. In the present article, reference has been made to some of the common aquatic plant communities of our tanks, jhils, lakes, ponds and puddles and to the part they play in the economic life of this province. The study of our aquatic vegetation is of considerable importance in tackling the problem of irrigation, pisciculture, sanitation, public health and of provision of good drinking water in our villages.

In a water reservoir, where aquatic plants are allowed to have free play, one finds, other than the vital layer (the bottom layer of fine muddy silt with minute bacteria, algae and lower animals) and zone of rooted aquatics, another zone of submerged plants which generally float in suspension under water. Of such plants the most common species of our country are *Hydrilla verticillata, Ceratophyllum demersum, Myriophyllum tuberculatum, Lagarosiphon Roxburghii, Najas indica, N. foveolata* and the

insectivorous bladderwords—*Utricularia flexuosa, U. stellaris* and others. These submerged suspended aquatic plants in old lakes, tanks, etc., often develop an impenetrable network of dense vegetation in the central column of water. Some of these plants, *e.g., Utricularias,* prefer to occupy the surface layer of water. These plants, like other water plants, propagate more rapidly by vegetative method of reproduction than by sexual method, that is, by seeds which on maturing drop on the mud and germinate. These plants growing from seeds are at first attached to the mud during the juvenile stages of growth, but later on they dislodge themselves from the loose muddy layer and float freely in suspension under water. The fruits of *Ceratophyllum demersum* are, like those of *Trapa bispinosa* and *T. natans* (Panifal), furnished with three spinules at the three corners. When they fall in the mud, they stick on to the soil and are not easily shifted by the movement of the water below. During January and February and sometimes in March too, these plants flower and fruit, and the seeds are available from July to September and October. During the cold season, *Utricularias, Hydrilla verticillata, Ceratophyllum demersum* and other submerged aquatic plants develop vegetatively by another kind of winter buds known as "hibernacula" or "squamulae intravaginales", which also grow out into new plants, thus tiding over the unfavourable season. These plants depend for their growth mostly upon the nutrient salts dissolved in the water. But their occurrence in the middle zone deprive the rooted water plants below much of their light and oxygen. The floating submerged aquatics harbour many epiphytic algae, especially *Conjugatae, (Desmids), Oedogoniales, Ulotrichales, Diatoms, Charecium* and colonial members of *Chlorococcales,* such as species of *Scenedesmus, Pediastrum, Coelastrum, Ankistrodesmus, Oocystis,* species of blue-green algae of the family of *Chroococaceae, Chamaesiphonaceae, Oscillatoriaceae, Rivulariaceae, Scytonemataceae* and others.

The suspended mass of vegetation gradually leads to a denser surface vegetation, partly due to the stagnation of the water and partly to the supply of rich plant food in the form of dissolved salts. The conversion of rotten vegetation and other organic matters into nutrient salts is entirely due to the activity of the putrefying bacteria and schizomycetes of the vital layer at the bottom, where older portions of the vegetation and other organic matters continuously settle down. There is thus a cycle of biological actions and reactions by which the lakes, tanks and ponds are supplied with an inexhaustible store of food materials for the growth of plants. In such tanks there is frequently met with not only a rich macro-phyto-plankton (macro-plankton is composed of a plankton flora whose members are visible to the naked eye) but also amphibious plants. By amphibious plants here are meant marsh plants or those terrestrial plants which grow on moist soils along the edges of tanks and adapt themselves easily to aquatic conditions. The macro-phyto-plankton of our country is mainly composed of the representatives of the family of *Lemnaceae,* of which *Wolffia arrhiza* is a very minute gregarious plant floating in water as green granules. Of similar habit is *Lemna polyrrhiza, L. paucicostata* and *L. trisulca,* which are characterised by their small, round or oval flat leaf-like modified shoots. The aracious *Pistia Stratiotes* and Pontederiacious *Eichhornia speciosa*(the water-hyacinth) are larger members of the Phanerogamic macro-plankton flora. The others belong to *Hydropterideae* (the water-ferns), of which the rootless *Salvinia natans, S. cucullata,* the Brazilian *S. auriculata* and *Azolla pinnata* are quite common everywhere. The largest fern associated with dense growth of aquatic macro-plankton flora is *Ceratopteris thalictroides.*

The micro-phyto-plankton of this warm country is not fundamentally different from those of the other warmer parts of the world. Of the representatives of the micro-phyto-plankton, the blue-green alga *Clathrocystis aeruginosa* is the most dominant species found all over the Indian Empire in lakes, tanks, pools and other water reservoirs floating in great abundance as minute blue-green granules. This alga is not infrequently mixed up with other plankton species of *Cyanophyceae,* such as *Microcystis flosaquae, Anabaena flosaquae, A. indica, Spirulina major, S. platensis.* Associated with these are sometimes found mucous nodules of *Gloetrichia pisum* and *G. natans.* These members of *Nostocaceae* are at first attached but later on found floating. The green algae, such as *Velvox Aureus, Pandorina morum, Gonium pectorale, Chlorella vulgaris,* and zoospores of *Ulotrichales* floating in enormous numbers form either pure or mixed association. Diatoms: *Synedra affinis,* and its var. *fasciculata, S. ulna, Melosira sp., Fragilaria sp., Nitszchia* sp., and others; *Desmids*: *Cosmarium* species, *Closterium species, Euastrum* species, *Xanthidium* species, *Staurastrum* species; *Scenedesmus*: *Scenedesmus quadricauda, S. prismticus S. brasiliensis, S. obtusus, S. acuminatus; Pediastrum*: *Pediastrum tetras, P. duplex,* and its var. *clathratum; Coelstrum cambricum; Ankistrodismus falcatus* and others, are the common constituents of micro-plankton flora. Both the unicellular and colonial members of the micro-phyto-plankton exhibit various peculiar adaptations for the purpose of floatation, locomotion and absorption of food materials. Mixed with these green algae are also found ciliated representatives of unicellular green algae Dinoflagellata. Of the Flagellates, Euglena is the most common in the lakes, tanks, and particularly in smaller pools and puddles where the water is rich in organic matter. Due to the variation in intensity of light the Euglenas change their colour from green to brownish red.

The water of the filterbeds is supplied from the pre-settling tanks. These feeding settling tanks of the filterbeds harbour a luxuriant stock of rooted aquatic and submerged vegetation nearly choking up the whole area. This accounts for the rich organic contents of the water of the filterbeds. The growth of the smaller members of micro-phyto-plankton, as found in the filterbeds running for a few days, is interfered with by the development of filamentous algae, such as *Tribonema bombycinum, Hydrodictyon reticulatum, Cladophora crispata.* These algae at first grow on the beds of sand of the filterbeds, but later on dislodge from the bottom. They then gradually rise to the surface due to the pressure exerted by the bubbles of gas (oxygen produced as a result of photosynthesis) caught up in the plankton or 'tricho-plankton'. Of this 'tricho-plankton' formation, when one dominant species forms more or less pure association, as frequently found in the filterbeds, they are distinguished as a particular association of that species, such as Tribonima association or Tribonemetum, Hydrodictyonetum and Cladophoretum. Thus floating in dense masses these filamentous algae finally choke up the entire bed. This condition leads to serious damage of the beds due to fissures caused by the uplift of the algae breaking up the vital layer which is highly beneficial to filtration. The large filamentous algae of 'tricho-plankton' harbour in its turn a huge stock of animal organisms by supplying food and shelter. Among the animal organisms, *Crustacea, Mollusca,* worms (Nematodes) etc., burrow holes in the beds of the filterbeds which destroy the vital layer and seriously interfere with the action of filtration. Further their excrements and respiration disturb the biological balance of the water of the filterbeds by inhibiting the self-purificatory action of the micro-phyto-plankton. The favourable action of the micro-organisms of the vital layer of the filterbeds, and consequently the action of filtration is in this way considerably checked.

In stagnant lakes, ponds, etc., which harbour a rich submerged and surface vegetation, the biological conditions of the water like those of choked-up filterbeds are also entirely upset. The submerged vegetation under the screen of a dense surface vegetation gradually dies in the absence of light and oxygen. They then settle down and rot at the bottom. The rooted members of the aquatic plants beneath, after mouldering to death under the double roof of surface and suspended vegetation, gradually decompose. The micro-plankton, and in some cases the smaller members of macro-plankton flora, are eliminated at the very outset, as they are unable to cope with the rapid growth of the larger members of mega-plankton flora and amphibious plants forming the surface vegetation. The water of such tanks and pools, thus devoid of light and oxygen, becomes surcharged with the excess of humic acid, carbonic acid and other injurious productions of putrefaction bacteria, such as ammonia, sulphuretted hydrogen, acetic acid, peptone and other various compounds of complicated structure. The colour of the water of such tanks, ponds, etc., appears dark brown due to rich humus contents. Such unhealthy condition of water is detrimental to all freshwater fauna, not to speak of human beings and consequently the edible fauna with others soon disappear for want of food materials in the form of lower members of the animal kingdom, such as *Cyclops, Copepods, Rotifers, Paramecium, Amoeba* and various others living on the micro-phyto-plankton. Their absence in such foul water is partly due to want of oxygen, illumination and insanitation and partly to abundance of poisonous elements prevailing in such unhealthy waters. The prevalence of fish mortality in jhils, tanks, ponds, etc., in this country causes great economic loss. This phenomenon generally takes place during the hot days before the advent of the monsoon. The cause of such fish mortality may perhaps be partly ascribed to the upsetting of the biological balance by the aquatic vegetation in a jhil, tank or pond.

These biological causes thus lead not only to unhealthy state of water in tanks, jhils, ponds and puddles in our villages but sometimes choke them up completely. Such a state of affairs produces considerable scarcity of drinking water in the villages. Bengal is drained by a number of rivers and waterways but in spite of this there is so much scarcity

of water. The unhealthy state of water due to vegetable growth also raises a fundamental difficulty in maintaining public health, particularly in regards to epidemics of malaria. The life history of parasite-carrying mosquitoes, in larval stage, is intimately associated with the aquatic vegetation of the country and it should be of special interest for the malario-logists to study these aquatic plant communities to ascertain the distribution of these mosquitoes.

The great energy of the micro-phyto-plankton, and the micro-organisms at the bottom, absorbing and utilising in various ways the diverse kinds of organic substances resulting in maintaining a bio-logical balance in water, is generally spoken of as the "self-purifying" action of water. For the maintenance of the balance of self-purificatory action of water it is obvious that the lakes, tanks, ponds, etc., must be devoid of surface vegetation, macro-plankton flora and suspended submerged vegetation. The rooted plants utilising the nutrients from the mud should be allowed to grow to a certain limit, as their existence is favourable to the development of micro-phyto-plankton. The micro-phyto-plankton is the chief source of food for *Rotifers* and *Crustaceas*, which in their turn serve as food to smaller aquatic animals. These are again devoured by larger fishes which finally form an important diet of human beings.

In these days, when there is a cry everywhere for economic return of scientific undertakings, and as the value of the results of scientific investigations and discoveries is sometimes estimated in rupees, annas and pies, I may be permitted to emphasise the great commercial importance of pisciculture in this country and particularly in Bengal. In Bengal there is an enormous field for scientific cultivation of fishes which might result in an inestimable money value. As some of the fishes feed on mosquito larvae, fish cultivation is useful for anti-malariological work too. Scientific pisciculture leads to biological investigation. In Europe and America it has attained a very high stage of advancement. In our country we are still hesitating to take up such investigation and speculating about its profit and loss. Proper limnological researches require a team work of biologists, chemists and phy-sicists—the latter to study the plant food in the form of nutrient salts dissolved in the water, physico-chemical changes under diverse con-ditions at different times of the year and so on. Investigations of the relation between plant and animal life, their periodicity and life-history and similar other problems should be tackled by biologists. Our rivers hold potential treasures in the various kinds of edible fauna. Some of the most favourite fishes, such as *Hilsa*, *Vetki*, and others pass a particularly important period of their life-history in these rivers. The rivers and streams also act as great migratory agents, and the biologists have to reveal the secrets of distribution of the flora and fauna and control their migration in our lakes, jhils, tanks, ponds, etc. The economic salvation of the country can therefore be partly attained by developing this enormous wealth of vegetable and animal resources of our land and water by modern scientific methods. We should therefore spare no pains to undertake and sustain researches in the field of biology.

Telescope Making at Home

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(Continued from the last issue)

DIFFERENT TYPES OF TELESCOPE

So far we have described how a small telescopic mirror of general type can be prepared and tested by the simple equipments at home. Larger mirrors, 18 or 20 inches, can also be made in a similar way but greater difficulties are encountered in course of the process. Larger mirrors are more powerful, and the power increases more rapidly with its diameter. The mirror-surface increases proportionally to the square of its diameter and much intensity is thus obtained. It enables the telescope to produce higher magnification without impairing the bright view.

Besides grinding larger and larger mirrors, amateurs will find it interesting to attempt different types. A few of these used for different purposes are described below:

R. F. T.: Amateur telescope-makers who have gained some experience in the technique of grinding and testing general types of mirrors may proceed to prepare a short-focus for making a Richest Field Telescope or the R. F. T. Not only it has to be scooped too hollow which is a hard labour, but the testing and parabolizing will also be a difficult task. Such mirrors have short focal length near about F/4. This gives a short tube length making it a handy instrument. R. F. T. is used with eye-pieces giving nearly 20 magnification showing an angular field of view of about 2°. As the short focus mirrors have high light-gathering power they show up wonderfully sparkling image.

Long-focus Mirror: The long-focus objective making should be taken up by a person who has gathered experience in astronomical studies. He may become a sort of professional astronomer in the sense that he may utilize this type for a specific type of astronomical observation. Such long-focus objec-tives are specially suited for photographing the solar features in general and the eclipse, in particular.

There are very few amateurs who have prepared a solar mirror. The size of the solar image is given by S=0·0093F, where, S denotes the image diameter, and F the focal length of the objective. Thus in order to get an image of 2 inches in diameter, the objective should have a focal length of about 18 feet.

Clyde Tombough who discovered the planet Pluto, prepared a 12-inch F/12·3 solar mirror with plate glass, and used it unsilvered. This gave 1·4 inch image size of the sun. With 200 astronomical magnification the details of sun-spots, grains and faculae were clearly visible. The biggest Solar Tower at Mt. Wilson consists of 60 ft. focus, 24-inch mirror (F/30). giving a solar image of 6·7-inch in diameter.

Cassegrainian Mirror: For many of the ama-teurs considerable interest will lie in making Casse-grainian mirror with short focus and perforated at the centre. This gives short tube-length, direct vision and high magnification. The mirror is usually about F/4 and perforated with a hole about 1/5 the diameter of the disc. The auxiliary convex mirror which is of the size of the perforation, has its focal length depending upon the resultant focal length re-quired of the system. Obviously enough, the shorter the focal length of the convex, the longer is the focus of the combination. But usually the convex has focal length of about 1/4 or 1/5 that of the primary concave. The convex mirror for the Cassegrainian combination may be conveniently made from a spectacle lens of suitable power (curvature), silvered at one face by the Brashear's process described early.

The perforation is generally done after the mirror has been prepared. A 6-inch Cass may be perforated with 1 or 1¼-inch hole. It is done by a copper or brass tube of the same external diameter, driven by an electric drill and fed with carborundum powder. No. 120 carborundum should be used first, and when some depth has been obtained, coarser

grade may be used to get quick cutting action. But towards the end, No. 120 must be reverted to in order to avoid the risk of chipping. Gentle pressure and low revolution (about 200 r. p. m.) of the drill should be used. One inch plate will take about 1½ hour to perforate through. The first surface drills cleaner than the succeeding where chipping is more likely to take place. It is therefore advisable to begin the drilling from the optical surface taking sufficient care not to scratch it with abrasive. A

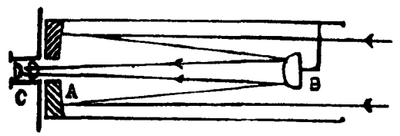


FIG. 9.
Cassegrainian Telescope. *A*. Perforated concave mirror. *B*. Secondary convex mirror. *C*. Eyepiece.

coating of lacquer-varnish may be painted over the surface to give a protection. When the drilling is complete, the coat may be peeled off and washed with ordinary methylated spirit which is its solvent.

The F/4 Cassegrainian primary may also be used very well as an R. F. T. in the usual Newtonian form, and both the features may be retained in the tube. Such a double featured mounting gets the abbreviated name "Newt-cass".

Off-axis Mirror : A new technique has been evolved to eliminate the small diagonal mirror in a Newtonian telescope. The diagonal stops a small fraction of light ; but that is not why it is to be avoided. The obstruction presents itself as a source of diffraction centres, and that impairs the quality of the image. In spite of its perfect achromatism and high light-gathering power, it forms an image which is somewhat inferior in optical quality as compared with that formed by a refractor.

This was experimented upon by W. H. Pickering, who stopped the mouth of a reflecting telescope with a diaphragm having a small circular aperture on one side of the axis. The light passing down the tube did not therefore run across the diagonal which was on the axis of the mirror. In this experiment it was found that although the illumination was heavily cut down, the quality of the image improved. Thus one can cut a parabolic mirror into halves (rather a little smaller) and use the diagonal just outside the path of incoming rays. But it will be painful for the grinder to cut his large mirror into small ones. It is however possible to give a small mirror a sort of tilted curvature so as to drive the optical or geometrical axis of the parabolic mirror outside the mirror itself. In fact, such off-axis mirrors are existing, and experienced amateurs are taking interest in preparing such mirrors. There is however no definite method which may be prescribed for making an off-axis mirror. It depends entirely on the experience and sense of feel of the worker. The testing is also a difficult problem here.

LARGE MIRRORS

Larger mirrors are more prone to catch local defects. What is more primary, the weight of the disc and the force of drag will land the worker in serious complications. The danger of vacuum seizure of the mirror with the tool will increase in the same way. It should be remembered that larger diameter will necessitate thicker disc, otherwise defect of curvature,—specially due to sag and temperature effect,—will come in. Usually, one should not attempt mirrors larger than 10 inch with 1-inch thick plate, although it is customary to keep ⅙ to ⅛ as the ratio of the thickness to the diameter of the disc.

But if sufficient care is taken, thinner plates may serve quite all right. The 12 inch F/12·3 solar mirror referred to in connection with long-focus mirrors was made out of 1¼ inch plate. The ratio of thickness to diameter is 1/10·7. The author has seen 10-inch optical flat made from ¾ inch plate, giving the ratio 1/13·3. But it is always better to get thick ones for the telescopic mirrors.

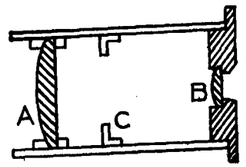
Taking density of glass to be 0·097 lb. per cu. in., a 12 in. × 2 in. disc. will weigh 22 lbs., 16 × 2-disc about 49 lbs. and 20 × 2½-disc about 80 lbs. But large mirrors are not made out of solid discs ; they are usually honeycombed at the back. This makes the mirror light yet strong, and facilitates equalization of heat in the changing temperature during grinding and during observation.

So far an amateur has worked up a 21-inch Pyrex completely by hand. It is about 3½-inch thick and weighs about 100 lbs.

EYE-PIECE

A mirror and an eye-piece make a telescope optically complete. The astronomical magnification

is given by the ratio of the focal length of objective to that of eye-piece. A ½-inch eye-piece will give a magnification of 100 when used with a 50-inch focus objective. The choice of eye-piece depends chiefly upon the magnification desired. For a 6-inch mirror, magnification up to 50 may be called 'low', 50-100 'medium', and above 100 as 'high' magnifications. For low and medium magnifications, Huygenian or Ramsden eye-pieces are quite suitable. But for higher powers some kind of achromatic eye-piece should be used. Among achromatic varieties the 'orthoscopic' (triple cemented field-lens, single eye-lens) is most reputed. It is a great asset for the telescope maker to possess a 7 or 9-mm focus orthoscopic eye-piece for high magnification.



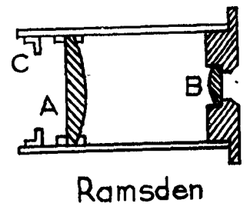


FIG. 10.
Two different Eye-pieces.
A. Field lens ; *B*. Eye lens ;
C. Field-stop at the plane of image.

As regards making the eye-pieces it is quite within the reach of an amateur to construct the Huygenian and Ramsden types. These do not require achromatic combinations. The same variety (refractive index) of glass is used both for field-lens and eye-lens. Apart from actually grinding them up it may be possible to get small plano-convex lenses, as spare parts of other instruments, suitable for housing them into a small tube to make a Huygenian or a Ramsden eye-piece. One source is the watch-makers' magnifier, but that has rather too long a focus. But the view-finder lenses of small cameras are often found with suitable focal length, and they may be obtained at cheap rates.

If both the lenses are of equal focus (f), they are suitable for a Ramsden. The lenses are separated by a distance of about ⅔f, giving the resultant focus F = ¾f. The general formula for the resultant focus is given by $F = ff'/f+f'+d$, where f and f′ are the focal lengths of the two lenses separated by a distance d. It should be remembered that for convex lenses the d has got the opposite sign. For convenient calculation, we may put f and f′ as positive, d negative. Putting for a Ramsden, f = f′ and d = −⅔f, we get F = ¾f. For Huygenian, we have usually f = 2f′ and d = −½f′ = −⅓f, so that the resultant F = ⅔f. Sometimes f = 3f′, and d = −2f′ = −⅔f (always the distance is half the sum of the two focal lengths, in a Huygenian), giving F = ¾f.

In order to grind lenses for eye-piece a $\frac{1}{10}$ or ⅛ h.p. electric motor is necessary. The diameter of field-lens is generally less than an inch, while that of the eye-lens is only about ½ of an inch. If a good piece of glass (such as a microscope slide, or a zero-power flat spectacle glass) is used, only one surface has got to be worked up convex by means of a brass or iron 'tool' according to the calculated curvature. For a plano-convex, the focal length will be given by $1/f = (\mu-1)/r$, where f = focal length of the lens, μ = refractive index of the specimen of glass, and r = radius of curvature of the convex surface. Taking $\mu = 1{\cdot}5$ roughly, f = 2r ; we have therefore a general rule that the focal length of a plano-convex lens of crown glass is equal to its diameter of curvature. It is however found that ordinary crown glass has μ between 1·51 to 1·52, so that the simple rule includes an error of 2 to 4 per cent. for the focal length on the shorter side.

To begin with, the glass is cut into octagonal blank and held at the end of the motor spindle by means of resin, melted by a spirit lamp. It is however better to use a brass cap about one inch long fixed with a screw to the motor spindle. This will ensure easy manipulation with the lens. The speed of the spindle may lie between 500 and 1000 r.p.m. A separate spindle mount, with belt coupling to the motor, will serve better. It will keep the motor safe from water and abrasive. The octagonal glass piece is edged into a circle by holding a bent thin strip of zinc or iron sheet fed with carbo. 80 and water.

It is better to use two sets of grinding tools,—one for roughing and the other for fine grinding. The roughing is begun with the carbo.80 and continued till the required curvature is obtained on the glass. It is then changed over to the next grade No. 120, and then to No. 220. The fine tool is then used, beginning with 220. It is needless to mention that the lens and the tool must be washed up carefully between the change of grades.

The polishing is also carried on the spindle, using rouge on pitch or resin-beeswax (95% + 5%) lap on the face of a small piece of wood. The lap may or may not be channelled into a 'honeycomb'. The surface after polishing should be carefully watched with a good magnifier so that no hazy patch remains. Continuous polishing will clear all such unpolished region. Polishing being over, the housing of the field-lens and eye-lens into a brass tube to make an eye-piece needs no special instruction. A field-stop should be placed at the plane of the image. Provision for dark glass attachment may be made in order to facilitate solar observations.

MOUNTING

We now come to the mechanical side of telescope making. In fact, as experience will show, this is more troublesome than the making of mirror or eye-piece. Although we shall always call a six-inch telescope a 'small' one of its kind, it will nevertheless make quite an unwieldy instrument.

There are two essential forms of mounting—the altazimuth and the equatorial. An altazimuth mounting will give the telescope all possible rotations on a fork and vertical axis (fig. 11). An equatorial mount (figs. 12 and 13) will give, in addition, a provision to follow the apparent travel of the stars in the sky. This makes the axis inclined towards the pole star. This is therefore called the 'polar axis' of the telescope. The other axis of rotation is called the 'declination axis'. The astronomical field of view diminishes with increasing magnifications. Usually a magnification of 50 will show a circular field nearly 1° in angular diameter, ½° for 100 magnification, and so forth. Such small fields sweeps away within a minute, so that readjustment of the telescope becomes necessary. In an equatorial telescope the polar axis is just turned a little in order to catch up the escaping star.

If the mirror turns out very well and if any serious observation is to be taken with it, the mounting should be made heavy (it usually comes out to be 200 lbs.), perfectly free from shake, and smoothly turning about the axis. The bearings of the axis

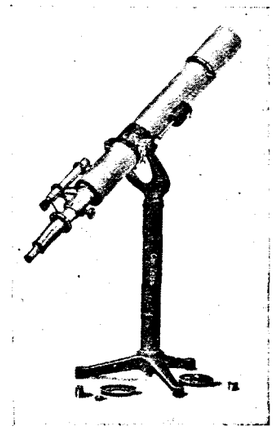


FIG. 11.
Altazimuth Mount in Fork and Vertical Axis.

however need not be on balls ; bush-bearing of brass will do. The tube may be made from 24-gauge galvanized iron sheet, with a ½-inch flange reinforced

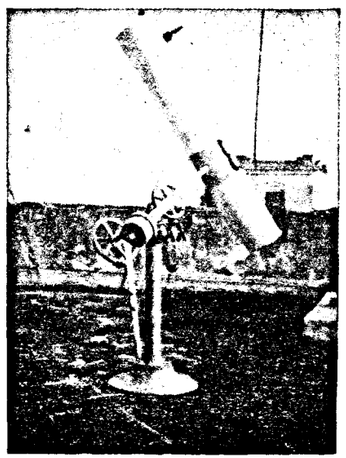


FIG. 12.
Seven-inch Newtonian Equatorial Telescope made by the author. Pillar stand 3¼ ft.; telescope tube length 5½ ft. diameter 10 ins.

at the lower end, so that the mirror holder with similar flange may be clamped on with three small bolt-nuts. When not in use, the mirror case may be easily removed from the telescope and be covered with a cap. This will prolong the life of the silver film. The tube may also be made in square section out of ½ or ¾-inch thick teak wood, as is seen in fig. 13. Such tube will make the fittings and attachments very easy.

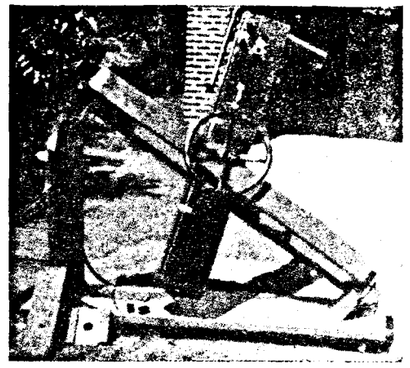


FIG. 13.
Wooden Equatorial Mount.

A properly working worm-and-gear slow drive for the polar axis will make the telescope very useful, but all these details require a substantial assistance of a workshop. Details of mounting cannot be given in the limited space of this article, but a few typical forms shown here will give the reader a general impression. The amateur maker should use his discretion in devising the plan with the facilities available.

HOUSING THE TELESCOPE

Even when the whole thing is complete, the telescope cannot be used profitably unless housed in a dome of suitable size. This will protect the heavy instrument from sun and rain, and also from the disturbing air draught. A 10-12 ft. dome with about 2½ ft. slit opening will do for a 4-ft. focus telescope. Those who live outside towns and have a small plot of land attached to the house, can build up easily an astronomical observatory and the dome with wooden or bamboo frame-work finally covering it with cheap matting and canvas.

NEED OF AMATEURS' ORGANIZATION IN INDIA

Scientific hobbies not only provide a valuable pastime to the people directly concerned, but they also immensely help the progress of science and industry. They also arouse public interest in science. There have been many valuable systematic as well as chance discoveries made through the hobby-work of amateurs. Scientific studies as hobbies are very much encouraged in other countries where they have been organizing clubs for amateur workers in astronomy, wireless, photography, motoring, gliding, etc. Unfortunately, hobby is not looked upon in this country with the same spirit. The need for arousing public interest in science does not require restressing. Scientific bias in people's mind is necessary for India's industrial development. One way to achieve this is by encouraging the young people who have taken up scientific and technical work as a hobby.

India being near to the equator, she gets an extended view of the southern sky, which is not enjoyed by the United States or England. This opportunity may serve as an initiative for organising an amateur astronomers' association in this country. It appears that this amateur astronomers' association may be conveniently organized through the co-operative agency of the Indian universities.

Recent Advances in Our Knowledge About Certain Enzymatic Reactions in the Living Cell*

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INTRODUCTION

ABOUT two decades ago Willstätter aptly stated that life may be regarded as a system of co-operating enzymatic reactions. Indeed when we consider that all metabolic processes of the living cell concerned in its manifold activities, such as hydrolysis, oxidation, reduction, disintegration, synthesis, etc., depend upon enzymes for their proper execution, we realise the intimate connection between enzymes and that state of existence which we call life. The understanding of the course of events in the living cell, which is the simplest unit of life, in terms of the established concepts of physics and chemistry has been the concern of scientists ever since the time of Lavoisier (1780) who declared "La vie est une fonction chimique". But the chemical transformations brought about by the living cell could hardly be imitated outside it, and it was only fifty years later when Berzelius (1836) introduced the concept of catalysis and Wöhler (1828) synthesized urea that Lavoisier's view could be harmonized. With the isolation of diastase from germinating seeds by Payen and Persoz (1833) the idea and role of enzymes became more firmly established. The early history of enzymes and their function in the living cell is closely associated with the phenomenon of alcoholic fermentation by yeast. The controversy between Liebig and Pasteur (1870) is too well known to be recounted here. Liebig (1839) twenty years earlier had developed a purely chemical theory of enzyme action and he was genuinely pained to see a very important chemical change, namely, the conversion of sugar into alcohol, once again being relegated to the domain of that mysterious vital force from which chemistry had just been rescued by Wöhler's brilliant synthesis of urea. Yet the experimental evidence adduced by Pasteur was too strong to be dismissed so easily as had been earlier in the cases of Schwann, Kutzing and others. Liebig was ill at ease and delayed his reply almost for twelve years. However, soon after, Buchner (1897) obtained a cell-free extract capable of causing fermentation and the problem was solved in a manner satisfactory to both sides.

Buchner's discovery of zymase brings us almost to the modern era of enzyme research. Harden and his co-workers discovered co-enzymes in 1904 and the essential intermediary formation of a phosphoric acid ester of hexose in 1908 for the successful breakdown of sugar in the cell. Neuberg (1911) discovered another enzyme, carboxylase in yeast, which decarboxylates α-keto acids and thus proved the disintegration of pyruvic acid to be a definite stage in the process of fermentation of sugar. These landmarks in the early history of enzymes are summarized in Table I.

TABLE I

LANDMARKS IN THE EARLY HISTORY OF ENZYMES

1820	Planche :	Discovered the first enzymes.
1833	Payen & Persoz :	Isolated diastase from germinating seeds.
1836	Berzelius :	Described fermentation of sugar as a catalytic process.
1839	Liebig :	Developed a purely chemical theory of Enzyme action.
1857	Pasteur :	Demonstrated alcoholic fermentation by living yeast.
1870	Liebig & Pasteur :	The well-known controversy.
1897	Buchner :	Prepared a cell-free extract capable of causing fermentation; discovery of zymase.
1904	Harden & Young :	Discovered co-enzymes; zymase consists of apozymase and co-zymase both of which are necessary for fermentation.
1908	Harden & Young :	Isolated hexose diphosphate } and showed these to be the intermediary products of fermentation.
1914	Harden & Robison :	Isolated hexose monophosphate }
1911	Neuberg :	Discovered carboxylase and showed the disintegration of pyruvic acid to be a stage in the process of fermentation of sugar.

Twenty years which followed were spent in lot of spadework and lot of theorizing. During this time hundreds of enzymes were discovered, each highly specific in catalysing a particular chemical transformation. Confining our attention to a particular phase of cellular activity, namely, the disintegration of hexose in the cell, we find that a number of intermediary compounds were isolated and on this basis a number of theories were advanced regarding the course of the reactions. As a result of this work two facts stand out very clearly :

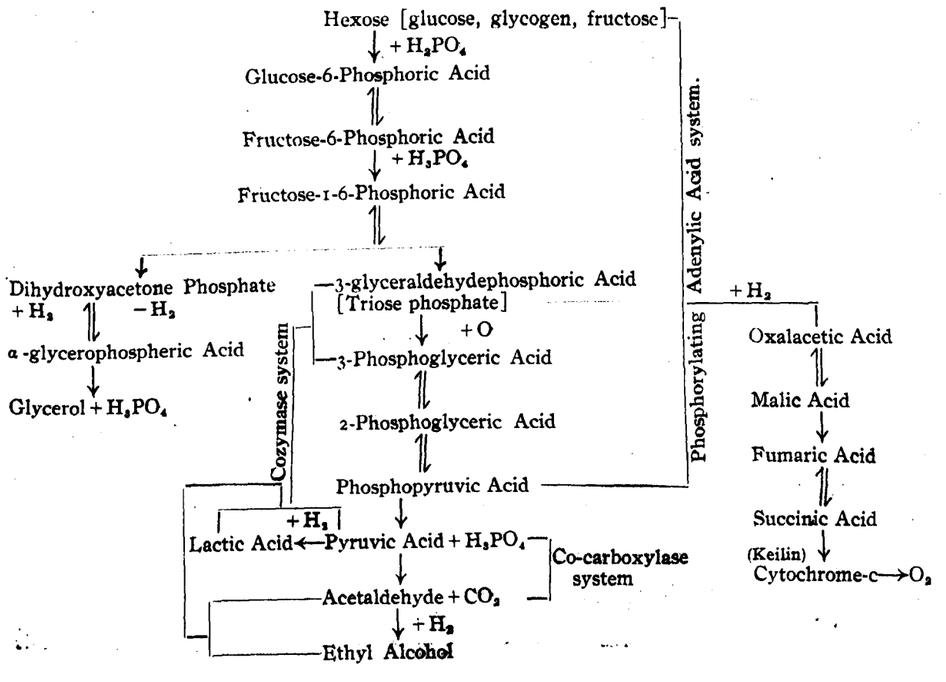
(*i*) That the disintegration of the hexose molecule in the living cell occurs in a series of intermediary stages and a series of enzymes are necessary to bring these about.

(*ii*) Reactions involved in the transformation of the sugar molecule to alcohol in the yeast cell, and lactic acid in the muscle cell are more or less similar in character.

The techniques of organic chemistry which rapidly developed during these years helped to unravel the complicated changes and firmly established the various stages in which the reaction occurs. Without going into any technical details or into the account of thirty years of laborious research which preceded this achievement, the result can be at once placed in the form of a summary (Table II). The understanding of these facts is necessary for the proper appreciation of the recent developments.

In the above brief introduction I have shown one series of transformations, or chemical events which take place in the living machine. What would be however more fundamental in understanding the living unit is the mechanism by which these transformations take place. To continue the analogy of a machine, we have taken the machine to bits and we know its component parts. But unless we know the function, the arrangement and the inter-relationship of those parts, our knowledge about the machine would be very meagre. If we at all know the machine well, not only should we be able to take it to bits but also to reconstruct the original. Therefore the knowledge about the functions or inter-relationship of the different components is fundamental to the understanding of the living cell. This knowledge has just begun to develop

TABLE II

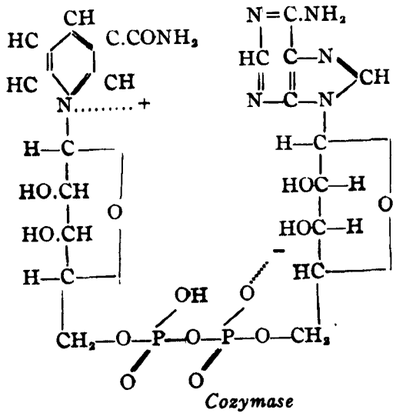


during the last 4 or 5 years. Though what we actually know is very little, but even at this stage, the importance, the applications and implications of this knowledge are tremendous.

COZYMASE

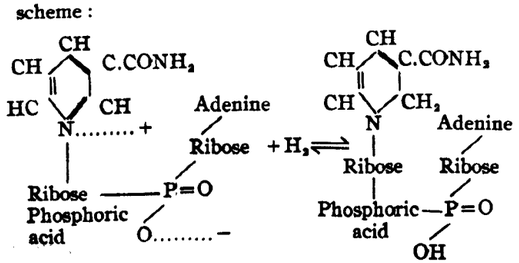
First of all, let me take the case of cozymase. Cozymase is the prosthetic group of zymase in which it is combined with the protein carrier or träger. The first separation of cozymase in 1904 by Harden and Young has already been referred to above. In 1918 Myerhof made the important discovery that the cozymase of yeast also occurred in the muscle and other tissues of animals. Recently Warburg (1936), and Euler and Schlenk (1936) established the chemical composition and constitutional formula of cozymase.

It consists of two molecules of phosphoric acid, two of ribose, one of adenine and one of nicotinic acid amide.



Cozymase

Warburg and Euler have shown that nicotinic acid amide is the active group in the molecule, the nitrogen atom of the pyridine ring being reversibly reduced or oxidised according to the following scheme:



Or briefly:

Substrate + Cozymase ⟶ Cozymase. 2H + Oxidised substrate.

In alcoholic fermentation and muscle glycolysis the following reactions take place:

1. Glyceraldehyde Phosphate + Cozymase ⟶ Glyceric acid phosphate + Cozymase.2H.
2. Cozymase.2H + Acetaldehyde ⟶ Ethyl alcohol + Cozymase.

or 3. Cozymase.2H + Pyruvic acid ⟶ Lactic acid + Cozymase.

Here thus we have a definite insight into the nature and the function of cozymase in carbohydrate metabolism of the cell. The practical implications of this knowledge will be interesting here.

As already stated the active grouping in cozymase is nicotinic acid amide. The dietetic factor concerned in pellagra was identified to be nicotinic acid in 1937 by Elvehjen and others at the University of Wisconsin. Pellagra, a condition characterised by a severe dermatitis, severe gastro-intestinal disturbances accompanied by mental symptoms has been endemic in many areas, particularly in U. S. A., Egypt, Italy and Rumania. Even in the advanced and relatively prosperous country of U.S.A. pellagra claimed as many as 7,000 victims annually until recent times. Quite a large number of cases continue to be reported from England, Denmark, and other European countries. It was believed that pellagra does not occur in India but during the last few years several cases have come to light. Since the identification of the P.P. factor as nicotinic acid, experimental nicotinic acid deficiency is being intensively studied in the dog, in the pig and the monkey in which a condition akin to pellagra results. With regard to clinical experience with nicotinic acid, I have only to quote the following typical statement by Mathews:—

"The most striking as well as the most gratifying observations in my clinical experience were the rapid healing of lesions from the alimentary tract with the development of an excellent appetite and gastro-intestinal function and the spectacular disappearance of mental symptoms".

More recently 150 cases of an encephalopathic syndrome characterised by clouding of consciousness, cogwheel rigidities of the extremities and uncontrollable grasping and sucking reflexes, are reported from New York which have responded to nicotinic

acid therapy. Hitherto this condition had been almost always fatal. The authors of this report believe that these were cases of more complete nicotinic acid deficiency.

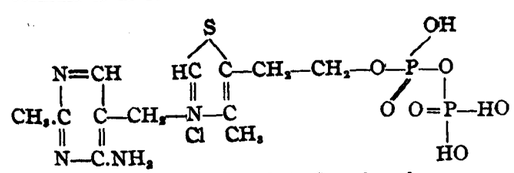
These two grave conditions are enough to illustrate the dangers of nicotinic acid deficiency. We know nothing as yet about the mild, unrecognised condition which may be equally detrimental to health. Nicotinic acid is not only essential for the higher species of animals but also for protozoal and bacterial growth.

The coenzyme function of nicotinic acid possibly represents the main tissue activity of this substance, though the possibility of other additional functions cannot be excluded. It has already been shown that cozymase of blood decreases in both pellagrins and diabetics (Spies, 1939). This is corrected by the administration of nicotinic acid in either case, and the continued administration increases very much the cozymase content of blood.

Recent nutritional studies have again shown that certain minerals namely, manganese, cobalt, zinc and magnesium are essential for normal nutrition of animals, even though in very small traces. We did not know what functions these minute traces of minerals could possibly have. Now we are beginning to have a glimpse into this problem. It is found that sodium ions inhibit the action of cozymase. Manganese ions counteract this inhibition by sodium ions, and actually augment the action of this enzyme. Magnesium ions have been found to be necessary for the action of another enzymic system (adenylic acid).

COCARBOXYLASE

Twenty years after the discovery by Neuberg in 1911, of the enzyme carboxylase, which decarboxylates α-keto acids, Auhagen (1932) described its coenzyme. Two years ago Lohmann and Schuster (1937) succeeded in identifying it as thiamin pyrophosphate or vitamin B_1 pyrophosphate. The formula is as follows:



Thiamin-pyrophosphate-Cocarboxylase

The function of cocarboxylase is to decarboxylate pyruvic acid to acetaldehyde

$$CH_3.CO.COOH \longrightarrow CH_3CHO + CO_2$$

In this case also, magnesium and manganese ions increase the activity by the enzyme, while acetaldehyde inhibits it.

This discovery at once threw flood of light on the function of vitamin B_1 in animal tissues. Vitamin B_1-deficiency was known to produce the following derangements:

(*i*) The accumulation of pyruvic acid in the blood, brain and other tissues of the animal.

(*ii*) Very much increased excretion of pyruvic and lactic acid by way of urine.

(*iii*) Low oxygen uptake by the tissues *in vitro*.

(*iv*) Low heart rate due to the accumulation of pyruvic and lactic acids in the heart muscle.

(*v*) Severe polyneuritic symptoms in birds, rapidly cured by administration of vitamin B_1.

(*vi*) Decreased sugar tolerance.

(*vii*) Failure of appetite, gastric and intestinal atony.

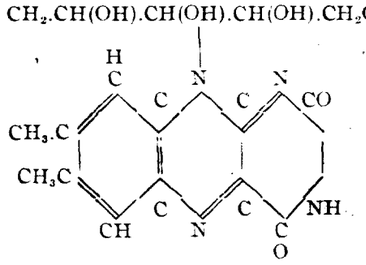
Now all these symptoms are easily understandable when we know that vitamin B_1 is a constituent of cocarboxylase whose function is to oxidise pyruvic acid. In the deficiency of the vitamin the accumulation of pyruvic acid in the tissues occurs and gives rise to all the symptoms and derangements of carbohydrate metabolism described above. It has also been found that there is a reduction of cocarboxylase in the tissues of vitamin B_1-deficient animals and that synthesis of cocarboxylase takes place if vitamin B_1 is administered.

The exact mode of action of cocarboxylase in animal tissues, however, is not yet fully understood, though it is connected with the metabolism of pyruvic acid.

RESPIRATORY ENZYMES

Now let us take the case of another type of enzyme which is not so specific as cozymase or cocarboxylase but is a nonspecific oxygen carrier in cell respiration. In 1933 Warburg and Christian discovered a new type of "Atmungsferment" from bottom yeast. It became soon clear that it consisted

of a protein carrier of high molecular weight to which a yellowish-red dye was attached and which belonged to the class of flavines, a group of pigments widely distributed in nature in both the plant and the animal kingdom. Warburg and Christian found that this enzyme not only had the biological oxygen-carrying properties, but this could also act as a hydrozen acceptor and bring about dehydrogenation of biological substrates. At the same time when Warburg and Christian discovered this remarkable enzyme, Györgyi, and Kuhn and Wagner-Jauregg discovered that flavine constituted the major part of the vitamin B_2-complex. In the following year Kuhn completed almost all knowledge about the flavines—formula, constitution, synthesis:



6,7,dimethyl-9-l-araboflavin.

Thus have we had at once a discovery not only of an important vitamin but also of its relation to enzyme, and its role in the tissue cells. In the beginning, the only effects of flavine-deficiency noticed in animals were the cessation of growth, and a non-specific dermatitis and alopecia. Recent studies have shown that certain acute and fatal conditions are associated with flavine deficiency. Sebrell has reported an acute and fatal condition of flavine deficiency in the dog known as "Yellow Liver". It is characterised by bradycardia, cardiac arythmia, yellow mottling of liver, degenerative changes in the central nervous system, collapse and coma. In birds an acute paralysis characterised as neuromalacia has been observed which rapidly responds to pure riboflavine administration.

FERMENTATION AND OXIDATION IN THE CELL

Finally let me recount one more chapter in this fascinating history of cellular activity which the brilliant researches of Szent-Györgyi have brought to light. Taking the muscle cell as our example, it is well recognised that in this cell hexose is converted into lactic acid. The manner in which this change is brought about has been shown already in the chart. The fact that the formation of phosphoric acid esters is necessary for this fermentation to occur does not affect our conclusions. The net result is that first hexose—a six membered carbon chain—is broken down to a three-carbon triose. Triose is then changed through pyurvic acid to lactic acid. Triose, $C_3H_6O_3$ has only two atoms of hydrogen more than pyruvic acid $C_3H_4O_3$, while pyruvic acid has two less than lactic acid.

$$\text{Triose } C_3H_6O_3 \xrightarrow{-2H} \text{Pyruvic acid } C_3H_4O_3 \xrightarrow{+2H} \text{Lactic Acid } C_3H_6O_3$$

Thus the hydrogen atoms taken out at one stage are added in at the other. The change involved in this fragmentation of the hexose molecule to lactic acid is only a minor change and the energy liberated is of a low order.

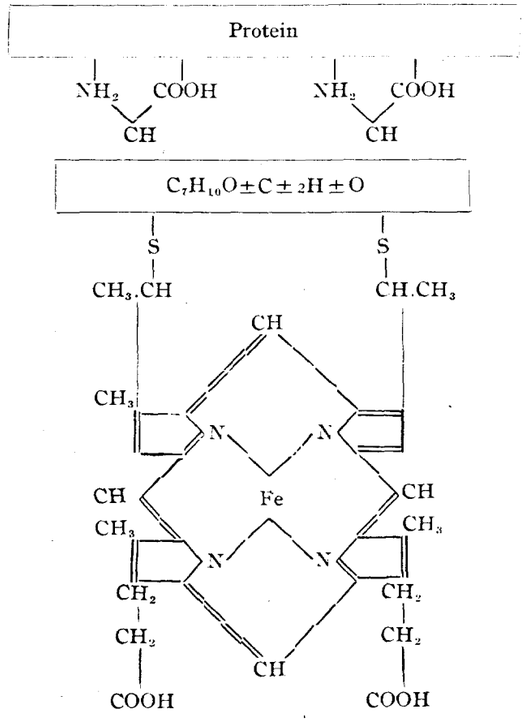
The cell wants energy for life. The energy set free in the fragmentation of the hexose molecule to lactic acid is very small. The only other alternative is to completely burn the hexose molecule to $CO_2 + H_2O$, whereby the bulk of the energy would be set free. This energy would be 30 times more than in the former process. Indeed nature did adopt the latter process of oxidation in order to obtain more energy.

The anaerobic fermentation of hexose to lactic acid whereby only a small amount of energy is set free represents a lower stage in the evolutionary history of the cell. This could maintain only lower forms of life. The evolution of the higher forms of life became possible only after nature discovered oxidation by molecular oxygen, in which case the hexose molecule could be completely burnt. It is a very fascinating story how nature changed over from fermentation to oxidation. In fact it did not completely change over, as both the processes exist today side by side—fermentation, the relic of the older age, and oxidation, the new achievement. Let us now examine the mechanism of oxidation and the manner how it was evolved.

The older process of fermentation by which the cell derived its energy was anaerobic. Oxygen was now to play the chief role in the new drama of oxidation. The molecule of oxygen is a fairly stable entity and cannot be made to do anything which the cell wants, especially at the body temperature. What was necessary was to activate the oxygen. It is the most brilliant achievement of Warburg that he

discovered the catalyst which the cell used for this purpose. This contains iron and is different from the yellow respiratory enzyme. Warburg believed that this alone affected the oxidation but it is only a link in the chain. The next link was Keilin's 'cytochrome-C', a compound closely related to haemoglobin.

Cytochrome, whose formula has not been quite definitely established yet, is very much like what is shown below:



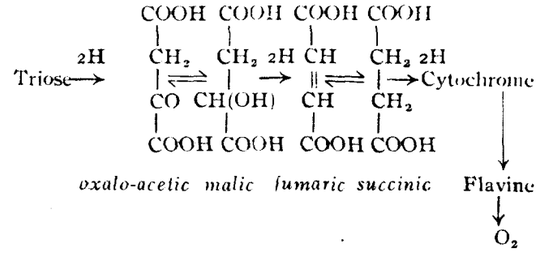
Cytochrome contains an iron atom which is capable of being oxidised from the divalent to the trivalent form. The "Atmungsferment" of Warburg oxidizes the cytochrome.

Now it was the discovery of H. Wieland that helps us further in understanding what the cell did. Wieland discovered that as oxygen was being activated through the respiratory ferment and the cytochrome system, so also the hydrogen of the hexose was activated by a system of "dehydrogenases". These enzymes release the hydrogen in such a way that it can be easily given up if there is any substance present to take it over. The simple explanation now would be that activated oxygen combines with the activated hldrogen and in this way the oxidation proceeds. But even this is not whole of the story.

The discovery of the intervening steps we owe to the genius of Szent-Györgyi. Let us quote his own words:

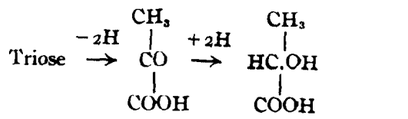
"From the very beginning of my biochemical studies my mind was bothered by the special position of the four-carbon atom dicarboxylic acids. I was taught that succinic acid was oxidized by most animal tissues at a very rapid rate to fumaric acid. Later I convinced myself that there is in fact no other substance oxidized by tissues as fast as succinate. Ogston and Green showed that the only substance cytochrome could act on was succinate. It was also known that all tissues contained a very powerful enzyme, 'fumarase', which converts fumaric acid to malic, till the relative concentration of both is 1 : 3. In the same way it converts malic into fumaric. Later on I found that this enzyme is in fact one of the most powerful enzymes known. But what is its function? Nature is not extravagant, and yet neither succinic nor fumaric acid was regarded as among the most important metabolites. Also Thunberg showed that the isomer of fumaric acid, *e.g.*, maleic acid, was a strong and specific poison of respiration. I began to suspect that something must be wrong about the WK-Wieland theory. It might be true, but must be incomplete, and the C_4-dicarboxylic acid must play some very important catalytic role in respiration."

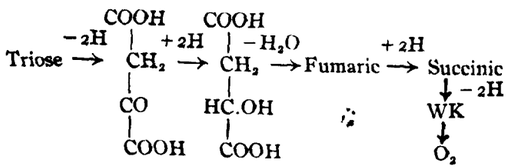
Thus Szent-Györgyi embarked on his investigation to find this out. It took several years of hard work to discover the whole chain. It was found that four dicarboxylic acids undertake the work of transferring the hydrogen from hexose to the flavin-cytochrome system.



Thus it was found that such dull substances as these acids, whose formulae we find in the first pages of an

elementary text book of organic chemistry, were found to play such a fundamental role in cell metabolism. But Szent-Györgyi points out another interesting fact *i.e.*, how nature discovered and made use of these acids. Let us put the two systems, fermentation and oxidation side by side.





We realise the remarkable similarity between the two systems. Oxalo-acetic acid is only a carboxy-pyruvic acid and malic acid is only a carboxy-lactic acid. Thus what nature did millions of years ago was simply to carboxylate pyruvic and lactic acids in its older process and add to it the fumaric succinic acids to unload the hydrogen on to the flavin-cytochrome system. Thus by simple carboxylation nature achieved, the remarkably ingenious way of adapting things for a new function.

Here we have thus the complete story of the oxidation of hexose in the cell. The above discussion makes it clear that hydrogen is actually the fuel of the cell. The carbon atoms in hexose serve merely as pegs to hang the hydrogen or the parcels of fuel on them.

These are just a few fragments of our rapidly developing knowledge about the nature of enzymes and their important role in the phenomena of life. The fundamental importance of these studies will be evident from the fact that the Nobel Prize has come to most of those who have taken a hand in this remarkable achievement.

Let me recount the names serially:

1. Eduard Buchner (1907) for his discovery of zymase and demonstration that a living cell was not essential for fermentation.
2. Otto Meyerhof (1922) for his studies of oxidation-reduction systems in cells.
3. Heinrich Wieland (1927) for his discovery of the role of dehydrogenases.
4. Arthur Harden (1929) for his discovery of cozymase.
5. Hans Von Euler (1929) for biochemical studies of coenzymes.
6. Otto Warburg (1931) for studies of "Atmungsferment".
7. Albert Szent Györgyi (1937) for investigations on the role of 4-carbon dicarboxylic acids in cell respiration.
8. Richard Kuhn (1939) for chemistry of substances of biological importance. (The offer has since been refused due to the Nazi decree).

* Adapted from a lecture delivered before the Journal Club, All-India Institute of Hygiene and Public Health, Calcutta.

Notes and News

Critical Edition of the *Mahabharata*

WE have received from the Bhandarkar Oriental Research Institute a statement regarding the progress of the critical edition of the great Indian epic, the *Mahabharata*. As is well known the *Mahabharata* is the longest epic in the world containing, according to tradition 100,000 couplets, but, actually containing about 85,000 couplets. Compared with this, the great epics of the Greeks, the *Iliad* and the *Odyssey*, can be accommodated in two chapters of the *Mahabharata*. Unfortunately there are a large number of different editions differing fundamentally in their contents. The Bhandarkar Institute took upon itself the task of bringing out a critical edition about 21 years ago with a handsome donation of one lakh of rupees provided by the Chief of Aundh, which has meanwhile been supplemented by grants from other sources. The Institute has been able to collect a large number of manuscripts of all ages from all parts of India, from Bengal to the Punjab and Kashmir to Ceylon and has been able to secure the collaboration of a large number of scholars. In reviewing the work hitherto achieved, Dr V. S. Sukthankar, the General Editor reported that in spite of the time passed (now about 21 years) only three of the 18 books have been completed. The first, the *Adiparvan* was completed by the General Editor himself in 1933. The *Virataparvan* was completed by Dr Raghu Vira of the Sanatan Dharma College, Lahore. The latest is the *Udyogaparvan* edited by Dr S. K. De of Dacca University. The General Editor and the collaborators are following in the selection of the text the critical method laid down by the Western savants and this has led to the elimination of a large number of interpolated passages, a notable one being the hymn to Durga recited by Yudhisthira, about which doubts were cherished for a long time. The progress has been extremely slow but the General Editor informs us that by the next year 45 per cent of the work containing 40,000 *slokas* and about 4,500 pages will be finished. The general reader will probably grow impatient, because if the present rate is not accelerated, the completion of the task may take another 30 years. The cause of this slow speed, we understand, is lack of funds. In fact, the balance sheet is rather alarming and unless the public comes forward with more funds, the work may be suspended in the near future. We warmly support the appeal which has been issued by the Trustees of the fund for more generous response from the public of India towards the completion of this gigantic task. It is said that the *Mahabharata* text was dictated by the sage Vyasa so quickly that only the God Ganapati (or Lord of Hosts) could pen it down. Probably this is a camouflaged version of the fact that a large number of penmen were required to write down the text originally. In finding out the real text, a large number of editors is needed from the very nature of things but a morphological analysis of the text is very much desirable.

The Date of Kalidas

IN the *Nagpur University Journal* of December, 1939, Mr T. J. Kedar, the Vice-Chancellor of the University has taken up the never-ending theme of the Birth Place and Date of Kalidas, the greatest of Indian poets. It is a matter of great regret that the idea of chronology was the weak point of ancient Indians and the date of Kalidas according to different authorities has varied between the first century B. C. and the sixth century A. D. He has been assigned to the period just after the Sunga Kings at the earliest and at the latest to the time of Yasodharman Vishnuvardhan of Malwa, who in an inscription, dated 540 A. D., claims to have routed the Huns. But of late, the tendency has been to assign him either to the time of Chandragupta II (382—413 A.D.), or to Skandagupta (455—472 A.D.), both of whom bore the epithet of Vikramaditya. Mr Kedar examines the various claims and in the absence of historical data supported by monuments and inscriptions he probes into the Kalidas' accredited writings and comes to the view that he must have lived in the first century B.C. after the end of the reign of the Sunga Dynasty. In fact he is in favour of the hypothesis that he lived at the court of a real Vikramaditya of Ujjain about 57 B.C. This view has been put forward earlier, but from entirely different points

of view by Professor Kshetresh Chandra Chattopadhyay of Allahabad University and still earlier by Professor Sten Konow. Professor Chattopadhayay refers to the remarkable similarity in literary passages in the writings of Asvaghosa (the Buddhist poet of the first century who wrote in verse the story of renunciation of Buddha) and Kalidas, and came to the conclusion that the former (Asvaghosa) must have copied from the latter (Kalidas). Professor Sten Konow bases his theory on the Jaina tradition that a certain Vikramaditya expelled the Saka intruders about 60 B. C. from Ujjain. But these views have not yet found favour with the historians. The chief reason being that inscriptions discovered hitherto have not yet revealed a single instance where the era, now known as the Vikrama Era, was called by this name before the eighth century, A.D., and no inscriptional records of Vikramaditya of the first century B.C., reigning at Ujjain has been as yet discovered. Earlier it was known as the Krita Era, or alternatively as the Era of the Malawa people.

Mr Kedar shows that Kalidas shows such intimate knowledge of the geography of Central India particularly of the Ujjain region that he must have known it intimately, *i.e.*, he must have hailed from this region. Secondly, he shows such an intimate knowledge of the palace intrigue of the early Sunga Kings of Vidisa, that he could not have been far removed from their times. He therefore positively declares in favour of the 56 B.C. theory. We have in Greece seven cities claiming Homer, but we have here seven centuries, claiming the greatest poet of India. We suggest to the Oriental Conference to hold a symposium on the subject, with a view to coming to a definite decision, if possible, on the available records.

Satakarni Chronology

IN the *Journal* of the Royal Asiatic Society of Bengal (Vol. V, 1939) Professor K. P. Chattopadhyay returns to his theory about the chronology of the Satavahanas, which was first propounded by him nearly 13 years ago in the *J. R. A. S. B.* This chronology of ancient India is still far from being settled but no problem had presented a more hopeless maze than the present one. The *Puranas* assigned a period of 455 years to this dynasty and the number of kings in the different Puranic lists varies from 19 to 30. From inscriptional record, the dynasty appears to have ended about 200 A.D. and if the whole 455 years is to be assigned to them, it ought to have its beginning about 230 B.C., that is, before the end of Asoka's reign. But all the *Puranas* uniformly testify that the dynasty was started after the fall of the Kanvas, that is, about 70 B.C. Many theories have been advanced to solve this difficulty but few have given complete satisfaction. Professor Chattopadhyay holds that the dynasty comprised two lines, one of which reigned over an old ancestral kingdom and the other over a conquered realm. Succession to the throne was from mother's brother to the sister's son. Also the two kingdoms were connected by matrimonial relations (cross cousin marriage) and usually the son of the reigning emperor was appointed to the rulership of the later kingdom by virtue of his mother-right. He is thus of opinion that the periods of reign of the princes reigning in the two capitals have been added together thus giving the large total of 450 years while actually the time period during which the main line flourished did not probably exceed 300 years. Various objections have been taken to this theory by different historians notably by Professor H. C. Raychaudhury but Professor Chattopadhyay appears to have proved to his satisfaction that this theory is substantially correct.

The Netherlandes Indies

IN the *Geographical Review* of April, 1940, Mr J. M. Broek of the University of California gives an interesting account of the economic development of the Netherlandes Indies which may be read with great profit by people of this country in view of the great political changes taking place in the present times. In India we are hardly conscious of the fact, that of the European nations, who once contended for the possession of India, the Dutch still possess the largest area next to that of Britain. In fact, the Dutch are very proud of *their* India. Of the group of islands, which form Netherlandes Indies, the islands of Java and Madura are very densely populated and are known as the Inner Provinces in distinction to the Outer Provinces comprising Sumatra, Borneo, Celebes and other smaller islands. Mr Broek gives a very interesting account of the economic changes in the different parts. It appears that the inner provinces have reached almost saturation point in economic development and population, and now the people are migrating towards the sparsely populated outer parts. The staple means of livelihood of the population is agriculture but the enterprising Dutch have in this respect gone in some points beyond their English prototypes in British India, for they have developed many agricultural industries on a wide scale, chiefly for export. These are chiefly sugar, coffee, palm oil, cocoanut products, rubber, cinchona. In fact, at one time Java supplied the whole of India with its sugar but with the development of the industry in India the Java sugar industry has undergone marked decline. For cinchona, India is still dependent largely upon the Java product though India offers unique opportunities which have not yet been fully taken advantage of. The different provincial governments in India may take a lesson from the Dutch government because none of them has completely studied the possibilities of starting new agricultural industries in India. Java is further rich in minerals. It produces 3·4 per cent of the world's total of petroleum, and the eastern countries are to a large extent dependent upon Javanese supply. The outer provinces are still mostly unexplored, but they are attracting the notice of the capitalists. They are mostly covered with dense forests containing large amount of economic products like timber, resins, wild rubber, bee-wax, and the enterprising Dutch Forest Service has got a comprehensive scheme of development. We learn from this paper that for a long time Java was the main profit area and remitted large sums of money to the Netherlands. But during the last 30 years the 'burden of the Dutch Empire' has been shifting to the outer provinces. The natives of the Java have however shown very little enterprise in the industrialisation of their country and sometimes the Dutch people advertise this fact as an argument in favour of their continuance on the island. But generalisation of this theory of permanently imposing one nation over another is rather too dogmatic. The superiority of the Dutch, and for the matter of that, of the Western peoples, is not their exclusive property. For, another Eastern people, the Japanese, have shown themselves to be as much enterprising and agressive as any Western people. They are now clamouring for their *Lebensraum*, which will have to be found possibly in eastern and south-eastern Asia.

Alleged Discovery of the Element No. 85

WE learn from the *Science Digest* that the Swiss University Press has published the account of the alleged discovery by Dr Walter Minder, Chief of the Radium Institute at Berne, of the missing element No. 85 in the Periodic Classification. Up to the time of writing, three elements in Mendeléeff's Table have not been discovered with certainty. These are Nos. 61, 85 and 87. Of these, No. 61 has been claimed to be discovered by an Italian and an American, but their story of discovery has not yet found general credence. Element No. 85 which is claimed to have been discovered is analogous in properties to iodine and may be called radio-iodine. It has been obtained as an impurity in radium to the extent of 1/10000th of a milligram. It has been christened Helvetium in honour of Switzerland. The story so far given is so meagre that people must wait for further details before they can be persuaded that the claim is a genuine one. Element No. 87 which is similar to caesium in its properties and would be an alkali is also still missing, though claims have been made by several workers. A number of leading scientists are of view that the missing elements 61, 85, 87 are unstable from the very nature of their nuclei and therefore cannot occur in nature.

Quater-centenary of Copernican Theory

EXACTLY four centuries have elapsed since the Polish astronomer-monk, Nicholas Copernicus, revived the theory that the earth and the planets revolved round the sun as centre. We say revived, because the Babylonian Selucus (who lived in the third century before Christ and was not a Greek in spite of his name) and somewhat later the Greek sage, Aristarchus Samos actually propounded this theory in the 3rd century B.C., but it was rejected by Ptolemy (150 A.D.) whose lead was followed by other astronomers. But as observations multiplied, the Ptolemic theory was found more and more untenable and had to be supplemented by making the planets move on subsidiary circles (epicycles and deferrents) till the whole thing became so complicated that an astronomer-king, Alfonso XIII of Castille, remarked that if he were present at Creation, he would have advised God to make His system simpler.

Born on February 19, 1473, Copernicus studied at the University of Cracow and after three years, left for the University of Bologna in 1496, where his special subjects of study were astronomy and mathematics. Copernicus found that the simple heliocentric theory gave a far better explanation of the movement of planets. He came to this conclusion in 1500, but he could not publish his theory for fear of opposition from the Church and papal administration. In 1539, however, Copernicus sent a brief account of his new ideas to his old teacher, John Schoener, at Nuremberg; and his *'First Account'* (*Narratio Prima*) was published at Danzig in 1540, exactly 400 years ago. Thus he had to wait for more than forty years before he could publish his discovery; for, the truth was 'contrary to Scripture' which said that the earth was the central Creation, and the two lights were created to illuminate her, the bigger light, sun, to illuminate her during the day and the lesser one, moon, during the night. Later he decided to publish his entire work *'De Revolutionibus Orbium Coelestium'* or *'On the Revolutions of the Celestial Orbs'*. The first printed copy of *'De Revolutionibus'* reached Copernicus on May 24, 1543, the day he expired at the age of seventy. Curiously enough, his book was dedicated to the then Pope, who received it graciously, probably never suspecting its contents. But later the book

was proscribed and forbidden against teaching it in schools and universities. Much of such oppositions against science can be found in the life histories of Galileo and Bruno ; Bruno being burned at the stake.

Copernicus is truly called the father of modern astronomy, and although his discoveries received attention of the scientists and astronomers, no English translation of his work has so far appeared. Recently, however, Mr Edward Rosen's English translation of the *Narratio Prima* has been published by the Columbia University Press. Were it not for the present war, scientists in Germany, Poland and other European countries might this year be celebrating the important anniversary of the Copernican theory first made public in 1540. We understand however that Mr Rosen has plans to translate *De Revolutionibus,* and to issue it before 1943, the quater-centenary of its original appearance.

Technical Terms in Indian Languages

THE problem of a common script for India is fairly old now. To give the least offence to both the Hindus and the Muslims a new language 'Hindusthani' with an extremely limited vocabulary, bereft of nearly all Sanskrit and Perso-Arabic words as used by the intelligentsia and in the books, has been suggested as the common meeting ground between Hindi and Urdu of today. Following this wave of public enthusiasm, the medium of instruction in a number of universities has been changed to the regional languages but provincial patriotism has so long stood in the way of finding out a *lingua franca* for the whole country and also a script for that.

Mr K. P. Sagreiya, silviculturist at Nagpur has recently devoted *inter alia* much thought to this problem in his article on Translation of Technical Forestry Terms in Indian languages in the *Indian Forester* of October, 1940. Already for teaching (even in colleges up to the highest degree in Hyderabad) translation work has been done by Osmania and Calcutta Universities, Gurukul Mahavidyalaya, Hindi Sahitya Sammelan (Benares) and also indirectly by the journals *Vijnan* in Hindi from Allahabad and now defunct *Prakriti* in Bengali from Calcutta.

The new language Hindusthani as the *via media* between modern Hindi and Urdu being primarily designed as the spoken language is inadequate for literary or scientific purposes, and it is exactly at this point that the divergence comes. There is no difference in the language, as used by a Hindu or a Mahomedan of U. P. for ordinary purposes of life, but when required to express higher thought, the Hindu falls back on Sanskrit and the Mahomedan on Arabic and Persian. The correct line of approach to this serious obstacle of multiplicity of scripts and undeveloped languages, in the path of educational progress will not be by imposing a made-to-order language, *viz.*, Hindusthani. Mr Sagreiya while dealing with the problem of translating the scientific terms has suggested the harnessing of the two main languages equally in this task immediately. He has planned a bold step and insists on every child being taught two synonyms for every English word, one derived from Sanskrit and the other from Perso-Arabic, besides the corresponding equivalent in the regional language (which so far as technical terms are concerned will in 90 cases out of 100 be either the one or the other, for instance, *king* meaning *Raja* and *Badshah,* and *country* meaning *Desh* and *Mulk*). Every one will have the freedom to use one or the other or sometimes one and at other times the other according to his liking, but we should insist on his understanding and recognising the other equivalent used by some one else. For the present, we think the question of Hindi vs Urdu may be solved satisfactorily in this manner without wasteful public agitation. Mr Sagreiya's suggestion is quite ingenious and will be very helpful in the transition period. With lapse of time we believe the duplicate list of words will pave the way for a single comprehensive list throughout India, and each word will be incorporated, specially for teaching and writing purposes, on its merit of accuracy and simplicity. The best word will survive. At one time, there were 72 words used for gas, but the word 'gas' (which some say was derived from chaos) has survived on account of its simplicity.

The advent of Industrial Revolution and the development of printing presses in other lands had very little effect on the different scripts existing in our country. These remained neglected without any attempt at their development. Some of the oriental scholars in the foreign countries for the convenience of making available their studies to the readers adopted the Roman alphabet with various signs for transcribing the different Indian languages. There should be no false sense of national vanity and of sanctity of our ancient culture while discussing about a common script. The Germans have discarded Gothic in favour of Roman alphabets. Similarly, in order to have more intimate international intercourse the Turks have also taken up the Roman script for their language. We are also in favour of our adopting the Roman script (see SCIENCE AND CULTURE, *1*, 117, 1935-36).

The International Congress of Orientalists at Athens in 1912 adopted a scheme of transcription of all Hindi sounds in modified Roman script which is still the only rational and satisfactory method for transliterating Sanskrit. Mr Sagreiya however has suggested a modification in this method. He claims that in adopting his system for expressing modern Hindi sounds only 37 symbols will be needed as against over 200 different types at present used to correctly print Hindi in the Devanagari script (because half-consonants, conjunct-consonants and vowels-in-combination-with consonants change their form altogether, and besides linear composing as is the case with the Roman script in Hindi, parts have also to be inserted above and below the line). The above script has been also adapted by him for typing by using the signs of colon, accents etc., in the ordinary present-day typewriter.

Mr Sagreiya has prepared this modified script and has suggested uniform translation of technical terms in the two principal languages of the country for the immediate convenience of his forest staff and desires that a start in this direction may be made at the next session of the All-India Silvicultural Conference. Some work on the subject has already been done in the Punjab where a committee of forest officers has been formed to prepare a glossary of technical forestry terms in Urdu, (*vide* item 10 of the Punjab Forest Conference, 1939), who are proceeding in the task with the help of Osmania University.

Cyclone at Bombay

AN account of the recent Bombay cyclone and of the warnings issued to ports on the west coast has recently been released by the Director-General of Observatories, Poona. The charts prepared at Poona from the daily routine observations of 8 A.M. and 5 P.M. gave indications of the impending foul weather and accordingly during the progress of the storm special observations from selected stations were also called for. But it was necessary to infer positively the weather out over the Arabian Sea. If the observations made at the observatories along the west coast of India were supplemented by observations from steamers at sea, the forecasting could have been improved and the terrifying nature of the depression could have been appreciated in time. Due to exigencies of war the observations out in the sea were not available on the present occasion. The development of the storm out at sea was therefore judged from its secondary effects and the positions of the centre estimated. approximately. Though signals were augmented by special observations, unfortunately the last signal arrived in Bombay just when it was experiencing the strongest winds of the storm. The meteorological warnings, it should be noted, can at best be circulated after three hours from the time of observation. This is due to the time taken by the observation telegram to reach the forecasting centre, the time taken for decoding and plotting the observations on the charts and lastly the time required for analysing the charts before the meteorologist can decide upon appropriate warnings.

The origin of the storm is traced to a feeble low pressure wave from the Coromandel coast (where conditions were unsettled on October 7) to the Arabian Sea. This movement gave indications of a spell of thundery weather off Malabar, Kanara and Konkan on October 8. On the evening of October 9 conditions seemed definitely unsettled off the Malabar-Kanara coast. On October 10 a depression was believed to have formed with centre out at sea within two degrees of Lat. 13°, Long. 70° (a position little over 120 miles south-west of Bombay), which on the evening chart of the same day, was centred within two degrees of Lat. 14° and Long. 70° and was moving in some northerly direction. These conditions reigned for the next day. On October 12 there were indications of a weakening of the depression, which continued till October 13. But next morning conditions reversed and became markedly unsettled off the coast from Ratnagiri to Mangalore. Towards the evening a depression seemed to exist in the east central Arabian Sea.

Special observations at 2 A.M. were asked for from a number of observatories on October 15 in order to watch the situation. On the 8 A.M. charts of that day it was announced that the depression had moved much nearer Bombay and was moving in north-easterly direction. The 10 P.M. chart indicated the storm centre to be still nearer Bombay but it was then thought, in the absence of any data from ships at sea, that the movement was towards the Gulf of Cambay. The direction of the movement changed quickly and the 5 P.M. chart showed that the cyclonic storm, at that time of small diameter, with hurricane force winds at the core was rushing towards Bombay. This storm-centre passed just to the west of Bombay on its north-east track and in course of the day crossed the coast some 50 miles to the north of Bombay. It was inland near Surat by next morning. From the moment it crossed the coast the storm weakened slowly into a depression, but after reaching Surat it remained stationary for three days. This halt of a depression over one position for so long is most unusual. It filled up finally *in situ* by the morning of October 21.

Migration of Culture to America

WHEN the Ottoman Turks under Mohammed I conquered Constantinople in 1453, and put an end to the Byzantian Empire, there was a general exodus of scholars to Western Europe, notably Italy and Germany. It is usually believed that these scholars

brought with them a knowledge of Greek literature, philosophy and science to a barbaric Europe, and made it possible for the eager souls of Europe to drink first hand at the fountain source of Greek knowledge. This ultimately led to the great movement known as the Renaissance.

Since the beginning of the present war, there has been again an exodus of learned men and scientists on an almost equal scale from warstricken Europe to the peaceful United States of America. Prominent amongst such scholars are:

Albert Einstein (now a U. S. A. citizen, and professor at Princeton, Nobel Laureate);

H. Bruning (Hitler's predecessor in office);

Thoman Mann (German author, Nobel Laureate);

Werner Jaeger (Classical scholar);

Martin Wagner (City planner);

Walter Gropius and Marcel Breuer (Architects);

James Franck (physicist, Nobel Laureate, formerly at Gottingen, now at Chicago);

Enrico Fermi (Italian physicist, Nobel Laureate, formerly at Rome, now at the Columbia University, New York);

Bruno Rossi (Italian physicist);

Otto Stern (German physicist);

Peter Debye (Dutch physicist, but professor at Berlin, now at the Cornell University, Nobel Laureate);

Giuseppe Borgese (Italian novelist);

Ulrich A. Middledorf (Art teacher);

Spiro Kyropoulos (German-born; carrying on important research on oil. Now at California Institute of Technology);

Arnold Schonberg (Composer, now at the University of California at Los Angeles);

Otto Marburg (Viennese neurologist, now at Columbia University);

Fernando de los Rios (once Spanish Ambassador, now at the graduate faculty of Alvin Johnson's Institute);

Erwin Piscator (one time director of Berlin's People's Theatre);

Fritz Lachmann (Economist);

Bertrand Russel (English mathematician, philosopher, and man of letters. The American papers announce that he is going to take U. S. citizenship);

Ivor Armstrong Richards (Linguist, now at Harvard University);

Bronislaw Malinowski (Anthropologist, now at Yale University);

Alvar Aalto (Finnish architect);

Lancelot Hogben (an English scientist, who wrote *'Mathematics for the Millions'*. He was on a lecture tour to Norway when the country was invaded by Germany and escaped with great difficulty with his equally famous wife Dr Enid Charles, a statistician, to Russia and ultimately to the U. S. A. He has expressed a desire to stay in the States if he can get a job).

This list gives information only about a few of the large number of eminent scholars who have found a home in America. So far, it seems to be only a one-way process. During the last war, the English writer Houston Chamberlain, a champion of the supremacy of the Nordic race, became naturalized as German, but in the present war, no example of any notable Englishman becoming a German or an Italian has been yet known, unless we except that mysterious personality of Lord Haw Haw.

Automatic Weather Reporter

FOR the last eight months an automatic weather station is functioning at an U. S. Naval Air Station. The station utilizes the same principle as the radio sonde. The radio sondes are used in unmanned balloons which give weather information of upper air, at heights which even stratosphere-flying airplanes cannot yet achieve. The radio sonde transmits dots or dashes and the records of these in a receiver are later interpreted in terms of barometric pressure, air temperature, and relative humidity. The wind velocities and directions are found by visual inspection or radio bearings.

The new weather robot, fit for stationary installations, is designed to transmit meteorological information at predetermined intervals. The variation in the meteorological element is converted here into a change in resistance which in turn produces a change in modulation frequency. The essential difference from the radio sondes lies in the use of much lower frequencies, 0·15 to 3·0 cycles per second. The station is equipped with a 15-watt radio transmitter with battery power-supply. The standard designs of each of the pressure, humidity and rain gauges have been provided with a relay-operated clamping bar which fixes instrument pointer against the edge of a wire-wound resistance and the instrument deflection is converted into a resistance variation. When no observation is transmitted, the pointer swings freely. The temperature element is a glass capillary tube filled with an electrolyte having a high temperature co-efficient of electrical resistance. The resistance of this device is a function of the surrounding temperature. The wind direction indicator has got eight contact segments corresponding to the eight principal compass points. A different fixed resistance is connected to each segment and is thrown into circuit when the wind vane assumes that direction. Intermediate directions are indicated on a proportional basis by the successive contacts of the wind vane (due to its oscillation about the average direction) with the adjacent principal vanes. The wind velocity indicator is a standard commercial cup anemometer with the "take off" contacts stepped up by a factor of four so that four contacts per minute correspond to one knot. There is a modulating equipment for keying the radio transmitter at a rate depending on the value of the particular variable resistance in circuit. An automatic control equipment connects the instrument resistances into circuit in a definite sequence and identifies the several observations by appropriate code letters. A timing clock starts the equipment at scheduled times. The average errors obtained in the measurements are exceedingly small and the advantageous feature is that any field crew may receive these observations by means of an ordinary radio receiver, headphones and a stop watch. Full details will be found in the August issue of *Journal of Research*.

Madras Government Museum

Under the superintendence of Dr F. H. Gravely, an important extension to the Government Museum, Madras, has been completed and opened to the public. Its main function is to give suitable expression to the evolution of the decorative motifs of the architecture of the magnificent temples of South India. For the Tamil country, these changes form an interesting and logical sequence. The temples of other parts of India differ from those of Tamil origin and in this section attempts have been made to indicate the succession of changes that has taken place during the course of development of Tamil architecture.

Racial Characters in Ancient India

DR WILTON M. KROGMAN of the University of Chicago, has published the result of examination of a skull from Chanhu-daro, a site of the Indus valley civilisation in Northern India. The skull is that of a young woman and was placed in a jar after decapitation. It is surmised that it may have been that of a princess or priestess. It was found in the course of the excavations carried out by an expedition of the Boston Museum of Fine Arts and has been dated as belonging to a period some five thousand years ago. Dr Krogman's report indicates a combination of characters usually to be assigned to diverse racial types. There are such Negroid characters as a flattened head vault, broad nose opening and low eyesockets with Caucasoid features, such as narrow nasal bones, small teeth and narrow distance between the eyes, as well as in the shape of the palate. His conclusion is that it represents a "Proto-Mediterranean type in which ancestral Negro traits have manifested themselves". Dr Krogman suggests that the modern Mediterranean race may once have had a mixture of Negroid blood which has since been eradicated.

Lac Research

RESEARCH work carried out at the Indian Lac Research Institute and the London Shellac Research Bureau during the year 1939-40 shows that greater emphasis has been laid on the practical application of the results of experiments. The Indian Lac Cess Committee's annual report for that year, states that the outbreak of war resulted in a rapid development of the activities of the London Bureau owing to the demands of the Defence Departments for various types of luminous and black-out paints, coating composition for anti-gas clothing, a quick-setting cement for metals, a flexible and grease-proof coating for rubber surfaces, a quick-drying oil-resistant paint for metals, and a quick-drying sea-water resistant paint. The process of hot-spraying of lac, worked out in the London Bureau, promises to open up commercial possibilities. Full details of this have been published in *Bulletin No.* 5 of the London Shellac Research Bureau.

Experiments are in progress at the Indian Lac Research Institute for the production of modified shellac powders for the moulding industry. The use of these powders in the making of electro-technical goods and a variety of common household articles will open up a considerable field for new industries. Practical details have been formulated for the manufacture of plastic moulded articles, motor car finishes and stoving enamels from shellac. A number of experiments have been designed to minimize the use of imported materials in the processing of shellac for these new industries. The Lac Cess Committee has entered into an agreement for co-operative research with the India Moulding Company, Calcutta, which will be helpful to investigate the processes under actual commercial conditions.

Buddhist Manuscript at Lauriya Nandangarh

IN the extreme north of the province of Bihar at Lauriya Nandangarh a pillar of the Emperor Asoka was excavated some years ago in almost complete

preservation. The pillar marks one of the sites of the pious king's visit from his capital near Patna to the birth-place of Buddha. The name, 'Lauriya', strictly applies to the village near the 'laur' or 'pillar', on the neighbourhood of which a number of mounds were some time ago examined by the Archaeological Department ; and Nandangarh is the name of a large garh or fort, lying at some distance from Lauriya and thickly covered with jungle. A stupendous monument discovered here is unequalled for its size and is possibly the earliest prototype of the architecture of the Burmese and Malayan *stupas* and the well-known Borabudur monuments in Java. The plan of the monument is a huge square cross with a number of projections in between the arms of the cross. As in the great temple at Paharpur in Bengal there are also several terraces rising one above the other. The evidence of the finds shows Paharpur to be much later in date than the Nandangarh mound. On the assumption that the monument must have been erected by the Buddhists, a shaft was dug in the centre and at a depth of some 36 feet from the top a complete *stupa*, a miniature of the exterior of the monument, has been uncovered. This is surrounded on all sides by a low platform at the foot of which has been found a copper casket containing a strip of white muslin with fragments of a birch-bark manuscript and small pieces of wood and carnelian beads. As the manuscript had been forced into the casket, it was found impossible to open the individual leaves without breaking. These have been found to contain certain Buddhist texts written in characters of the 3rd-4th century A.D. It apears that the original monument was several centuries earlier than the casket and the manuscript with which it was apparently reconsecrated at a later date. The present find is, important, being the only one from eastern India wherein an original manuscript has been recovered. So far all such discoveries have been confined to the north-west parts of India.

Indian Students in Great Britain

THE Report on the work of the Education Department under the High Commissioner for India for the academic year ending 30th September, 1939 has just been published. There were over 1500 students, and their academic, athletic and other records were quite satisfactory. Over 600 students were engaged in research and 300 pursuing courses in various branches of engineering and technology. About 100 were studying agriculture and veterinary science. The Secretary of the Department has again drawn attention to the futility of sending boys with the sole purpose of securing a better Service appointment. He lays stress on the personal qualities of character and steadiness, in addition to educational qualifications, which should guide the guardians. Another point in the report deserves serious consideration. The number of full-time students in the faculty of medicine at the different universities was 474. Medicine has all along attracted the largest number of students but it is to be regretted that the spirit of scientific enquiry has not been found in most of the persons who have returned bedecked with a number of degrees and with the membership of various colleges. Some even begin their medical courses in Great Britain but few have been reported preparing specifically for some research course. Up till now very few students, if any, have been found to take up research in a field largely untapped in this sub-tropical country. The Report informs that the Royal College of Surgeons, England, has decided to grant in principle recognition of resident surgical posts held at Indian hospitals not associated with the universities and medical colleges in India, for the purpose of satisfying the relevant regulation for admission to the Final F. R. C. S. examination in London. The Institution of Mechanical Engineers has also decided to recognise the engineering degrees of Benares Hindu University and of Bombay University, and exempt the holders of such degrees from part II, section A, of their Associate Membership examination. So far university education is concerned the facilities are fairly satisfactory though the utility of it for each of the boys that now go is doubtful. The opportunities for practical training are however meagre and we shall discuss about it in a subsequent issue.

Announcement

A LARGE collection of reprints, bulletins, memoirs etc. on mycology and plant pathology has recently been presented by Dr B. B. Mundkar of the Imperial Agricultural Research Institute, Delhi, to the Fergusson College, Poona. The collection consists of about 5250 publications, besides complete sets of *'Mycology'* and *'Phytopathology'*, and several books on these subjects. The collection is specially rich in the works of American, Finnish, Swedish, German, Swiss, Italian and English mycologists and plant pathologists, and for the present will remain with Dr Mundkar so that he can use it in his investigations.

SCIENCE IN INDUSTRY

Transferring Heat in Chemical Processes

FOR heating a substance the source of heat should be at a higher temperature than the substance to be heated. By means of direct firing, where the heat is transmitted by radiation, or conduction and conduction-convection from the flue gases, materials can be heated to a very high temperature depending on the temperature of the furnace. But in many chemical processes, where a close control of heat is of utmost importance, heating by direct firing is unsuitable. For a closer heat control, a medium is necessary, which, after receiving heat from the furnace, is circulated through coils and pipes and transmits heat through them to the substance to be heated.

Media for low temperatures are many, but heat transfer media for higher temperatures have always presented a serious problem to the chemical engineer. Steam, water, flue gas, and air are the most widely used and cheapest heat-transfer fluids. The boiling point of water is 100°C. or 212°F. at atmospheric pressure. Now if a substance is to be heated to a higher temperature than this by means of steam, the boiling point of steam is raised by raising the superincumbent pressure on it. Even then, the upper limit for steam, so far used for heating purposes, is 460°F. corresponding to a pressure of 450 pounds per square inch. Although modern high-pressure boilers produce steam having much higher temperatures than the above, their use for heating purposes is most uneconomical. Flue gas and air temperatures can be much higher and though their temperature range is wide they have several serious drawbacks for use in many chemical processes. Their specific heat per unit of volume and heat-transfer co-efficients are very low. Great volumes of gas are therefore necessary to transfer relatively small amount of heat. Furthermore it is difficult to control the temperature with flue gas and air and local overheating is liable to occur.

Mercury (boiling point 673°F. at atmospheric pressure) is, in many respects, an ideal heat-transfer fluid for the temperature range above that of steam. But the cost is prohibitive and due to its high density the equipments to handle it should be heavy and consequently costly. Moreover there are hazards due to toxic vapours leaking through the system. In some installations molten lead is used as a heat-transfer medium but its use has not attained any commercial importance.

Hot oil, Dowtherm and HTS are the principal commercial heat-transfer fluids now available in cases where temperature of steam is insufficient and in which flue gas is inapplicable. The practical top limit for oil is somewhat above 550°F. and that for Dowtherm (see SCIENCE AND CULTURE, 5, 297, 1939-40), which is a mixture of 75 per cent. diphenyl-oxide and 25 per cent. diphenyl, is approximately 700°F. at a pressure of 135 pounds per square inch. Both the oil and Dowtherm are organic materials and they begin to coke and plug up pipe lines at temperatures higher than those mentioned above.

Important Heat-Transfer Fluids

Fluid	Usual Temperature limits, deg. F.	Pressure Lb./sq. in Gauge.
Steam or water	32—460	0—450
Oil	30—550	0
Dowtherm A (75% diphenyl oxide, 25% diphenyl) ...	54—700	0—135
Mercury	37—1000 or higher	0—180 or higher
HTS	290—1000	0
Flue gas or air	Up to 800 in iron ducts, to 1600 in special alloys.	0

A molten mixture of nitrates and nitrites of sodium and potassium is known as HTS. It has very recently come into industrial use as a heating liquid. It consists of approximately 40 per cent. $NaNO_2$, and 53 per cent. KNO_3 by weight. Similar nitrite and nitrate mixtures are being employed for many years in molten baths for the heat treatment of the metals and in small installations requiring heat-transfer at a high temperature

level, but was not of so much commercial importance. Now chemical engineers are using it on a large scale in Houdry process of catalytic cracking and refining of petroleum. Extensive investigations into the properties of such nitrite and nitrate mixtures were undertaken and finally the above mentioned proportions of nitrites and nitrates of sodium and potassium have been adopted because they have a low melting point of 288°F., high heat-transfer coefficients, a lack of corrosive action on steel at temperature above those obtainable with Dowtherm, hot oil, or steam, and a good thermal stability. Depending on operating conditions, the upper limit for HTS seems to lie at present in the range of 900 to 1100°F. under atmospheric pressure.

N. K. S. G.

Transparent Fabrics Impermeable to Fluids

ACCORDING to a recent report a new process has been developed by the Imperial Chemical Industries for making fabric transparent and impermeable to fluids, and at the same time increasing their gloss. The process consists in impregnating the fabric with nondrying oil or semidrying oil-modified polyhydric alcohol polybasic acid resins in conjunction with urea-formaldehyde condensation products. Silk or rayon fabrics are treated by immersion in a solution of a synthetic resinous composition in a volatile organic solvent, volatilizing the solvent at 70° to 80°C. and subjecting the fabric to further heat treatment. If necessary the treatment is repeated. Plasticizers like dibutyl phthalate or tricresyl phosphate are used. The oil-modified polyhydric alcohol polybasic acid resins used are glyceryl phthalate resins modified with oil such as soybean, sunflower, safflower, walnut, or poppyseed, the proportion of the oil in the resin being from 35 to 55 per cent. by weight, the middle range, 40 to 50 per cent. being most usual. The modified resin, in which part of the polybasic acid is replaced by monobasic acid derived from a nondrying oil used in the process, is generally a castor-oil-modified glyceryl phthalate resin.

Dyed or printed fabrics as well as cotton fabrics are being treated similarly but the proportion of the chemicals and the treating temperatures are different depending on the nature of the fabrics. It is claimed that the new process eliminates discolouration when fabrics are subjected to heat treatment for short periods of time ; and that it imparts excellent flexibility, softness, freedom from cracking or powdering and from objectionable tendering.

N. K. S. G.

Glowing Carpet

ABSOLUTE darkness is necessary to bring out the full beauty of the modern motion pictures in colour. This drive towards perfect darkness has increased the chances of accidents to people entering the cinema house from brightly lighted outside. The shaded lights along the aisles of theatres, which illuminate only the area near the light do not fully eliminate the danger of slipping. Moreover they interfere with the picture itself. A recent report from the Calco Chemical Division, American Cyanamide Co., reveals that a new "magic carpet", which will glow in the dark, will henceforth avoid the above-mentioned trouble. The new carpet is dyed with special dyes which appear quite ordinary in daylight but glow softly with various colours in the "black light" of invisible ultraviolet rays. The paths will be covered with carpets dyed with fluorescent dyes and small electric tubes will shed ultraviolet rays on the carpet. The exact nature of fluorescence has not yet been completely understood, but it seems that when ultraviolet rays are absorbed by fluorescent materials, they radiate soft visible light, which shows the path clearly but does not interfere with the beauty of the modern coloured pictures. It is stated in the report that the application of fluorescent dyes as guides in the dark is expected to have important uses in other fields.

N. K. S. G.

Indian Grape Vines

THE Agricultural Marketing Adviser in his *Report on the Marketing of Grapes in India and Burma* states that grape vines in Mysore State and Bombay Presidency give the highest yield of table grapes in the world. The average yields in these areas are 11,610 lb. and 11,160 lb. per acre respectively; the next highest yield is 7,678 lb. in California. But the area and quantity produced in India is very small. India produces only about half her requirements of fresh grapes and practically no dried raisins or currants, although she imports 225,000 maunds of these every year. To meet the requirements of her own markets India would have to treble the present acreage of grapes, which is now 4,200 acres. This would involve an addition of sixty or seventy lakhs of rupees to the agricultural income as at present derived from that crop. More than half of the present acreage is in Baluchistan, nearly a quarter in Bombay Presidency and the remaining portion distributed amongst the North-West Frontier Province, Madras Presidency, Sind and Mysore State. The total production of grapes in 1934-35 has been estimated at 375,000 maunds, valued at about Rs. 25,00,000.

India ranks sixth among the principal importing countries. The average annual imports are 272,000 maunds valued at Rs. 21,78,000. The major portion of this quantity comes from Afghanistan ; the United States of America, the Union of South Africa and the Commonwealth of Australia together supplying about 2 per cent. only. Burma imported from India about 2,200 maunds in 1935-36 ; but the bulk of this consisted of "Chaman" grapes which were re-exported from Calcutta.

As a stabilising influence on prices, it has been stressed that the important factors are a regular and more efficient news service between producing and consuming areas, wider dispersion of the produce to smaller consuming centres, chiefly through improved transport facilities, and the provision at distributing markets of conveniently situated cold storage accommodation for the relief of temporary day-to-day surpluses. The provision for these depends on the State. But before the demand can be made insisting more research work is necessary in the production of these fruits. In India very little work has been done in classifying existing varieties and in evolving new varieties and types of grapes likely to be more profitable than those under cultivation. At least one or two experiment stations in grape growing areas might undertake this work. There is again the problem of poor keeping quality, which stands against transport to distant markets. Problems relating to grafting and budding, training and pruning, manuring and spraying of vines with insecticides and fungicides also require attention. In the propagation of vines with a view to extension of the existing area it is desirable that there should be a system of registering approved nurseries, some of which at present sell stocks which are not genuine. But in this task also a precise knowledge of the morphological characteristics of the different varieties of vines and root stocks has yet to be acquired by the fruit specialists.

Glycerine Substitutes

Investigations into the production of substitutes for glycerine were first started in Germany during the war of 1914-18. The famous Protol process is based on the fermentation of sugar, starch or maize. Recently an American process was announced which synthesises glycerine from propylene, broadly by means of chlorination and later replacing chlorine by the OH-groups from alkali. This propylene is generally obtained as a rich constituent (30%) of the gases from petroleum subjected to cracking process. In Germany where petroleum supply is deficient, they are trying to improve the poor yield of this raw material from coke oven gases. It should be remembered that the search for substitutes is based on the specific uses to which they will be put. Some should possess more or less the same physical and chemical character as glycerine itself and others might be useful if only there is a resemblance in the physical properties. As a result of investigations so far glycols and erythritol have been classified in the first group which are suitable for the manufacture of explosives and synthetic resins. In the manufacture of transparent cellulose sheet and resin, Sorbitol syrup prepared from glucose is now under investigation in America. In Germany, the marine plants have a rich source of Mannitol, which is closely related to Sorbitol and is used in explosives. The second group resembling only in physical properties includes lactates, notably sodium lactate. These materials are used in place of glycerine as textile assistants and as shock absorbers in artillary recoil buffers and the like. In place of glycol some lactates are also used as anti-freeze agents. In tooth pastes and cosmetic preparations sugar or starch syrups have been suggested as substitutes. But for the medicines no replacement has yet been possible. Propylene glycol has shown possibilities while in printing rollers and hectograph apparatus glycerine is still the only substance.

Artificial Silk Industry

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SINCE the last Great War, the growth of the artificial silk industry has been tremendous and the manufacture of artificial silk has become one of the major chemical industries of the world. In the first phase of its development, the United States played an important part. In 1930, the American production excelled that of Germany, England and Italy taken together. But during the last ten years, the situation has radically changed. The policy of economic self-sufficiency, specially in the case of vital

raw materials, has been intensified during the last decade in anticipation of war. As a result, countries which are poor in textile raw materials have directed their attention to the development of synthetic fibres with a view to becoming independent of foreign supplies. Japan, Germany and Italy have now become the principal producers as the following table will show :—

TABLE I.

SHARE OF DIFFERENT COUNTRIES IN THE PRODUCTION OF SYNTHETIC FIBRES.

(In million pounds)

Countries.	1929 Art Silk.	1937. Art Silk.	1937. Staple Fibre
U. S. A.	112	282	18
Italy	59	98	140
Germany	45	115	200
France	37	—	—
England	63	108	32
Japan	18	300	155

The above figures indicate the enormous increase in recent years not only of artificial silk yarn but also of short "staple" fibre which is used either as a substitute for cotton or in admixture with it. Evidently the staple fibre has been welcomed in the market, for countries like U. S. A. and Great Britain which command enormous cotton resources are also increasing the production of staple fibre. While the world production of artificial silk yarn is slowly increasing, that of stable fibre is increasing by leaps and bounds (table II). This is due to the efforts of countries like Japan, Germany and Italy, which are dependent on other countries for their supply of cotton fibre. These countries are anxious to replace it with home-made substitutes.

TABLE II.

WORLD PRODUCTION.

(In million pounds)

	Art. Silk Yarn	Staple Fibre
1925 ...	185	Nil
1930 ...	417	6·1
1935 ...	932	139·9
1939 ...	1125	1025

The increase in production of artificial silk yarn and staple fibre is more vividly expressed in the graph (Fig. I).

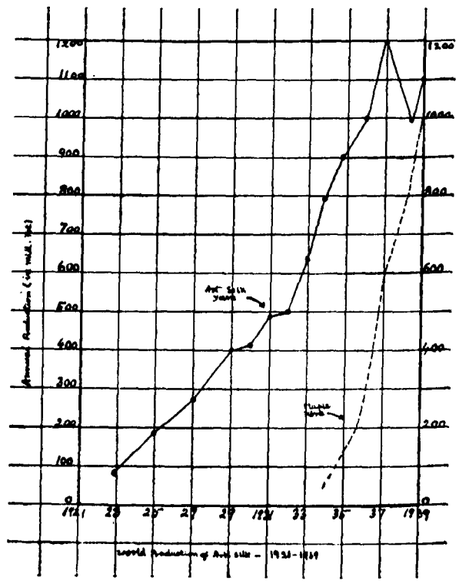


FIG. 1.

The staple fibre, though originally developed as a substitute for cotton, is now finding a wide application. It is no more a mere competitor for cotton but may be considered a supplementary fibre. This view will find confirmation in the increased production of U. S. A. and Great Britain.

PRODUCTION IN U. S. A.

(In million pounds)

	Art. Silk Yarn	Staple Fibre
1930 ...	127	0·3
1935 ...	257·6	4·6
1939 ...	331·2	53

In fact, the consumption of staple fibre in U. S. A. is considerably more than its production. It has been estimated that 47 million lbs. were imported in U. S. A. in 1939 to meet the country's requirement. It is expected that the production of staple fibre will increase more in near future in spite of the country's huge resources of natural cotton fibre. But in India, it is often argued that the development of artificial silk industry would be detrimental to the cotton industry. It is to be remembered that the synthetic fibres are now used to improve cotton textiles and for artificial silk industry the Indian short-staple cotton fibre will be a raw material. This use will not only increase the demand for Indian cotton but will also reduce variations in the prices of cotton considerably. A similar argument was heard some time ago in England with regard to coal, where it was believed that the enormous increase of internal combustion engines based on liquid fuels would reduce the demand for British coal and thus endanger the prosperity of the British coal industry. In practice however the enormous demand for liquid fuels led to the invention of processes for making oils from coal, thus creating more demand for coal which provided employment to a large number of workers. The apprehension entertained in some quarters in India regarding the future of cotton as a result of the development of the artificial silk industry will prove equally groundless.

The necessity for development of artificial silk industry in India will be evident from the fact that this country imported not less than 4·87 crores of rupees worth of artificial silk goods in the year 1937-38 and this figure is increasing year by year. Almost the whole of Indian import came from one single country, namely Japan, which supplies the product at a very cheap rate.

IMPORT OF ARTIFICIAL SILK IN INDIA, 1937-38.

	Total quantity.	Japan's share.
Art. silk yarn ...	31·6 mill. lbs.	28 mill. lbs.
Piece-goods	89·7 ,, yds.	88·5 ,, yds.
Art. Silk-mixed piece-goods	16·1 ,, yds.	15 ,, yds.

RAW MATERIALS FOR MANUFACTURE

The principal raw materials for the manufacture of artificial silk are (*i*) purified cotton, and (*ii*) wood cellulose. The former is used for the manufacture of the acetate silk and the latter is generally used for viscose rayon, purified cotton also having a limited use. The cellulose for the purpose must have certain definite characteristics and is generally obtained by the sulphite process from certain species of wood, such as spruce, hemlock, balsam and occasionally certain species of firs and pines. Economic reasons demand that the above species of wood should occur in easily accessible areas so as to be hauled by waterways. As these species are being used up and their accessibility is becoming more and more difficult, improved methods of haulage are being introduced in western countries. In India suitable species are known to occur in abundance in difficultly accessible Himalayan regions. Introduction of modern scientific methods of haulage may however make them available for industries in this country.

It is interesting to note that Japan, the largest producer of artificial silk, meets her requirement of rayon pulp largely by importation from U. S. A. and Canada. In recent years however Japan has been rapidly increasing her domestic production with a view to self-sufficiency. The Japanese Government has planned a four-year programme for increasing pulp production and the country is expected to become independent of foreign supplies by 1942. Investigation into indigenous materials has been intensified and the imported pulp has already been replaced partly by the country's own raw materials. Several species of coniferous and foliaceous wood, rice and wheat straw, stems and pods of soya beans, bagasse and reed are being successfully used for the manufacture of pulp. Similarly Italy has been utilising Abyssinian bamboo, hemp and straw for the manufacture of rayon pulp. In U. S. A. intensive research has made southern pines available for the rayon industry. In India, our forest resources in easily accessible regions and large stocks of agricultural by-products, which are now wasted, should be explored for the purpose. Some of these materials are known to have short fibre-lengths and high ash-content. Fibre-length, which is an important characteristic for paper-pulp, may not be of equal significance in the manufacture of artificial silk, in which the cellulose has to be dissolved before spinning. The ash-content may also be reduced by suitable treatment. Apart from certain species of wood, the following materials may prove promising sources of rayon-pulp in India :

(*i*) Short-staple cotton,

(*ii*) jute, hemp and barks of certain plants,

(*iii*) bamboo,

(*iv*) rice and wheat straw,

(*v*) sabai and elephant grass,

(*vi*) bagasse, and

(*vii*) reed.

The rayon pulp should have high alpha-cellulose, a proper viscosity in solution, low ash, easy bleach and other suitable characteristics. But the best test for the suitability of a raw material is its actual conversion into fibre and subsequently testing the properties of the fibre obtained.

MANUFACTURING PROCESSES

Though there are several processes in the field, only two processes are in extensive use, *viz.*, the viscose process and the acetate process. The former uses purified wood-cellulose as the chief raw material, while the latter uses purified cotton. Viscose rayon is reputed to be cheap but the cost of production of acetate silk is now being rapidly reduced by large-scale manufacture of solvents and improved methods of acetylation. The difficulties of dyeing the acetate silk have been largely overcome by the introduction of new dyes placed in the market by manufacturers. On the other hand, the viscose process is also undergoing rapid improvement. The introduction of stretch-spinning in a strongly acid bath has considerably improved the tensile strength of viscose yarn in both dry and wet state. Stretch-spinning is also being introduced in the acetate silk industry. A short description of the two processes is given here.

VISCOSE PROCESS

The preparation of a uniform raw material is of the greatest importance. For this purpose, cellulose is obtained from wood and other raw materials by freeing it from lignin, resin and other accompanying impurities. The sulphite process, which is usually used for the purpose, consists in digesting disintegrated wood with an aqueous solution of calcium bi-sulphite under pressure at temperatures varying from 120° to 150°C. The excess of sulphur dioxide is re-used and the sulphur in the waste sulphite liquor is recovered as far as possible. The cellulose pulp is washed, bleached and blended to obtain a uniform raw material and then compressed into sheets of standard size which are soaked in caustic soda under closely controlled conditions. The excess of alkali is pressed out and the alkali-cellulose is "aged" by standing for a definite time at a constant temperature. The material is then disintegrated in a shredding machine, treated with carbon bisulphide in rotating drums and again allowed to stand or 'ripen". The ripened xanthate is then dissolved in water or dilute alkali and the impurities are settled out by standing. The solution is then re-aerated and passed through filters into spinning jets immersed in coagulating bath.

The spinning jets are made of plates having a number of tiny holes, 25 or more, through which the clear viscose solution is forced under a pressure of over 200 atmospheres. The liquid passes downwards through the jets into spinning boxes which contain dilute sulphuric acid with sodium bi-sulphate and other additions. The viscous solution coagulates here into yarns, the acid combines with the alkali, decomposes the xanthate with the production of CS_2 and H_2S and regenerates the cellulose. The carbon disulphide and sulphuretted hydrogen are recovered from the vapours of the spinning box. The coagulated fibres are passed over guides through the spinning bath into collecting bobbins and are later bleached, twisted and reeled. In the centrifugal or pot-system of spinning, the yarn is given a twist of 2·5 per inch as it collects in rotating spinning boxes.

The properties of the yarn may be modified by adding certain ingredients, either in the xanthate solution before spinning or in the coagulating acid bath. Titanium dioxide has been used to reduce the glaze (delustering), while glucose in the coagulating bath makes the fibre stronger and smoother. The yarn is also subjected to after-treatment in order to increase its strength, appearance and water-resisting properties.

The properties of solution of cellulose vary considerably with the nature and history of raw materials. Small variations in the treatment of cellulose at different stages have profound effect on the properties of cellulose solutions. Great care is therefore necessary at every stage of manufacture to ensure that constant conditions are maintained.

LILIENFELD'S MODIFICATION

Lilienfeld obtained yarns much stronger than ordinary viscose rayon by using a strongly acid precipitating bath and stretching the filaments considerably between the spinning jets, the yarn guide and the collecting device. This stretch spinning is being widely adopted not only for viscose but also for acetate rayon. Certain other modifications, such as cooling the alkali cellulose in shredders, treating the same with large excess of carbon disulphide, controlling the temperature, and composition of the coagulating bath and after-treatment of the yarn, are known to improve the quality of the fibre considerably.

STAPLE FIBRE

The viscose process of spinning is generally used for the manufacture of staple fibre, using a very large number of jets or openings in each plate. The yarns coming out from these jets are coagulated in the usual manner, collected in a bundle and cut into short lengths of 1½ to 2 inches. These are blown into a fluffing machine, packed into bales and used very much like cotton.

ACETATE PROCESS

The acetate silk is usually prepared from carefully purified and dried cotton which is soaked in glacial acetic acid. The mass is then dipped in an acetylating bath containing 20 to 30 times its weight of acetic-anhydride and glacial acetic acid in the presence of certain substances, usually sulphuric acid, chloro-sulphonic acid or perchloric acid. These substances, commonly called catalysts, accelerate and complete the acetylation into tri-acetate of cellulose. The cellulose gradually dissolves in the bath kept at the ordinary or slightly elevated temperature and when the acetyl content has reached the maximum, *i.e.*, about 62%—an operation which takes many hours—the acetylating bath is diluted with a small quantity of water sufficient to convert the anhydride into acetic acid. A little sodium acetate or other sodium salts are then added and the solution heated so as to hydrolyse the tri-acetate under careful condition until the acetyl content is reduced to 55 to 57%. The radical of the catalyst which may have entered the cellulose molecule is removed in the process. It is only after this careful hydrolysis that an acetone-soluble product is obtained. It is interesting to note that breaking off the acetylation process as soon as the desired acetyl content is reached (55 to 57%) does not yield an acetone-soluble product. When the hydrolysis has proceeded to the desired limit, the whole mass is poured into excess of water to precipitate the cellulose-acetate which is washed, dried and dissolved in acetone mixed with other solvents before spinning.

The above method of preparing cellulose acetate has the disadvantage that large quantities of glacial acetic acid and acetic anhydride remain in the form of diluted acetic acid, which has to be concentrated before it can be used again. In recent times however methods have been developed for acetylation without destroying the fibrous structure of the product which may be centrifuged, and the acetylating liquid recovered for further use. The fibrous product is washed, dried and dissolved in acetone or chloroform for spinning.

The solution in acetone must be a viscous liquid containing 7 to 8% of the ester. It is de-aerated and forced through filters into jets similar to those used in the viscose process. The spinning is downwards —the solution is extruded into a cylinder or chamber usually 10 to 20 ft. in height. A current of warm air is drawn through the chamber to take away the volatile solvents and coagulate the solution into yarns which pass over guides through apertures in the side of the chamber near its bottom and wound on spools. The speed of winding is carefully adjusted to subject the filament to tension and thus diminish the cross-section. About 2·5 twists per inch are given to the yarn as it collects in the spool. The air carrying the solvent vapour comes out at the top of the chamber and is drawn through absorbers where the solvent is recovered.

COST OF PRODUCTION

On account of the cheapness of the process, viscose rayon is extensively manufactured in various countries. Japan, the principal producer of artificial silk yarn, follows the process almost exclusively. In U. S. A., however, an appreciable amount of acetate silk is manufactured. The production of the acetate and of the solvents on an extensive scale has been organised in that country and as a result the cost of production has been steadily coming down. In India where the solvent industry is practically non-existent and the cheaper products are likely to be more in demand, the viscose process seems to have a brighter future. The following materials will be necessary for the production of *one ton* of artificial silk:

1·2 ton cellulose,
1·8 ton caustic soda,
0·46 ton carbon disulphide,
1·5 ton sulphuric acid,
2·0 ton bisulphate of soda,
1·6 ton sulphate of magnesium, zinc and glucose,
0·05 ton bleaching powder,
0·04 ton lubricating oil,
6 to 8 tons coal, and
30 to 40 sq. yds. filter cloth.

As part of the chemicals used can be recovered and their cost varies in different places, no attempt is made here to estimate the total cost of production. It may however be stated that power consumption is considerably low in larger installation and as a result only larger units can operate economically. As large quantities of sulphur and its derivatives are required in the process, it is desirable to develop indigenous sources of sulphur. Various western countries are producing large quantities of sulphur as a by-product and have become self-sufficient with regard to this important raw material. Even if we

have to depend temporarily on foreign supplies of sulphur, this argument need not be used against developing this important industry in India. Japan has built up a large and prosperous artificial silk industry though she is largely dependent on foreign supplies of the most important raw material, *i.e.*, cellulose.

The average cost of production in Japan has been estimated at 0·73 Yen (about -/9/- as.) per lb. for artificial silk yarn, made up as follows :--

Cellulose	0·25	Yen
Caustic, sulphuric acid and other chemicals ...	0·145	,,
Coal and power ...	0·08	,,
Labour	0·055	,,
Packing, sale, freight and repair	0·12	,,
Tax, depreciation and interest	0·08	,,
Total ...	0·73	Yen

It is interesting to note that though the cost of production in Japan is -/9/- as. per lb., the C. I. F. price in Calcutta for Japanese goods is As. -/10/4 only. In U. S. A. the price of artificial silk yarn is considerably higher, *i.e.*, 60 cents or Re. 1/12/- as. per lb. The low cost of Japanese goods is due to Government subsidy, low cost of labour and efficient trade organisation. Chemicals are supplied by the Government at reduced prices, demonstrations and propaganda work are carried on at Government expense and legislative action is undertaken by the Government to increase internal consumption of synthetic fibres by enforcing their admixture with cotton and wool.

NEED FOR RESEARCH

The synthetic fibre industry has made tremendous progress in course of the last 20 years as a result of intensive researches in the field of cellulose chemistry and chemical engineering. Today the progress is still greater than before and the climax is still far from being reached. In contrast with this progress, the textile industry is, on the whole, standing still. The synthetic fibre industry is essentially a chemical industry while the textile is a process industry, in which knowledge of fundamentals, though useful is not essential. Our industrialists, from their experience of cotton textiles are inclined to look upon research as an unnecessary and costly luxury. They often favour a 'wait and see' policy, so that the necessary research and improvement may be made at the expense of foreign countries and India may take advantage of them by simply paying for a few foreign experts. This may, to a certain extent, be true for a process industry like cotton and wool textiles ; but it is far from true in the case of larger chemical industries. Western countries have not built up their chemical industries —the dye-stuff, the synthetic fuel, the synthetic fibre and other large chemical industries—without constant research and progress. In addition to fostering research in universities and other educational institutes, special research institutes have been established in various countries with the object of fostering research on cellulose and its products. Only recently, Japan has established a special cellulose research institute at Kanagawa at a cost of 2·5 million Yen (20 lakhs of Rupees), in spite of numerous other organisations already engaged in researches on cellulose. It is time that India should take all necessary action for developing a synthetic fibre industry in this country. Already in European countries, large concerns with extensive financial resources have interested themselves in the manufacture of artificial silk and the success of smaller and newer concerns will gradually become increasingly difficult. Our attempts in this direction should be made in time before it is too late.

MEDICINE & PUBLIC HEALTH

Medical Stores Supplies for India

MANY problems affecting medical supplies to the Army were considered at the third meeting of the Drugs Supplies Committee, now called the Medical Stores Supply Committee, held recently under the chairmanship of Lieut.-General G. G. Jolly, I.M.S., Director-General, Indian Medical Service. Samples were shown of emetine hydrochloride, apomorphine hydrochloride, acriflavine and dried blood plasma made in India under schemes of investigation fostered by this Committee in close liaison with the Board of Scientific and Industrial Research.

To combat shock through loss of blood, blood transfusion is largely used in modern medicine. Such blood is difficult to obtain in quantity for the treatment of the wounded in the field and so other methods are being carefully considered. One of the most successful and promising of these methods is the use of dried blood plasma. Blood to which sodium citrate has been added to prevent coagulation is allowed to settle and the clear liquid drained off. This liquid is dried in vacuo to a granular powder and packed aseptically in containers. Before use it is made into a solution with sterile water and given to the patient in the same manner as a blood transfusion. The sample of dried blood plasma, the first to be made in India, has shown the possibilities of its manufacture in India.

The production of emetine hydrochloride which is still required for the treatment of amaebic dysentery is closely associated with the growth of *Ipecacuanha*. This drug grows wild in the forests of South America but is more and more difficult to obtain. The plant has been demonstrated to grow well in Mungpoo, Bengal, and the question of encouraging its cultivation in India is under consideration.

Much progress has recently been made in Travancore, Bombay and Madras in the development of fish liver oil schemes for supplying India with substitutes for cod liver oil. The esential factor in these oils is their content of vitamin A and vitamin D. As the shark liver oil has ten times the vitamin A content of cod liver oil it forms a valuable source of vitamin A. This oil however is lacking in vitamin D so that it is necessary to add this vitamin to it. Vitamin D is reported to have been made at the Indian Institute of Science at Bangalore.

Location of Tuberculosis Clinics

THAT if a tuberculosis clinic is to be of maximum benefit, it should be situated in, or as close as possible to, a thickly populated area, is the unanimous opinion of the committee of experts recently appointed by the Tuberculosis Association of India at the instance of the Government of India to consider what conditions should govern the selection of sites for such clinics and whether any particular precautions were necessary in the case of clinics situated in populated areas. The committee were also of the view that no particular conditions are necessary regarding the distance of a well-conducted clinic from the nearest house. They recommended, however, that if a clinic is located in a part of a building used for other purposes, the clinic should have a separate entrance.

Ascorbic Acid Deficiency and Cellular Blood Constituents of Guineapigs

SIGNAL (*Proc. Soc. Exp. Biol. and Med.*, *42*, 163, 1939) observed that in anaemia accompanying scurvy in guineapigs, there was a progressive decrease in the haemoglobin and red blood corpuscles and a slight increase in the white blood corpuscles. He also observed that when guineapigs receiving 3 mg. of the vitamin C per day were given subcutaneous injections of diphtheria toxin, there was less disturbance in their blood cell count than in similarly treated animals receiving 0.5 mg. of the vitamin.

S. B.

Sulphathiazole and Sulphamethylthiazole in Gonorrhoea

2-SULPHANILYL aminopyridine known as sulphapyridine has been found to be very useful in combating coccal infections. Recently two thiazole deriva-

tives of sulphanilamide, 2-(p-aminobenzene-sulphonamido) thiazole, known as sulpha-thiazole and 2-(p-aminobenzene-sulphonamido) 4-methylthiazole, known as sulphamethylthiazole have been used by Lloyd *et al* (*Lancet*, *2*, 186, 1940). As compared to sulphapyridine, sulphathiazole has been found by them to be equally effective in its therapeutic action. Sulphamethylthiazole is less efficient and the action is very slow. The patients tolerate the drugs very well.

S. B.

Capillary Fragility and Vitamin P.

BORBELY (*Munich. med. Wschr.* 77, 886, 1930) observed that syphilitic patients receiving injections of salvarsan often suffered from increased capillary fragility *i.e.*, the capillary walls burst as a result of the application of lesser amount of either positive or negative pressures than normal. Scarborough and Stewart (*Lancet*, *2*, 610, 1938) observed that cases of purpura occuring as toxic manifestation of antisyphilitic therapy with arsenic and bismuth had diminished capillary resistance and the capillary resistance in these cases was raised by the administration of vitamin P. Horne *et al*, (*Lancet*, *2*, 66, 1940) have shown that redness and dermatitis occurring as toxic manifestations of antisyphilitic therapy are also associated with increased capillary fragility and these cases improve after administration of vitamin P. Vitamin C is without any effect.

S. B.

Diarrhoea and Gastrointestinal Absorption of Ascorbic Acid

ABT and Farmer suggested (*J. A. M. A.*, *111*, 1555, 1938) that under certain pathological conditions the absorption of ascorbic acid from the gastrointestinal tract is abnormal. Meyer and Dobinson observed (*Ann. Pediat.*, *152*, 283, 1939) that when infants suffering from diarrhoea were supplied with massive doses of ascorbic acid per mouth, the blood ascorbic acid was low and the urinary excretion was diminished. When the vitamin was administered by injection, a rise in the blood ascorbic acid and increased elimination of urinary ascorbic acid were noted. Abt, Farmer and Topper (*Proc. Soc. Exp. Biol. and Med.*, *43*, *24*, 19404) determined the ascorbic acid content of the faeces of infants by the method of Chinn and Farmer (*Proc. Soc. Exp. Biol. and Med.*, *41*, 561, 1939). Ascorbic acid was found to be excreted in smaller amounts in the stools of normal infants When these infants were purged by means of cathartics large amounts of orally fed ascorbic acid were excreted in the faeces. This shows that the intestinal tract fails to absorb ascorbic acid in such a condition and explains the low blood level and diminished urinary excretion of ascorbic acid in infants suffering from diarrhoea.

S. B.

Effect of Insulin on Plasma Level and Excretion of Ascorbic Acid

RALLI and Sherry observed (*Proc. Soc. Exp. Biol. and Med.*, *43*, 669, 1940) that when insulin was injected in normal dogs there was a fall in the plasma concentration and urinary excretion of ascorbic acid. The effect persisted for about 7 hours after which the plasma level and urinary excretion of the vitamin returned to normal. The fall in the blood level and urinary excretion of ascorbic acid was very sharp when insulin was injected into depancreatised dogs. This effect of insulin, however, could be overcome by intravenous injection of glucose.

S. B.

Recovery of Ascorbic Acid from the Urinary Bladder

IN assessing the ascorbic acid nutrition by urine analysis, the question may arise as to the loss of the vitamin, if the urine is retained in the urinary bladder for a considerable time. Sherry and Friedman, however, observed (*Proc. Soc. Exp. Biol. and Med.*, *42*, 707, 1939) that after instillation of ascorbic acid in amounts varying from 0.5 to 30 mg. into the urinary bladder 92-107% could be recovered in the urine after periods of 1-5 hours. Therefore they have concluded that practically no loss of the vitamin takes place inside the urinary bladder.

S. B.

Announcement

THE 3rd All India Obstetric & Gynaecological Congress will be held this year in Calcutta from the 27th to the 30th December 1940, both days inclusive. The subjects for discussion are: (*i*) Anaemia of Pregnancy; (*ii*) Functional Uterine Haemorrhage; and (*iii*) Maternity & Child-welfare. Detailed information may be obtained from the Jt. Hony. Secretaries, Bengal Obstetric & Gynaecological Society, 01B, Chittaranjan Avenue, Calcutta.

Sugar

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THE importance of sugar as a food is now well recognised. Several different varieties of sugar are known. The two main groups are (*i*) disaccharides, the chief examples of which are cane-sugar, beet-sugar, maple-sugar, malt-sugar and milk-sugar; and (*ii*) mono-saccharides, such as grape-sugar, fruit-sugar and invert-sugar, which is a mixture of grape-sugar and fruit-sugar. The technical names applied to these sugars are as follows: (*i*) sucrose or sacharose is cane, beet or maple-sugar; (*ii*) maltose is malt-sugar; (*iii*) lactose is milk-sugar; (*iv*) glucose, grape-sugar; (*v*) laevulose, fruit-sugar and (*vi*) invert sugar, a mixture of glucose and laevulose. Of the above sugars, cane-sugar is the most familiar of all. It is mainly derived from the sugarcane. When derived from sources other than the sugarcane, special names as beet-sugar or maple-sugar are usually given to it. But, from the chemist's point of view, beet-sugar or maple-sugar is indistinguishable from the sugar, derived from the sugarcane.

Sugar, derived from the sugarcane, has been in use in the world as a food for many ages, but it is only within comparatively recent times that it has been manufactured cheaply enough to take an important place in ordinary diets. It may be of interest to know that the sugarcane was known in China 2,000 years before it was used in Europe. It appears to have been known at more or less the same time in India as well. It travelled westwards later. The Greek physicians, several centuries before the Christian era, spoke of sugar under the name of *'Indian salt'*. It was called 'honey made from reeds'. In the 14th or 15th century, the Indian sugarcane was cultivated in North Africa and later in the West Indies and Brazil. It is reported that sugar was first used in Great Britain in 1319.

The history of beet-sugar is interesting. In 1747, Marggraf, a chemist of Berlin, discovered that beets, with other fleshy roots contained crystallizable sugar, identical with that of the sugarcane. In 1796, his pupil, Achard, is said to have erected the first manufactory for beet sugar. Only 2 to 3 per cent. of sugar could be extracted by the methods then in use. Therefore, the amount was too small for making the manufacture of beet-sugar a commercial success. A great stimulus was given to the manufacture by Napolean in 1806. He granted State sugar bounties and the methods were rapidly improved, especially in France. By scientific investigation, a beet was gradually developed, having a large percentage of sugar.

It is not necessary in this connection to consider the other forms of sugar, as they are not of such commercial interest as sugar from the sugarcane and the beet. To the ordinary consumer, beet-sugar is hardly distinguishable from the cane-sugar. To the chemist, the two are really identical. The manufacturers say that for some purposes, sugar derived from the cane is preferable, *e.g.*, in the manufacture of fruit-syrups, because cane-sugar is said to be less liable to fermentation.

I need not deal with the methods of preparation of raw sugar and the methods of purification and the process of refining. It may suffice to say that most of the sugar manufactured and sold in the world today is only refined sugar. Sugar, which was not so long ago a rare luxury, occupies today a very prominent position in the diet of a civilised man

It has been stated by a writer in the *British Medical Journal* (*1*, 119, 1901) that the difference between cane-sugar and beet-sugar is not a chemical, but a physiological one—a question of taste and flavour—and that it is similar to that between silent spirit faintly coloured and genuine Scotch whisky. There is no evidence for the statement that beet-sugar is more injurious to health than genuine cane-sugar, though there are evidences to show that genuine cane-sugar is of higher value as a food and as an article for therapeutic purposes. While the diet of the modern civilized man appears to be a great improvement on that of his ancestors, his habit of consuming large quantities of concentrated refined sugar, is an item on the debit side, because such sugar is deficient in nearly all the most valuable food factors. It has been shown that 'molasses' or treacle, a residue separated from sugar in the process of manufacture, is richer than sugar in organic elements, particularly—iron. Its high iron-content gives 'molasses' a peculiar importance in the diet of the people of Labrador.

In western countries, the consumption of sugar has increased from a few lbs. per person per

year a little over a century ago, to upwards of 100 lbs. per capita today. This increase is not uniform as regards individuals ; it is however true to state that during the past 25 years the Germans, the Americans, the English and other nations are consuming a large proportion of refined and manufactured food products, including sugar. Unfortunately, the proportion is sometimes so large as to make their dietaries frequently of poor quality in respect to several nutrients—mineral elements and vitamins.

The following figures compiled by the International Institute of Agriculture will be of interest, because it gives us an idea as to the per head consumption of sugar per year.

PER HEAD CONSUMPTION OF SUGAR PER YEAR

(Period : 1930-34).

	Lbs.		Lbs.
Austria ...	... 61	Netherlands ...	... 68
Belgium ...	... 62	Norway ...	... 70
Bulgaria ...	... 10	Poland ...	... 23
Czechoslovakia	... 56	Rumania ...	... 12
Denmark ...	... 120	Sweden ...	... 95
Finland ...	... 51	Switzerland ..	... 98
France ...	.. 57	United Kingdom	... 119
Germany ...	... 52	Canada ...	... 95
Italy ...	... 18	United States ...	... 103
India (1938-39)*	... 25·9	Australia ...	... 107

From the figures it will be seen that in all the progressive countries in Europe and America, there is a large amount of sugar consumed. Denmark leads in this matter and in the United Kingdom, the United States and Australia there is more than 100 lbs. per head consumption of sugar. Bulgaria and Rumania are the lowest in the scale.

As for India, Dr W. R. Aykroyd in his *"Note on the Results of Diet Surveys in India"*, states, "the sugar intake of most of the rural rice-eating groups was nil or negligible. The Industrial groups in Bihar consumed under 1 oz. of sugar daily. The intake of the families in Delhi province and of the Bombay workers was a little above this level. In Southern India, consumption of sugar and jaggery is in general very small. These figures suggest that the recent increase in sugar production in India has not yet been reflected in a substantial intake of sugar on the part of the poorer classes."

The cheapness of sugar is a development of recent years. It can hardly be without far-reaching effects on national health. It tends to make us consume more carbohydrate and less fat, for fat is always a dear form of food. Sugar is more easily absorbed and oxidised. It is more rapidly burnt up in the body than fat. On that account, it is a more efficient protein-sparer than fat. Sugar has now become one of the cheapest of fuel-foods. "The cheapness of sugar has a favourable influence on the health and growth of children, for it ensures them in ample supply of the body-fuel, which they so much need, and which the dearness of fat is apt to make unattainable. It has the advantage, too, of being a form of fuel, which few children are likely to refuse, and that is far from being true of fat." Though from the standpoint of nutrition, an increased consumption of sugar is not highly important, there can be no doubt as to its desirability.

It is as a muscle food that sugar is of special importance. Carbohydrates are the chief source of muscular energy. Sugar being a variety of carbohydrate which is most easily and rapidly absorbed, fulfils this function better than any other form of carbohydrate. The English give sugar to race-horses. To Swiss guides and Arctic explorers, the value of sugar as food has long been familiar. Athletes have known the value of sugar in lessening muscular fatigue. Just before the start of the famous annual Oxford-Cambridge Regatta, each player partakes of a spoonful of brown-sugar to lessen the effect of physical fatigue. The administration of sugar delays the onset of fatigue and the subsequent effects are quickly removed. It has been shown that the addition of sugar to diet increases the power of doing work and lessens exhaustion. There is a considerable evidence in favour of the free use of sugar in training and during the performance of hard muscular work, such as, rowing, running and all vigorous games like football, hockey, etc. The men of the German Army have been reported to carry sugar as well as first-aid dressings with them, so that in case of unexpected movements, where the Commissariat fails, they can undergo considerable muscular exertion on sugar alone. Alpine climbers find sugar more sustaining under the severe strain to the heart on account of the climbing. The above facts have been adduced just to show the important part played by sugar in the expenditure of muscular energy. It is no wonder therefore that the per capita consumption of sugar in the rich progressive industrialized countries in Europe and America is very large, as compared with the amount consumed per head in a poor and industrially very backward country like ours.

The ingestion of cane-sugar has a specific action on the nutrition of the musculature of the heart. The value of glucose as a heart-tonic is now widely appreciated, even by the lay public. Dr Arthur Goulston in his book on *"Cane-Sugar and Heart Disease"*, has laid special stress on the value of cane-sugar in various diseases of the heart, in conditions of valvular disease, in malnutrition and degeneration of the heart muscle. The rationale of the treatment by means of the ingestion of cane-sugar is explained by him in great detail in the above publication. In diseased conditions of the heart he administered 4 to 10 ozs. of sugar per day for a long period.

It is very interesting, however, to note his observation gathered from long experience that the best kind of sugar is the one from sugar-cane. He also observes that sugar from the sugarcane acts beneficially on the heart musculature, where the sugar from the beet fails. A number of clinical cases are quoted in support of this contention. He considers that the difference is something like that found between hand-pounded rice and mill-polished rice. He suggests that there might be an 'activator' in the sugar from the sugarcane, which did not exist in sugar from the beet-root. Probably, the activator is destroyed in the process of refining the raw cane sugar. An officer of the Indian Medical Service is said to have obtained much success in the treatment of heart disease among the poor patients in India by giving the ripe sugarcane to chew. There is evidently something in sugarcane sugar, which is not present in beet sugar. Is it of the nature of a 'co-enzyme' or 'activator', or what? It is not inherently impossible that there may be a factor in cane-sugar, which is not present in beet-sugar. It is also interesting to note that it is the experience of bee-keepers that the bees thrive, when fed with the syrup made with West Indian sugar, whereas the bees deteriorate and may contract disease and die, when fed on beet-sugar syrup.

Dr Goulston is of opinion that apart from the use of cane-sugar in the treatment of heart diseases, it is very useful even in the prophylaxis of heart disease. He hazards the opinion that if more sugar derived from sugarcane and less sugar from the beet root were consumed, we would soon find it a satisfactory means of prophylaxis of various kinds of heart disease, except those due to congenital defects.

Nadakarni, in his book, *"The Indian Materia Medica"*, describes the various preparations made from the juice of the sugarcane and described by the old Sanskrit writers. He also describes the various therapeutic uses to which sugar is put. He states that three American scientists have, as the result of exhaustive biological experiments, proved that cane molasses are far richer in vitamin B, than either beet molasses or sorghum. The different therapeutic applications and uses of the various forms of sugar described in ancient Sanskrit and other texts have not been investigated into. The laxative, diuretic, aphrodisiac, preservative, bactericidal and other properties are mentioned for different forms of sugar made from many species of sugarcane. Unrefined and under-refined sugar, probably, has some virtues, which yet remain uninvestigated.

It is, therefore, a matter for consideration whether, after all, it is not desirable to give up the complete refining of sugar and to popularise the use of brown sugar and other forms of raw sugar in the place of the white sugar, especially in a population, whose diet is miserably poor not only in the matter of essential foodstuffs, but also in the various vitamins and mineral contents, which go to make a well-balanced diet, and which mean so much for the active physical health for a nation which wishes to be progressive with the rest of the nations in the world. There is no greater example for a search of this kind than in brown bread vs. white bread, and hand-pounded rice vs. mill-polished rice, and white flour vs. whole grain flour. Attention may well be directed not only to an investigation into raw or brown sugar vs. white or refined sugar but also to a propaganda for increased consumption of the indigenous sugar from the sugarcane and the prevention of the import of foreign beet-sugar into India.

* From the *Indian Sugar Industries Annual*, page 92, which is the only source available at present. Of this consumption of sugar in India of only 25·9 lbs. per capita during the year 38-39, refined sugar is only 5·7 lbs. whereas unrefined *gur* sugar is 20·2 lbs. per head.

Research Notes

Synthesis of Factor V from Nicotinic Acid in Vitro by Human Erythrocytes

Henry J. Kohn and Raymond Klein (*Jour. Biol., Chem. 135*, 685, 1940) have shown that the incubation of defibrinated human blood with nicotinic acid increases the factor V content of the blood cells. Factor V is the factor necessary for the cultivation of *Hemophilus parainfluenzae*. Of known compounds only di- and triphosphopyridine nucleotide can serve as factor V.

They along with Axelrod, Gordon and Elvehjem who recently confirmed the synthesis *in vivo* believed that the synthesis occurred in the erythrocytes because the factor V content of the normal blood is practically confined to them. But Vilter and Spies, although able to confirm the synthesis *in vitro* by blood cells, state that ". . . . it seemed that the red cells stored and carried the enzymes instead of performing the synthesis."

Salts in the medium of synthesis and the physical conditions markedly affect the synthesis of factor V by erythrocytes. The synthesizing ability of the cells is greater in Ringer phosphate solution containing glucose than alone or in sodium chloride solution.

On the other hand, the presence of oxalate in the medium, rough handling of cells and too frequent passage through capillary pipettes are reported to diminish the synthesis.

P. K. S.

Some Factors Influencing the Oxidation of Alanine by Liver Tissue

It has been shown that boiled extracts of liver contain less flavin adenine dinucleotide when the animals are fed on a diet deficient in flavin and that there is also a diminution of O_2 uptake as measured by Warburg technique. A similar diminution of O_2 uptake with alanine as substrate has also been reported.

This result has been confirmed in a paper published by R. J. Rossiter (*Jour. Biol. Chem., 132*, 431, 1940). He has also demonstrated that additional flavin adenine dinucleotide *in vitro* caused a greater increase in O_2 uptake of liver preparations from animals receiving adequate amounts of riboflavin and concludes that the decrease in the O_2 uptake in liver preparations from animals fed on a flavin deficient diet is due to the deficiency in the *d*-amino acid oxidase flavoprotein of Warburg and Christian. His experiment proves that this deficiency can be made good by the addition of flavin adenine dinucleotide and this very fact also suggests that the protein constituent of the enzyme is present and that it is less active due to the lack of flavin adenine dinucleotide. Rossiter has also confirmed the observation of J. R. Klein that thyroid treatment causes an increase in the O_2 uptake in presence of *dl*-alanine and that there is no increase in flavin adenine dinucleotide content of boiled liver extracts of such thyroid-treated animals even if large amounts of riboflavin are given in the diet.

A. R.

Pyruvate Oxidation

Pyruvic acid occupies a central position in oxidation as well as in fermentation. It is the primary oxidation product of triose and the mother substance of lactic acid as well as of alcohol. According to Szent-Györgyi, fermentation and oxidation can be represented by the following schemes :—

$$\text{Triose} \xrightarrow{-2H} \text{Pyruvic acid} \xrightarrow{+2H} \text{Lactic acid}$$

$$\text{Triose} \xrightarrow{-2H} \underset{\text{acid}}{\text{Oxaloacetic}} \xrightarrow{+2H} \underset{\text{acid}}{\text{Malic}} \xrightarrow{-H_2O} \underset{\text{acid}}{\text{Fumaric}} \xrightarrow{+2H}$$

$$\underset{\text{acid}}{\text{Succinic}} \xrightarrow{-2H} \text{WK} \xrightarrow{-O_2}$$

In these reactions the catalytic function of the C_4-dicarboxylic acids and of their activation by enzymes in the cellular respiration of the pigeon breast muscles and of a number of other tissues have been well established from the experimental point of view. The extension of Szent-Györgyi's theory to include citric acid and ketoglutaric acid has been put forward by Krebs and his collaborators.

The main evidences for the occurrence of the citric acid cycle in pigeon breast muscle are as follows :—

(*i*) The oxidation of pyruvate is inhibited by malonate.

(*ii*) The malonate inhibition is partially overcome by the addition of fumarate, and the extra amount of pyruvate used in these conditions is in the proportion of 1 mol. of pyruvate to each mol. of added fumarate. In the presence of malonate, succinate is formed in amounts equivalent to the fumarate.

(*iii*) Under certain conditions fumarate and pyruvate can be shown to form citrate and ketoglutarate.

David Henry Smyth in a paper (*Biochem. Jour., 34*, 1046, 1940) has tried to furnish further evidence for citric acid cycle. Instead of pigeon breast muscle as worked upon by Krebs and his co-workers, he has used that of sheep's heart. He concludes that the main reactions on which the citric acid cycle is based occur in minced heart muscle. These reactions are the malonate inhibition of oxygen consumption and pyruvate usage, the specific effect of fumarate in combining with pyruvate to form succinate in presence of malonate, the formation of citrate and ketoglutarate and the effect of the substances involved in the citric acid cycle in maintaining respiration.

This work, however. does not meet the points raised against the citric acid by Breusch (*Biochem. Jour., 33*, 1757, 1930) nor can it throw any light on the following observations of Thomas (*Enzymologia, 7*, 97, 1939).

(a) The conversion of oxaloacetate into malate is the same in presence and absence of oxygen.

(b) In presence of arsenate the three C_4-dicarboxylic acids *viz.*, malic, fumaric, and succinic acids are rapidly transformed into oxaloacetic acid while the same process in the case of citric acid is slow.

(c) The catalytic effect of the C_4-acids manifests itself within ten minutes after the beginning of the experiments whereas the effect of citric acid becomes appreciable only after a delay of one hour.

Whether citric acid behaves like a metabolite or a catalyst in muscle respiration is a question of fundamental importance which confront Kreb's theory of "cytric acid cycle".

S. R.

SYNTHETIC RUBBER

In Germany and Russia the aim of research for artificially producing rubber has been to duplicate, or nearly duplicate, the properties of natural rubber ; in the United States, on the other hand, the apparent objective has been to produce a product superior to natural rubber in some respect, so as to justify, in a free market, the higher cost, which is in most cases at least three or four times that of natural rubber. Recent international events have somewhat changed the American viewpoint, but have not as yet had an influence on the development of synthetic rubber in that country.

As a result of these researches. there are thirty varieties of synthetic rubber, almost all of which are at present in commercial production. The varieties are grouped in six general classes, according to chemical composition. The classes are : (1) Chloroprene polymers, (2) butadiene polymers, including copolymers, (3) organic polysulphides, (4) isobutene polymers, (5) plasticized vinyl chloride polymers, and (6) dimethyl butadiene polymers. Familiar examples of each of these types are, respectively, (1) Neoprene, (2) the German Buna rubbers, (3) Thickol, (4) Vistanex, (5) Koroseal, and (6) "Methyl rubber".

BOOK REVIEW

From Savagery to Civilisation—by M. N. Roy, (Digest Book House, Calcutta). *Pp.* 240. *Price Rs. 1/8.*

As mentioned in the publisher's note, the major portion of this book consists of a reprint of a series of articles contributed in the columns of the *Amrita Bazar Patrika* of Calcutta.

The historical narrative depicting the reaction of the Christian Church of Mediaeval Europe, against the memorable and epoch-making scientific discoveries, especially in the domain of astronomy has been presented in a very lucid form by Mr Roy and he deserves credit for his able and vigorous delineation of the incidents connected with the various painful episodes in the history of the development of modern science.

Mr Roy, besides being a politician, is a great votary of modern science. He does not also hesitate to look deep into the various concepts (mostly European) of god, religion, and Creation in general. He firmly believes in the unilateral progress of the human race from, what he calls, savagery to civilisation. In his opinion, the greatest contributing factor to the growth of this civilisation is the invention and development of "machines". As a matter of fact, his idea of what he considers real civilisation must of necessity be linked up with the idea of the mastery of man over the forces of nature. This mastery cannot be achieved without harnessing the physical energy of nature, for which purpose machines are absolutely necessary. In this connection he has said many things relating to the conception of god and religion which cannot unfortunately be universally accepted. Perhaps Mr Roy will ascribe this to the influence of superstition which still persists in the minds of a large majority among the human race—remnant of the savagery from which the human race has not yet been freed. Be that as it may, no one will dispute the fact that science has played and will continue to play the most vital part in regulating the progress of the human race. This word 'science' has however to be understood in its all-embracing [illegible], and its method will have to be applied [illegible] all branches of knowledge. Further, what has been understood as the scientific method should not degenerate into a rigid and conventional procedure, but should continue to be a living system capable of assimilating other methods of enquiries, if they help to extend the boundary of human knowledge. In this catholic spirit we have to proceed from knowledge to knowledge. There is no discernible limit to our march, and no one can therefore—not even the greatest scientist—predict the journey's end. Whether the move is continuously forward or is caught up sometimes in cosmic or chaotic whirlpools, whether the progress is unilateral or follows a law of periodicity extending over millions of years, it is impossible for any scientist to predict with certainty. The greater the scientist, the greater is his doubt about the why and wherefore of things about him. Therefore in the domain of scientific research there is no room for dogmatism. This, it is believed, as the predominant note sounded by some of the greatest scientists of modern times. It is therefore devoutly to be wished that no scientist, however eminent he may be, ought to presume to settle once for all whether we can do without a definite concept of god or religion. That subject ought to be left alone till the flood gate of scientific knowledge opens very much wider. No one can say for what length of time mankind will have to wait for that day to arrive.

As already mentioned Mr Roy is an out and out advocate of "machines". In his opinion "machines" are the great harbingers of civilisation. "Machines", if properly organised and worked according to definite notions held by the socialists and others, will according to him lead to the salvation (in the material and even in the spiritual sense) of the human race. Unfortunately such is the perversion of nature (or providence, if there is such a thing) that calculations sometimes, —nay, very often,—go wrong. That is why there are innumerable instances around us where "machines" instead of leading to the desired end, have produced most diabolical results and have involved mankind into such fierce scientific savagery compared to which the unscientific savagery of the ancient times pales into insignificance. Of course, it is said that this is not the fault of the "machines", but of those who control them. This may be true and therefore

science should now apply itself to an investigation as to why mankind are so diabolical and why they misuse the machines after centuries of profession and practice of civilisation. Even Mr Roy will presumably admit that mankind have not really advanced from savagery to civilisation but have imbibed a certain amount of so-called civilisation and as a result, savagery, unable to exist in its naked form of by-gone ages, has hid himself in many novel disguises, such as "race superiority", "god's chosen people", "the will of providence to rule and for others to serve by the supreme decree" and so on and so forth. Therefore a better title of Mr. Roy's book would have been "Savagery *and* Civilisation" than "From Savagery *to* Civilisation".

The chapters dealing with the history and growth of socialism, though somewhat brief, will be found to be of considerable interest to laymen like the reviewer. The reviewer has derived real profit and pleasure by the perusal of these chapters. No one can have any doubt that a benevolent socialism will lead to all-round welfare and happiness of mankind. The difficulty however lies in putting the ideals of socialism into practice. Attempts have been made to introduce its principles in one form or other by violence or harsh regulations of the State. Arbitrary powers have been exercised by dictators. The methods employed have not satisfied the standards of civilisation in all cases. It is doubtful whether any country in the world has achieved any real success. Further researches are necessary and new methods have to be evolved. In carrying out these researches while science and its offsprings, the machines, should receive due recognition, the prime actor of the drama, *viz.*, the man himself should receive the first consideration. He should not be sacrificed even to the god of civilisation namely, science and machines. It has been said that man is a machine; certainly he is, but not in the narrow mechanical sense. He is quite different from a mere "mechanical" machine, if such a term is allowed. An experimenter in socialism will land himself into troubles if he overlooks this vital difference.

H. P. B.

Italian Economy and Culture—by M. Moulik. Published by Chuckervertty, Chatterjee & Co., Ltd., Calcutta, 1940. *Pp. 180 and Index. Price Rs. 3.*

The author of this collection of essays on "economic and social transformations" in Italy is a doctor of politics of Rome. He is already well known by his various journalistic contributions on matters relating to contemporary Europe and this volume will enhance his reputation. The twelve essays range in variety from "Tucci, Tibet and India" to "Sibilla Aleramo's Mythical Woman".

It has required some boldness for the author to have ventured upon the release of a volume on Italy at this time. Without being propagandist, Moulik has been able to be both readable and informative. The Italy of art and sculpture, of romantic movements and cultural associations, of new trends in literature and life is pictured with considerable success. For the student of socio-economic developments in Fascist Italy there are two chapters on 'corporativism' and 'Italy since Carducci'. Moulik does not obtrude his scholarship on the reader and is not dull: his performance has merits as a literary narrative but is not meant to be either critical or comparative.

B. N. B.

Simple Experiments on Physico-Chemical Principles—by M. L. Schroff and A. P. Srivastava. Published by the Indian Pharmaceutical Association, Hindu University, Benares, 1940. *Pp. 292 with Index. Price Rs. 5 or 8s. 6d.*

This book written for students of pharmaceutical chemistry is welcome in view of the growing recognition in this country of the importance of physical chemistry and colloid science in medical and biological sciences. The subject matter of the book has been well arranged and its scope has been extended fairly widely to include even some of the important advanced experiments in physical chemistry.

For the application of physical methods to chemistry and allied sciences, the student should be acquainted with the theory, and should know how to handle the relevant formulae and equations, and, last but not the least, how to enter their observations in his note book. The authors appear to have kept all these aspects in view. In describing an experiment they have lucidly discussed the underlying theory, have given the details of the apparatus necessary and pointed out the manner in which data should be entered in the note book. The book will be of great help to every beginner in practical physical chemistry.

The book however appears to have been printed rather hastily. We would be really glad to see the book with less of printers' devils which in some cases have created some confusion. For instance, on page 24 the symbol 'V' has been used for difference in velocity and also for the volume of the liquid with viscosity η. We hope these and similar points will be attended to in the next edition.

The book can also be recommended to all beginners other than students of pharmaceutical chemistry.

S. N. M.

LETTERS TO THE EDITOR

The Viscous and Electrochemical Properties of Constituents of Oil-well-drilling Muds

In this laboratory we have been studying for some time past the viscous and electrochemical properties[1] of bentonites, clays and shales of the type used in the preparation of oil-well-drilling muds.[2] Investigations in the Field Research Laboratories of the Burmah Oil Co., have shown that a knowledge of *pH* and buffer capacity of a drilling mud is useful in the control of viscosity and plastering power, and possibly of other properties. The relation of *pH* of clays and bentonites to their viscous and thixotropic properties has been observed

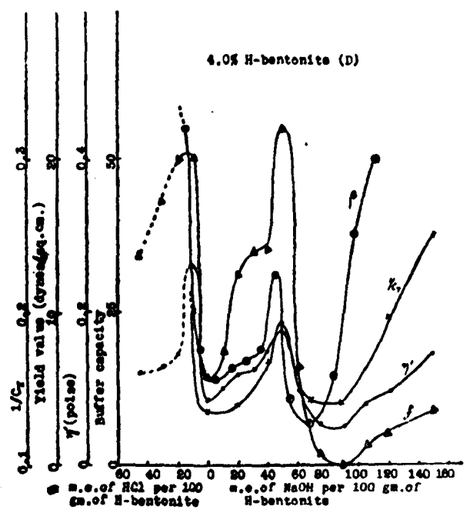


Fig. 1.

[Note: Viscosity measurements were carried out by means of a rotary viscometer.]

by several workers.[3] Broughton and Hand[4] found that yield value of a bentonite suspension to which increasing amounts of caustic soda are added, diminishes from *pH* 2·2 to *pH* 4, increases beyond *pH* 4 to a maximum at approximately *pH* 5 and diminishes slowly up to *pH* 10, the limit to which their data extended.

The titration curves of hydrogen clays, hydrogen bentonites and their subfractions with different bases and in presence or absence of salts have been studied in this laboratory[5] in some detail. These curves show a variety of features. What concerns us here is the titration curve with NaOH in the absence of salts. Dr R. P. Mitra[6] observed that hydrogen clays and hydrogen bentonites isolated from different sources give two types of potentiometric titration curves with caustic soda. In the first type the buffer capacity shows only one minimum (called the first inflexion point) corresponding to the complete neutralisation of hydrogen ions at a definite level of affinity and one maximum at approximately the point of half neutralisation of the quantity of acid neutralised at the inflexion point mentioned above. In the second type, the buffer capacity shows two minima and in between them one maximum, the curves resembling those of dibasic acids in true solution. The total acidity calculated from the first inflexion point is

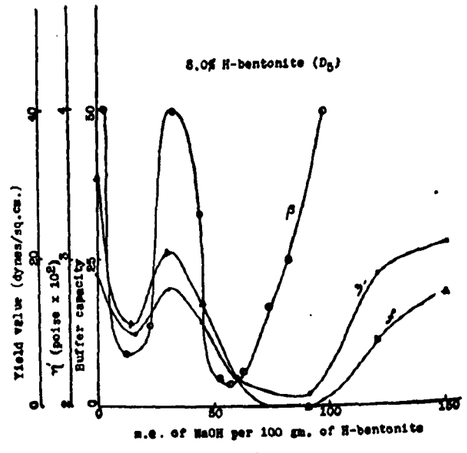


Fig. 2

[Note: Viscosity measurements were carried out by means of a capillary viscometer.]

only about ten to twenty per cent. of that calculated from the second inflexion point. Correlation of these results with observations in the Burma Oil Co., Laboratories would seem to indicate that the bentonites which give best results in the preparation and treatment of drilling muds possess the dibasic acid character. Inferior results have been obtained with what may be called monobasic acid bentonites.

Measurements made in this laboratory show that in the case of hydrogen bentonites treated with different amounts of NaOH and HCl there is a close correlation between yield value, consistency* and thixotropy on the one hand and buffer capacity on the other. Results obtained with a hydrogen bento-

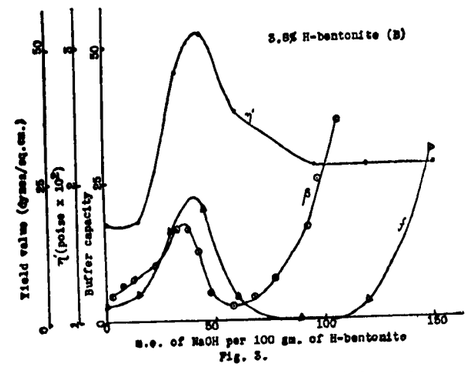


Fig. 3.

[Note: Viscosity measurements were carried out by means of a capillary viscometer.]

nite isolated from the entire clay fraction of a natural Indian bentonite are given in Fig. 1 and that from a fine sub-fraction of the same bentonite in Fig. 2. The buffer capacity (β) curve in Fig. 1 shows two minima at *pH* 2·8 and 8·5 respectively and a maximum at approximately *pH* 5·5. The buffer capacity also rises steeply above *pH* 9·0 and below *pH* 2·3. The yield value (f) and the consistency (η') curves run parallel to the β-curve. The second minimum in the f and η'-curves, however, occurs at a higher *pH*, namely, in the vicinity of *pH* 10. The minimum concentrations (C_T) showing thixotropy with different amounts of NaOH and HCl have been measured and $1/C_T$ found to vary in the same way (*vide* Fig. 1) as the properties discussed above. In the case of what may be described as the monobasic acid bentonite a similar correlation between viscous properties and the buffer index has also been observed (*vide* Fig. 3).

* Consistency is the reciprocal of mobility.

The possibility of controlling properties of drilling muds by measuring the buffer index is an attractive one and further research is clearly indicated.

Physical Chemistry Laboratory,
University College of Science and Technology,
92, Upper Circular Road,
Calcutta, 25-9-1940. J. N. Mukherjee.
N. C. Sen Gupta.

Fields Research Laboratory, Burmah Oil Co., Khodaung, Upper Burma. A. Reid.

[1] Mukherjee and Sen Gupta, *Nature*, *145*, 971, 1940.
[2] Evans and Reid, Drilling Mud, *Trans. Min. Geol. Inst., India*, December, 1936.
[3] Houwink, *Elasticity, Plasticity and Structure of Matter*, 1937, p. 351; Freundlich, *Thixotropy*, 1935, p. 35.
[4] Broughton and Hand, *Nature*, *142*, 255, 1938.
[5] Mukherjee and Sen, *Ind. Jour. Agric. Sci.*, *1*, 189, 1931. Mukherjee, Roychaudhury, Das Gupta and Chatterjee, *ibid*, *2*, 638, 1932. Mukherjee, Roychaudhury, Mukherjee and Mojumdar, *ibid*, *3*, 713, 1933. Mukherjee, Mitra, Ganguly and Chatterjee, *ibid*, *6*, 317, 1936. Mitra, *ibid*, *6*, 555, 1936. Mukherjee, Mitra and Mukherjee, *Trans. Nat. Inst. Sci. India*, *1*, 227, 1937. *Koll. Chem. Beih.*, *47*, 1, 1937. Mitra, Mukherjee and Bagchi, *Ind. Jour. Agric. Sci.*, *10*, 303, 1940. Mitra, *ibid*, 317; Mitra and Mitra, *ibid*, 344; Chatterjee (Silicic acid), *Jour. Ind. Chem. Soc.*, *16*, 589, 607, 1939.
[6] Unpublished results by Dr R. P. Mitra.

X-ray Diffraction Halo of a Flowing Liquid

DURING the course of an investigation of the effect of an electric field on the viscosity of liquids in this laboratory, it was considered important to ascertain if the motion of the liquid had any influence which penetrated into the molecular regions affecting the molecular orientations.

At the suggestion of the author of this note X-ray diffraction halo of benzene, which in the usual stationary state gives a fairly sharp ring, was also obtained with a cell of special design through which benzene was made to flow with a velocity of about 3 cm./sec. during exposure to X-rays.

Preliminary results obtained show that the X-ray halo of flowing benzene is much more diffuse and there is marked difference in the photographic densities of the halos with stationary and flowing benzene, clearly proving that the cybotactic groupings of the molecules in the two conditions of benzene are not identical.

Experiments are now proceeding with arrangements which will permit of exact determination of the photographic densities and hence intensities of the X-ray diffraction beam with the two states of any liquid under otherwise identical conditions of exposure and development of the plate. It would be, it seems, interesting to study in this way the difference between polar and non-polar liquids as revealed

by the disturbance due to their flow, affecting their molecular regions.

As a related problem, the effect of flow of liquids on their dielectric constant, is being studied in this laboratory by Professor S. P. Prasad, whose preliminary observations have shown that a real change as compared with the value of the constant in the stationary condition of the liquids, does seem to exist.

Further details will be communicated elsewhere when results are ready.

Physics Laboratory,
Science College, Kanta Prasad.
Patna, 20-9-40.

Magnetic Susceptibilities of Some Bromides and Iodides

A number of halides have been already studied from the point of magnetic susceptibility.[1,2] In this laboratory a detailed investigation a number of fluorides was undertaken by Mr. A. A. Chowdhury.[3]

We have studied the magnetic susceptibilities of the following substances using the usual Guoy Method and the relation :—

$$F_x = \tfrac{1}{2}(K_1 - K_2)\, AH^2 = mg$$

where F_x = Magnitude of the force on the specimen.
K_1 = Volume susceptibility of the specimen.
K_2 = " " " " " medium.
H = Field strength.
A = Area of cross-section of the specimen.
m = Magnetic pull in gms. on the specimen.
g = Constant of gravity.

Following results were obtained :—

BROMIDES

Compound	Temperature °C	$\chi_m \times 10^6$
$Ni(NH_3)_6Br$ (Nickel hexamin bromide)	32·4	+11·26
$CoBr_2$ (Cobalt bromide)	32·6	+3·96
$(CH_3.CH_2.CH_2.CH_2)_4NBr$ (Tetra-n-butyl-ammonium bromide) ...	32·9	+0·15
$(C_5H_{11})_4NBr$ (Tetra-iso-amly-ammonium-bromide)	32·8	−0·10
$TeBr_2$ (Tellurium dibromide) ...	32·2	−0·17
$(C_2H_5)_4NBr$ (Tetra-ethyl-ammonium-bromide)	32·2	−0·35
$(CH_3)_4NBr$ (Tetra-methyl-ammonium-bromide)	32·8	−0·087

IODIDES

Compound	Temperature °C	$\chi_m \times 10^6$
SbI_3 (Antimony iodide, sublimed) ...	32·2	−0·12
SI_2 (Sulphur iodide)	32·0	−0·16
AsI_3 (Arsenious iodide)	32·0	−0·24
$(C_2H_5)_4NI$ (Tetra-ethyl-ammonium iodide)	32·2	−0·08

Details will be published elsewhere.

Physical Laboratories,
Aligarh Muslim University, Ghulam Farid.
Aligarh, 16-10-40.

[1] *A. T. C.* Paris *8*, 1937.
[2] *Ibid.*, *17*, 1937.
[3] A. A. Chowdhry, *Current Science*, *8*, 550, 1939; and Aligarh Muslim University M.Sc. Dissertation 1940.

Energy-levels of an Artificially Bounded Linear Oscillator

Sommerfeld and Welker[1], because of its possible astrophysical application, have recently discussed the problem of the ground state of the H-atom, subject to the artificial boundary condition that it is enclosed within a sphere of radius r_0. The eigen-function has to vanish at $r = r_0$, and the energy W of the ground state is a function of r_0. The electron is bound to the nucleus ($W<0$) for $r>1{\cdot}835\, a_H$ (a_H is the Bohr-radius, $a_H = 0{\cdot}53$ A.U.), while for $r_0>1{\cdot}835\, a_H$, W is positive.

The present note deals with the case of the linear harmonic oscillator.

The Schrödinger equation is

$$\frac{d^2\psi}{dx^2} + \frac{8\pi^2 m}{h^2}\left(W - \tfrac{1}{2}\alpha x^2\right)\psi = 0, \qquad (1)$$

where m is the mass of the particle and $\tfrac{1}{2}\alpha x^2$ its potential energy for a displacement x. It is usual to define a proper-frequency ν_0 by $\nu_0 = \frac{1}{2\pi}\sqrt{\frac{\alpha}{m}}$, and write equation (1) in the form

$$\frac{d^2\psi}{d\xi^2} + \left(n + \tfrac{1}{2} - \tfrac{1}{4}\xi^2\right)\psi = 0 \qquad (2)$$

where $W = h\nu_0\,(n + \tfrac{1}{2})$, (3)

and $\xi = x\left(\frac{4\pi}{h}\sqrt{\alpha m}\right)^{\frac{1}{2}}$. (4)

The natural boundary condition is $\psi \to 0$ as $x \to \pm\infty$, and *for this case* n is a positive integer including zero.

We shall consider the oscillator subject to the artificial boundary condition that $\psi = 0$ at $x = \pm\frac{l}{2}$, *i.e.*, the oscillator is enclosed between infinitely high and infinitely steep potential walls at $x = \pm\frac{l}{2}$. Solving (2) by the method of approximate solution we find that

$$W = \frac{h^2q^2}{8ml^2}\left[1 + \frac{1}{3\pi^2q^2}\left(\frac{l}{l_0}\right)^4\left(1 - \frac{6}{\pi^2q^2}\right)\right], \qquad (5)$$

or

$$W = \frac{\pi^2q^2l_0^2}{4l^2}\left[1 + \frac{1}{3\pi^2q^2}\left(\frac{l}{l_0}\right)^4\left(1 - \frac{6}{\pi^2q^2}\right)\right], \qquad (6)$$

which is valid so long as the second term in the brackets [ ] is small compared to unity. The length l_0 is defined by

$$l_0 = \left(\frac{h}{2\pi^2\nu_0 m}\right)^{\frac{1}{3}}. \qquad (7)$$

l_0 corresponds to the (*classical*) 'amplitude' of the oscillator when its energy is $h\nu_0$ and q is an integer ; it is one for the ground state, two for the second state, and so on. For the natural boundary condition $l \to \infty$, $W_\infty = h\nu_0\,(q - \frac{1}{2})$.

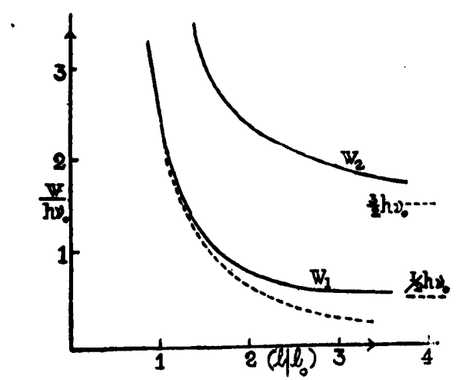


FIG. 1.

The curve W_1 is for the ground state and W_2 for the second state. $l_0 = \left(\frac{h}{2\pi^2\nu_0 m}\right)^{\frac{1}{3}}$. The dotted curve represents $\frac{W}{h\nu_0} = \frac{\pi^2}{4}\left(\frac{l}{l_0}\right)^2$ or $W = \frac{h^2}{8ml^2}$

Figure 1 represents $W/h\nu_0$ against l/l_0 for the ground state (q = 1) and the second state (q = 2). The dotted curve corresponds to

$$W = \frac{h^2}{8ml^2} \quad i.e., \quad \frac{W}{h\nu_0} = \frac{\pi^2}{4}\left(\frac{l_0}{l}\right)^2.$$

In the case of the ground state, when $l > 3l_0$, the oscillator behaves as a practically unbounded oscillator and the energy is very nearly $\tfrac{1}{2}h\nu_0$. As l decreases, the energy increases and for $l < \frac{3}{2}l_0$ the energy is practically given by $\frac{h^2}{8ml^2}$.

To illustrate an application of these results we take a recent investigation by Wildhack[2] on the proton-deuteron transformation as a source of energy in dense stars. He considers the motion of a proton in the interior of a white dwarf to correspond to an oscillator of proper frequency ν_0,

$$\nu_0 = \left(\frac{2\cdot3}{8\pi^2}\,\frac{e^2}{m_H r^3}\right)^{\frac{1}{2}} \qquad (8)$$

where e is the electron charge, m_H the proton-mass and 2r is the distance between nearest protons. r will correspond to l in our theory. The energy in the ground state is taken by Wildhack to be $\tfrac{1}{2}h\nu_0$. This, however, as we have seen, is justified only so long as $l > 3l_0$, which on substituting from (7) and (8) gives $r > \frac{8\cdot1}{2\cdot3}\frac{m}{m_H}\, a_H \sim 1{\cdot}0 \times 10^{-10}$ cm.,

where m_0 is the mass of the electron. For smaller values of r, the energy will be appreciably greater than $\tfrac{1}{2}h\nu_0$. However, to neglect this increase in energy with r decreasing below 10^{-10} cm. is not inconsistent with Wildhack's investigation as it is concerned with the lower limit of the rate of energy evolution in stellar matter.

A detailed discussion of the problem of the bounded simple harmonic oscillator will be published elsewhere.

Department of Physics,
University of Delhi, D. S. Kothari.
Delhi, 18-10-1940. F. C. Auluck.

[1] Sommerfeld and Welker, *Ann. d. Physik*, *32*, 56, 1938.
[2] Wildhack, *Phys. Rev.*, *57*, 81, 1940.

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