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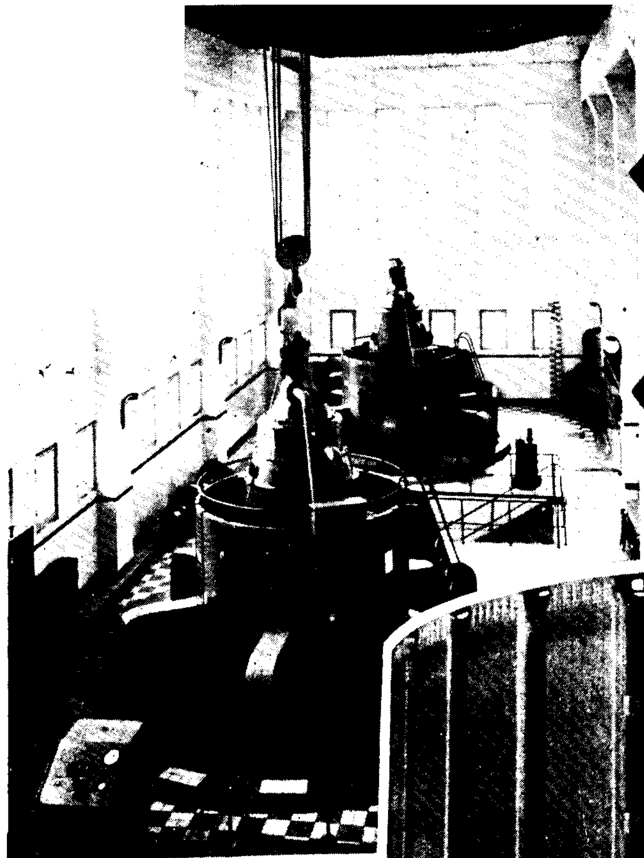

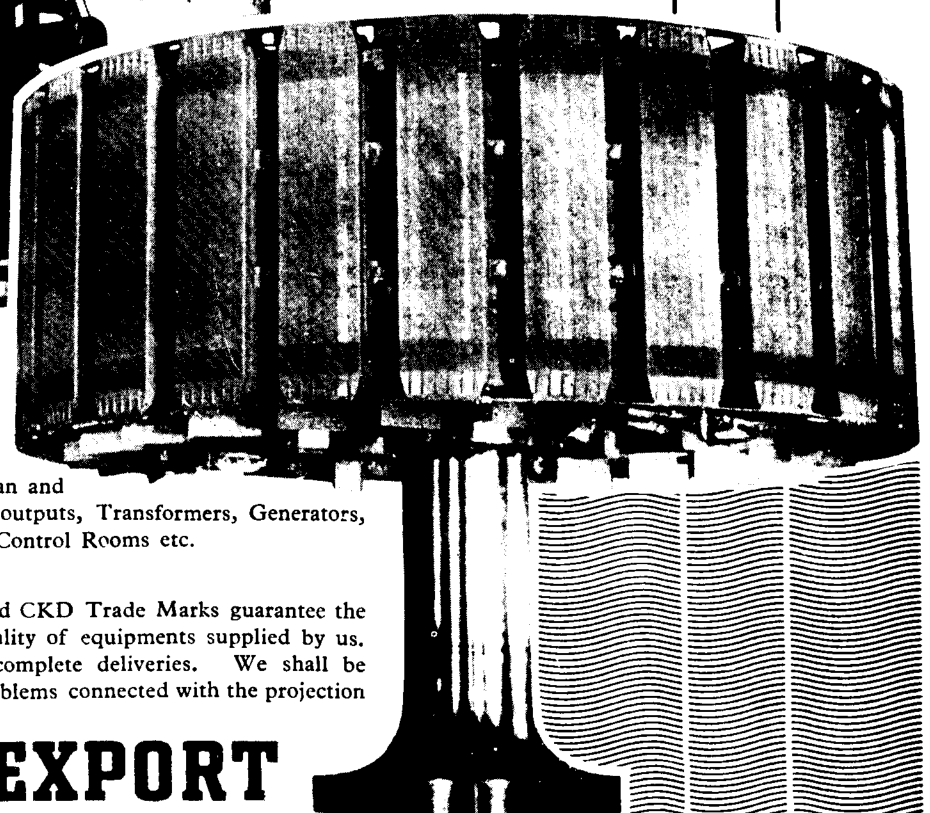

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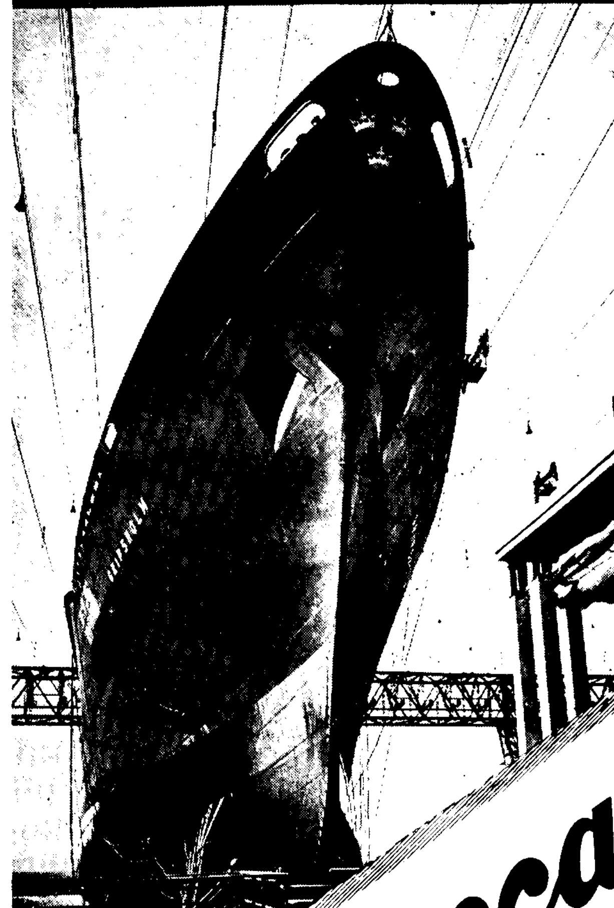

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JOURNAL OF INDUSTRIAL ENGINEERING

CONTENTS

SECOND FIVE YEAR PLAN

"The growth of industry, both big and small, is essential for any modern nation. Indeed, without industrial development, there can be no higher standards for our people, no strength in the nation, and perhaps, not even our freedom can be preserved" ....Jawaharlal Nehru.

THE basic fact of India's industrial life to-day is a new and an expanding horizon. It is no wonder therefore that Indian Industry is making big news now moving forward at unprecedented speed, entering new areas of development which were until now considered the preserves of industrially, more advanced nations.

The first World War brought India out of her industrial cradle. The second global conflict terminated her industrial adolescence. After the attainment of Independence, a distinct horizon for the industrial growth of the country was set in launching what was known as the First Five Year Plan.

The Second Five Year Plan which has been taken up at the conclusion of the First Five Year Plan, is the beginning of a still more difficult and an infinitely more ambitious plan. In it, the maximum emphasis has been laid on the development of industries. A whole new horizon has been unfolded before the Indian people for marching against the receding sky.

The principal objectives of the Second Five Year Plan, which contemplates an upsurge of activities in the overall economy of the country, are:

(a) a sizeable increase in national income so as to raise the standard of living in the country;

(b) rapid industrialisation with particular stress on the development of basic and heavy industries;

(c) a large expansion of employment opportunities; and

(d) reduction of inequalities in income and wealth and a more even distribution of economic power.

The first place has rightly been given to the desirability of achieving a sizeable increase in national income. During the First Plan, the national income rose to Rs. 1,08,000 million—an increase of 18% against a target of 11%. During the Second Plan period, it is to be raised by another 25% to Rs. 1,34,800 million. The per capita income should rise by 18% from Rs. 280 to 330 per year. This increase will not only raise the standard of living but will also provide the necessary resources to finance the future development of the country.

It is gratifying to note that the Second Plan lays special emphasis on industries and transport with particular stress on the development of basic industries. This is for increasing the country's productive potential. Out of Rs. 48,000 million to be spent during the Second Plan, Rs. 8910 million have been earmarked for industries and minerals as against Rs. 1790 million set apart in the First Plan for the same purpose. Amongst the major steps to be undertaken for implementing the plan are Rs. 13,500 million imports of machinery and equipment. Of this amount, Rs. 2,800 million will be spent for industrial development. This, however, is exclusive of the estimated requirements of Rs. 4000 million imported machinery and equipment for the private sector to be spent mainly to programmes of industrial development.

With regard to the scope of employment, the Planning Commission estimate that 10 million additional jobs would be provided by development programmes in Second Plan. It is in this context that the proposal has been made to develop both large-scale and small-scale and village industries side by side. These industries possess high employment potential. In order to take advantage of this it would be necessary to ensure that their role should be complimentary and not competitive. In a country like that of ours, the unemployment can only be solved when there will be maximum utilisation of our resources—human and material. The objective therefore has been to accept more or less the Smithian thesis of full capacity development of all our resources rather than full employment. For satisfactory results, our energies should be concentrated more on the development of the economy rather than alleviating cyclical distortion.

As regards the fourth objective, viz. reduction of inequalities, every precaution has been taken to frame the plan in such a way that the most of the increased wealth do not flow into the hands of a few, leaving the masses of the people in their present state of poverty. This however does not mean that there will be negative approach resulting in the reduction of the standard of living already attained by a section of the people. A positive approach has been aimed at so as to raise the living standard of common man by increasing the aggregate wealth and individual productivity.

So far as the planning itself is concerned, we have nothing to say against. But for its satisfactory implementation, it is necessary that the following factors are given due consideration.

Apart from tying the loose ends of the big projects already in progress, emphasis should be laid on the short range schemes, the schemes which will come to a productive stage in one or two year's time.

It is to be ensure that the targets to be worked to must be with due regard to the resources available. The technique of raising money by deficit financing is not always safe, especially for a country like India where increasing volume of currency, instead of bringing the idle resources into the process of production may generate inflationary forces; and once the forces of inflation start in economy it will create a vicious circle bringing in its train a major economic and financial crisis.

More than anything else, the existence of an honest and efficient administrative machinery for the execution of the Plan is absolutely necessary. Unless those of the old officialdom wedded to antiquarian and bureaucratic ideas are removed from the saddle and anti-social forces are ruthlessly rooted, there is practically no hope. There should not be any place for easy-going, sluggish, unimaginative careerists.

There must be a proper understanding of the human values so that the relation between the employer and employee, the factory manager and the worker and the buyer and seller may be satisfactory. A fair deal should be ensured at every stage.

It may be reiterated without any fear of contradiction that the Second Five Year Plan is a golden opportunity for the Private Sector to show its mettle and contribute its mite for rebuilding the Country. If it rises to the occasion, enforces fair trade practices, its future is assured.

A word about the engineers will also not be out of place since industry and technical personnel are interlinked together. In the life of an industrial nation engineering holds a unique position and there is no ease and no rest in engineering profession—it is one long round of strenuous labour. It is only in fitness of things that they should keep before their mind that " Engineers and engineering are the principal servants of mankind ".

The enormous man power that is available in the country is capable of doing far more than what is envisaged in the Plan. It is only when it would be possible to instill into the consciousness of every Indian a recognition of the imperative need for productive labour that the bright future, all look forward to, will not be far away.

STEEL PLANTS—THE PRESENT POSITION

The contract for the steel melting shop for the Rourkela Plant had been given to the German firm Krupp.

Contracts had been concluded with 16 German firms for the rolling mills and ancillaries.

Tenders for the coke oven by-product plant, the grey iron foundry and the tonnage oxygen plant have been received and contracts will be concluded shortly. The project report for the development of the iron ore mines has been generally accepted and preliminary work, like clearing the site and recruitment of staff, has commenced.

Eight consignments of equipment, structural steelwork, pipes and fittings have been received from the U.S.S.R. for Bhilai. Tenders have been invited in India for construction equipment, certain items of transport and tools and tackle. The Madhya Pradesh Electricity Board has taken up the construction of a thermal power station at Korba to supply power primarily to the steel works. A broad lay-out of the township has been approved.

An Industrial Engineering Department in a Steel Plant

By Sir Jehangir Ghandy, Kt., C. I. E.
Director-in-Charge, The Tata Iron & Steel Co., Ltd. Jamshedpur.

Exclusive to "Journal of Industrial Engineering"

INTRODUCTION

MANAGEMENT is as old as the industry itself. But the idea of Scientific Management is relatively new and was first introduced by cost-conscious stalwarts like Taylor and Gilbreths at the beginning of this century. Scientific Management embodies a code of activities which are directed at eliminating wasteful uses of the resources of industry, with the ultimate objective of producing a quality product at a cost cheaper than would otherwise be possible. It is a continuous process of struggle to discover easier and better ways of achieving results. This activity of Management is now classified as "Industrial Engineering" and has become an indispensable function of enlightened management.

The wasteful uses of materials and machines and the inadequate use of labour are not always readily apparent, particularly in under-developed countries like India. Now that India has embarked on national programmes of industrial development, it is of supreme importance that we should use industrial engineering techniques to achieve the maximum out of our investments by running heavy industries at a high pitch of productive efficiency. Steel industry is perhaps the most important heavy industry which involves investments in crores of rupees. There is therefore a great need for incorporating the industrial engineering functions in the management of Steel plants.

Industrial Engineering is the application of basic scientific and engineering knowledge and other analytical techniques to measure economically the advantages of one policy against another in the industrial processes. The ultimate goal towards which an industrial engineer works is "reduction in cost". To achieve this end he employs various tools such as wage incentives based on work-studies, production planning and control, preventive maintenance systems, improved plant lay-outs and working conditions, work simplification through methods improvements, etc.

Each of these techniques is briefly described below.

WAGE INCENTIVES

Wage incentive is a monetary reward paid to a worker in addition to his basic wages and allowances for improvement in his rate of production and/or the quality of product and/or the yield factor (material utilization). The measurement of this improvement must therefore be accurate and made by yard sticks which must be simple and equitable. The yard sticks (which are described as 'time standards') are established by work-study, which is an industrial engineering technique for measuring the human endeavour on the basis of time required to perform the task and also the strain involved in the task. The task which a worker is expected to perform and the quality of product which he is expected to turn out must be clearly defined to avoid ambiguity. The definition must cover such matters as equipment, lay-out, materials, processes, machine speeds and feeds, environmental condition, specification of the product, etc., which affect the time required for production and the strain on the worker.

Time standards for the satisfactory completion of all elements comprising a given task must include reasonable allowances for unavoidable delays and personal relaxation commensurate with the working conditions. Care must be taken to check the standards in order to ensure that a worker operating at normal speed and utilizing the legitimate rest allowances, can complete the task meeting the required quality specifications. Such time-standards form the basis of the wage incentive schemes. The worker is paid incentive bonus for improvement in his performance as measured by the time-standards, in addition to his guaranteed basic wage.

There are various types of incentive schemes proposed by industrial engineers, but they are all based on the same principal viz. the improvement in performance and sharing the resultant gains between the employer and the employees in proportions mutually agreed upon. Properly designed, wage incentives schemes provide an effective control on the manufacturing costs and help to effect cost reduction by inducing in each worker the desire to increase the output per unit of time.

The old adage "Well begun is half done" is only too true in its application to wage incentive schemes. It is not enough merely to ensure that a wage incentive scheme is properly designed and implemented. It must also be properly maintained, i.e., the operating procedures, the working conditions, the job specifications must be continually reviewed and any changes discovered must be appraised and incorporated in the scheme. This may need revision of time-standards so as to reflect the changes. This is a dynamic process and unless this process is meticulously followed it cannot be claimed that a wage incentive plan continues to be alive and useful to serve the purpose for which it has been designed.

PRODUCTION PLANNING AND CONTROL

Generally speaking, production planning and control consist of pre-determining what work is to be done, where and when it is to be done, and the control of the work after it is initiated, to ensure that it is accomplished in accordance with the plans. By designing and implementing effective systems of production planning and control, the industrial engineer ensures...

(a) Fullest utilization of the productive facilities to their optimum capacity, thus reducing unit costs and delays in delivery,

(b) Supply of necessary materials, facilities, personnel or information at the required moment and place, thus preventing avoidable delays,

and

(c) Prevention of losses caused by excessive or unbalanced inventories which unnecessarily lock up working capital and capacity.

PREVENTIVE MAINTENANCE

It is a short-sighted policy to think of maintenance after the trouble arises. When a machine breaks down, the damage is already done. This results in abnormal delays and the consequent loss in production. Therefore it is undesirable to postpone maintenance till the break down occurs. Although the machine can be repaired after a break-down and put into operation, the loss of production during the break-down period is irrecoverable. Hence the attempts to save equipment break-down time and the consequent loss of production, cannot be successful without adequate thought being given to improvement of the methods of maintenance. Maintenance of plant and equipment should, as far as possible, be carried out during the normally scheduled down time. Further, if attempts are made systematically to collect and record the data pertaining to causes and frequency of failures of each individual equipment, it will be possible to forecast, with reasonable accuracy, the time when the next break-down is most likely to occur. When this information is obtained, adequate steps can be taken to prevent its occurrence, thus obviating or minimising unforeseen break-downs and the consequent loss of production. The organisation and control of any effective preventive maintenance systems should normally come within the purview of the industrial engineer.

PLANT LAY-OUT

In most of the existing industrial undertakings and establishments, searching enquiries will reveal that the materials during the process of transformation to the finished products, usually move in a haphazard fashion, entailing heavy handling costs. If enough thought is given to the plant lay-out the material handling expenses could be considerably reduced by eliminating the movement of material over long distances which does not add by itself anything to the value of the article, but adds to the cost of the finished product. The industrial engineers who are particularly conscious of wastages involved in material handling have therefore found a very fruitful field for effecting cost reductions in their well-developed and systematic plant lay-out engineering. The principal objects of plant lay-out engineering are—

(a) to reduce to a minimum the distance of movement which the parts have to be moved through, during the manufacturing and assembling processes;

(b) to keep them moving with a minimum of interference,

and

(c) to use labour, space and equipment most effectively.

The overall purpose, of course, is to eliminate delays in the rate of production and to reduce costs.

METHODS STUDY

It is the policy of the Industrial Engineer to be always critical about the existing methods. He believes that there can be a "better way" of performing the given task. It may be the fastest, it is often the safest, it may be chosen to give the least 'operator fatigue' or the best quality of product; it is normally the cheapest method. Both by training and tradition, the industrial engineer has developed an outlook to be constantly in search for improved methods of work. He goes about seeking a better method in a systematic way by critically examining the present methods with the aid of 'man-machine charts', 'flow process charts', 'flow diagrams', etc.

especially prepared for the purpose, with a view to eliminating all unnecessary operations and combining the remaining ones into the best possible sequence which permits of the minimum cycle time for its accomplishment. Methods study by industrial engineers thus provides a potential field not only for effecting savings through reduced unit costs but also for providing operatives with less hazardous and less fatiguing methods of work.

JOB EVALUATION

In addition to the above tools employed by industrial engineers which have a direct bearing on the ultimate goal of cost reduction, there are yet other techniques like "Job Evaluation" which are frequently employed in industries with advantage. Techniques like 'job evaluation' go a long way in making the operatives happy and contented. It is a well-known fact that there is no substitute for a contented worker in achieving and maintaining high productive efficiency. Job evaluation measures the relative worth of various positions available in an enterprise. The wage structure based on "Job Evaluation" ensures an equitable distribution of the total wage fund. The principle of analysing jobs—or the comparative assessment of the working conditions and the skill and experience in different jobs—in order to establish the relative worth of different jobs provides a sound basis for making workers contented by ensuring uniformity of rates on identical jobs and realistic differential rates on jobs of unequal worth.

ORGANISATION FOR ACTION

The experience of companies that have tried to implement the industrial engineering techniques to improve productivity and cut down costs, has been long, varied and rich. The extent to which various factors have contributed to the difference between the astounding success of some firms and the terrible failures of others is a matter which could be argued without end. But there is no doubt that one factor of far-reaching importance has been the organisation. For example, who has the responsibility for initiating and following-up measures for reducing costs? What should be his position and responsibility in the organisation structure of an undertaking? The attention given to these and other related questions may spell all the difference between success or failure of the whole programme.

Here there is scope for differences to suit the particular circumstances of each individual plant depending on its size and complexity of operasions. But one thing is certain. The responsibility for initiating and seeing through the programmes of cost reduction must rest on a well-qualified person with the necessary authority and status. In a large company, like a steel piant, these functions should belong to a well-staffed department headed by a Chief Industrial Engineer.

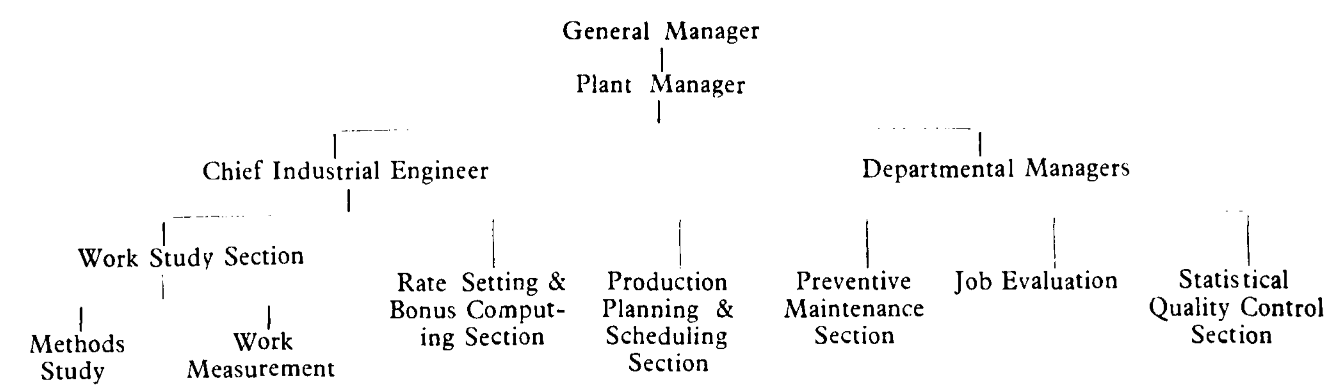
Our own experience over the past several years indicates that the Chief Industrial Engineer's job should meet the following specifications :

(a) He should be fully responsible for implementing and maintaining work-study programmes designed to raise productivity and reduce manufacturing costs.

(b) He should be responsible for developing Management Controls through preparing Production Planning and Control Schemes, and supervising their implementation.

(c) He should have under him a well-qualified and capable group of industrial engineers to assist him in the performance of all his functions adequately.

Below is shown an ideal organisation chart for a typical industrial engineering department in a large plant of the size of a steel plant.



For the efficient performance of the duties assigned to the industrial engineering department, the persons employed as industrial engineers need possess certain personal qualities as well as skill in industrial engineering techniques. For example, very often in the course of his work on industrial engineer will have to bring the recalcitrant workers into his confidence and enlist their co-operation. This can be done only if the industrial engineer is capable of 'selling' his ideas to the workers and their immediate supervisors and gaining their confidence. Again on the management side, he must convince the executives concerned of the soundness of his schemes so that they may accept his programmes and proposals. In other words, the industrial engineer must be trained in the skill of correctly explaining his ideas to people at all levels. Otherwise, however thorough his technical knowledge may be, his scheme will not bear fruitful results.

Two questions now arise logically. How is one to acquire these skills and personal qualities? What type of facilities are provided to young men in our Universities to enable them to qualify as industrial engineers?

Till very recently, there was no curriculum of study offered in any Indian University in the industrial engineering field. To fill this gap and to cater to the growing need of industrial engineers in India, the All India Board of Technical Studies in Management has recommended courses of study in industrial engineering and production engineering subjects at the Indian Institute of Technology at Kharagpur, Victoria Jubilee Technical Institute at Bombay, and the Indian Institute of Science at Bangalore. The students trained in these courses are expected to provide the necessary personnel from which managements of industries in India may recruit their potential industrial engineers.

And, now to conclude, let us look at the future of industrial engineering in India.

It is a well-known fact in the industrially advanced countries that the secret of their high standards of living lies in their high levels of productivity. We in India are now striving to increase our national wealth and to improve the standard of living of our general masses. It is therefore necessary for us to follow the trail of other industrially advanced countries in improving our production efficiencies. Industrial engineering will have to play an important role in the Management functions of improving the productivity of our industrial enterprises.

The Machine-Tool Industry in Britain

By A Technical Correspondent

(Exclusive to "Journal of Industrial Engineering")

The visit of a British mission to advise India on further extension of heavy engineering manufacturing capacity focusses attention on some of the latest developments in the British machine-tool industry described in the article below.—*Editor*

AUTOMATIC CONTROL SYSTEMS

THE word automation has been used so loosely that it is sometimes difficult to distinguish between the various mechanical, hydraulic, and electronic techniques which are generally included under that heading and which are increasingly becoming important features of machine-tool design and application.

Some authorities regard automation simply as the use of automatic handling methods, as in transfer machines where the work is held in a mobile fixture and passed from one operating position to another. More usefully perhaps, automation might be defined as the use of power to control power, as when electronic or servo devices are employed to govern the motion of a machine-tool cutter with respect to a workpiece.

Essentially, however, it is a group of techniques which serve to reduce the man-hours necessary for making any product or component, and is, therefore, as old as engineering itself.

Since the inter-tool handling aspect is not inherent in the actual tool, this article will deal with only those techniques which can be built into the machine. These may be divided into four main categories:

Control systems, by means of which drawings can be translated into finished workpieces with the minimum of human interference;

Programme units which permit a given sequence of operation to be performed at a number of predetermined machine settings;

Mechanisms which automatically feed and discharge the workpieces to and from the tool; and

Profiling and copying devices.

Much time is required in machining for such non-productive operations as setting up, loading, gauging, and checking, and it is here that these techniques can be of most value. Moreover, whereas automation is often thought to be only relevant to products required in large quantities, the first of these categories applies especially to small-number production. There are also various combinations and mutations of the four techniques: in a sense, electronic control systems in the first category combine the advantages of programming and profiling plus ease and economy of tooling, while automatic lathes employ, in effect, both a simple programme and mechanical means of feeding the workpieces. A number of typical systems and machines which illustrate these principles are described in this article.

ELECTRONIC CONTROL

The Ferranti System.—Where it is necessary to machine components in small numbers with considerable accuracy, as in the aircraft, tooling, and other industries, the use of human skill in conjunction with expensive tools, jigs, and fixtures has long been considered the only practical approach.

However, with the advent of electronic techniques it may be possible to abandon such costly methods, since with their aid the whole process can be reduced to the preparation of a drawing and planning sheet, and the operation of an instrument resembling a typewriter.

In the Ferranti system, the essential elements are as follows: an electronic digital computer capable of

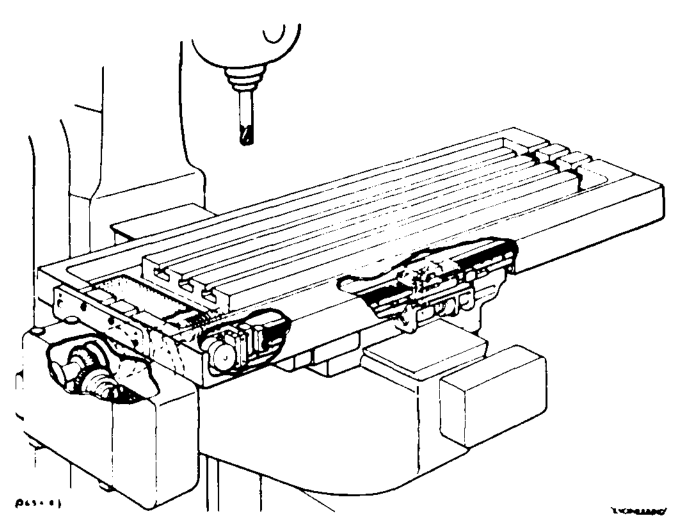


Fig. 1 Drive unit and measuring equipment associated with one slide of milling machine (Ferranti).

providing a service to a large number of machines; a control unit associated with the machine tool and its servo-motors; high-performance servo-mechanisms utilizing the measuring system as feedback; and an electro-optical method of measurement employing a long diffraction grating and having an inherent accuracy superior to that of the machine tool with which it is used; these items can be seen in Fig. 1.

There are five principal stages in the operation. First a drawing is prepared, preferably dimensioned in a form suitable for the system; a typical example appears in Fig. 2.

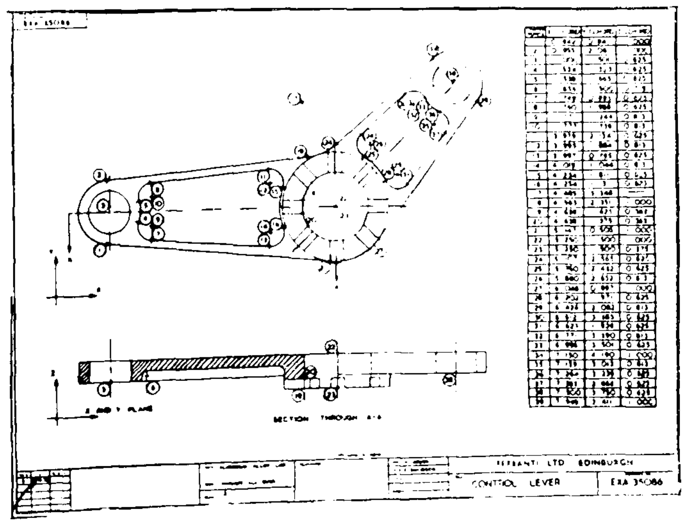


Fig. 2. Method of detailing drawing for use with Ferranti system, showing origin and co-ordinates.

From this a planning sheet is prepared, and the information it records is then transferred to punched paper tape by means of a machine having keys like a typewriter. This serves as input to the computer which prepares a magnetic control tape.

Finally, the tape is used in the control equipment to determine the continuous movements of each axis of the machine tool. It is claimed that, with high spindle speeds and excluding tool changes, once the magnetic tape has reached the control equipment a component can be made in 7 min. which would formerly have taken a skilled operator 12 hrs.

The basic element in the measuring system is a long diffraction grating marked at right angles to its length with a precisely known number of lines, and fixed to the table of the machine tools. When the grating is superimposed on another shorter grating slightly inclined to it, a Moire fringe pattern is produced which travels across the gratings as they are moved relative to one another.

The dark bands are detected by photo-sensitive elements which convert the light intensities into signals of equivalent intensity. These wave-forms serve to form a digital measuring system of two pulses per grating line, and to provide means of effecting a feedback control through servo-motors of the table movement.

There is, of course, one long grating for each axis of motion. Gratings currently in use are marked with up to 5,000 lines per inch, giving measurements to an accuracy of 0.0001 in.

The servo-motors are three-phase 400-cycles-per-sec. induction motors delivering 0.5 b.h.p. at 10,000 r.p.m. and fed by high-performance magnetic amplifiers. A magnetic drum brake is fitted to lock the slides when the motors are de-energized; the brake also operates as an emergency stop if the machining tolerances are exceeded or when the limits of travel of the slides are reached.

Each motor drives through a backlash-loaded gearbox. The reduction trained is designed to offer minimum inertia loading to the servo-motor. Lubrication is by oil mist, with the cast gearbox casing forming a sump.

The reduction ratio of the standard gearbox gives an output shaft speed of 120 r.p.m. at peak motor power. This shaft is arranged to drive in three alternative planes to allow for variation of machine geometry, and a self-aligning, torque-limiting coupling is fitted to safeguard the gearbox from overload. A typical lay-out of gearbox and measuring system on one slide of a vertical milling machine is shown in Fig. 1.

In preparing the drawing and the planning sheet, the basic consideration is the co-ordinate nature of the control system. Thus an origin must be given, as indicated in Fig. 2, and co-ordinates of all change points must be shown. It should be noted that for a curve its nature should be stated, whether circle, ellipse, parabola, or hyperbola and the pole of the curve indicated.

Finally, the basic machining information must be recorded, such as feeds and speeds. Once the planning sheet has been completed, no more skilled operations are required, and after the data have been encoded cutting can proceed. It has been found that the overall saving in time can be in excess of 5-to-1, while the only limitation on precision is that entailed by the machine tool.

The E. M. I. System.—Another control system employing electronic techniques is the E.M.I. system. This is believed to be of almost universal application, and has already been successfully applied to four types

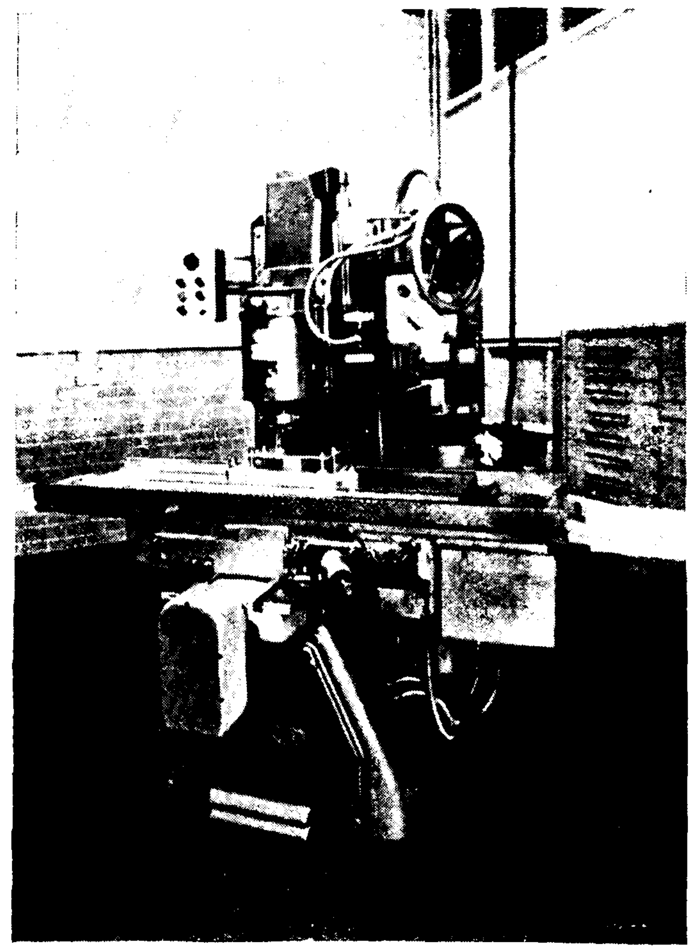


Fig. 3. E.M.I. electronic control system: control unit on right.

of machine tool: the Cincinnati Hydrotel, the Cincinnati No. 3 Vertical Miller, a high-precision copy miller made by Research Engineers Ltd., and a Wadkin high-speed vertical miller. The Wadkin machine is shown in Figs. 3 and 4. Fig. 3 shows the adapted high-speed miller with, on the right, the control unit; and Fig. 4 shows a detail of the table control mechanism.

The E.M.I. system, which also employs a computer and servo-mechanisms to control the feeds, enables the machine tool to cut two or three dimensional shapes without the use of templates or other patterns, and has the advantages of a copying machine, with the added benefit that short runs can be performed as economically as longer runs. It is, therefore, suitable for production of master cams, templates, and prototype parts.

In principle, the action of the electronic control system is to direct the tool in a smooth path through a number of points specified by the designer and designated by co-ordinates. In the machine shown, these points are spaced approximately $\frac{3}{8}$ in apart along the profile, but larger-point spacings are permissible, depending upon the accuracy required and the complexity of the part.

The points, which can be specified in rectangular or polar co-ordinates according to convenience, are listed in the form of a table of dimensions and recorded on perforated tape in a decimal binary code. The tape is then fed into the control unit, where analogue circuits perform a parabolic interpolation and deduce from the relatively small number of "marker" points in the table the large amount of subsidiary information required in order to cause the machine to cut a smooth profile through the specified points. No elaborate external computer is, therefore, required.

The system makes use of position control, whereby each dimension encoded on the tape is measured separately from the same datum point on the machine tool. Cumulative errors are thus eliminated.

The cut is both true and smooth, and requires no subsequent blending or hand-finishing. An important feature of the E.M.I. system is that an additional unit can be supplied, if required, to provide compensation for cutter diameter wear, thus allowing re-sharpened cutters to be used without the preparation of new tape.

The Wadkin machine has been modified by the attachment of servo-motors to the longitudinal and transverse feeds in place of the normal hand feeds, and a third motor for raising and lowering the head. This is controlled by an extra set of information punched on the paper tape, and gives the system the additional facility of cutting pockets within the profile specified for the workpiece. The electronic control system is designed to operate over the standard range of cutting speeds of the machine, which is a high-speed tool for fast cutting and routing of light alloys. Accuracy is achieved by taking position control measurements from the recirculating ball nut leadscrews. The accuracy of the information supplied by the control unit is greater than 0.001 in on dimensions of up to 100 in. The system has been designed by E.M.I. Electronics Ltd., Hayes, Middlesex.

PROGRAMME SYSTEMS

Somewhat simpler than the continuously controlled electronic machines are those which can perform a given sequence of different operations in accordance with a fixed programme without repeated setting up. In other words, the co-ordinate position of the cutting tool is set for each operation without intercession of the operator.

Such machines may be controlled by punched cards, metal tapes, paper tapes, film strip, and possibly other means. Though they are intended primarily for quantity

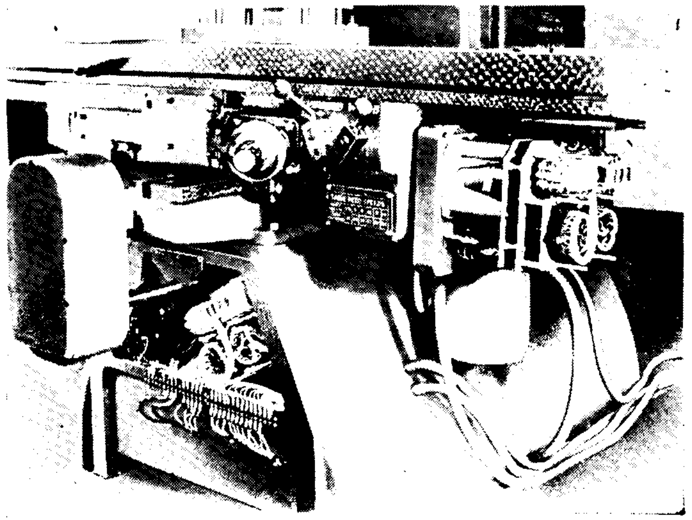


Fig. 4. Detail of E.M.I. system as applied to Wadkin miller.

manufacture, they may often be suitable, too, for small-number or prototype production.

Matrix Jig Borer.—Although the "Matrix" No. 150 jig boring machine is not strictly a programme-controlled units, it is in fact a step in the evolution of a jig borer with automatic positioning. It makes use of an electronic linear measuring system for locating the table and extensive pushbutton controls, and has been developed by the Coventry Gauge and Tool Co. Ltd, in conjunction with the Mullard Research Laboratories. Settings can be made in both directions to within 0.0001 in.

The internal standards of length in the Matrix No. 150 take the form of steel buttress scales, each consisting of a solid steel bar into which is accurately cut a sawtooth form of 0.1 in pitch. A step, machined lengthwise, reveals the form consisting of upright and sloping edges, and the maximum adjacent pitch error is 0.00002 in.

The scale is rugged and durable, being machined from a single piece of material; it also has the same coefficient of expansion as the rest of the machine. Interpolation between the 0.1 in steps of the master scale is accomplished optically.

A glass scale a little over 2 in. long carries upwards of 1,000 alternate opaque and transparent bars, equally spaced. These are scanned by a moving line of light, and the projected image reduced optically by a factor of 20 so that 1,000 bars fit exactly between adjacent vertical edges of the buttress scale.

As the table is driven, the bars are counted as they emerge from behind a vertical edge by means of photomultiplier tubes and an electronic counter. The number counted is subtracted electronically from the required number, and the error displayed on a row of dial lamps. When the error is reduced to zero, the central lamp lights and the table is clamped by operating a pushbutton.

The opaque and transparent bars on the glass interpolating scale are scanned four times per second by a line of light produced by a specially designed scanning mechanism, known as a flying line scanner. The light originates from a line filament prefocus car headlamp bulb.

A condensing lens provides a beam of parallel light wide enough to illuminate the glass scale over its entire length. The scale is, however, shielded from the light, which can only reach it through one of four glass-rod lenses mounted in the centres of four planet gears which form part of an epicyclic gear train. The scanner makes use of the fact that in an epicyclic gear train, if the sun gear and carrier are driven at the correct relative speeds, the plane gears, while moving round the sun, do not rotate about their own axes.

With large-diameter ball races for the planet bearings the centre of the gears can be bored out and rod lenses mounted in them at right angles to the gear axes. While the rod lenses move in a circular path, they remain upright, and by using a lens longer than ⅜ in., an arc of motion can be selected such that the 2 in. by ⅜ in. scale is fully scanned from end to end.

The equipment, which embodies many additional refinements including pushbutton control of table speed and magnetic clutches, is shown in Fig. 5. The last three digits of the desired table position in 0.0001 in. units are set up on dials of the electronic console on the left, while indication of position is given by a row of lamps above these dials; pushbuttons for controlling machine functions are on the panel in front of the table.

FEEDING AND CHECKING

The grinding process is also capable of automatic operation and may be used to illustrate not only the presetting of work cycles but also the automatic feeding and checking of workpieces.

Scrivener Automatic Systems.—Among the most comprehensive ranges both of workpiece feed and sizing devices and of controlled-cycle centreless grinding machines are those developed by Arthur Scrivener Ltd., Birmingham. To feed workpieces delivered at random into a grinding machine correctly positioned with the large end first, a vibratory hopper has been designed, from which the items pass down an inclined chute to a hook stop. The first piece is then gripped by spring-loaded transfer fingers, which contact the large-end diameter and, under the action of a rack and pinion, swing the piece over on to the plate. The piece is then released, ground, and ejected. Scriveners are also demonstrating a push-feed mechanism, a roller-type throughfeed unit, and an automatic overhead loader.

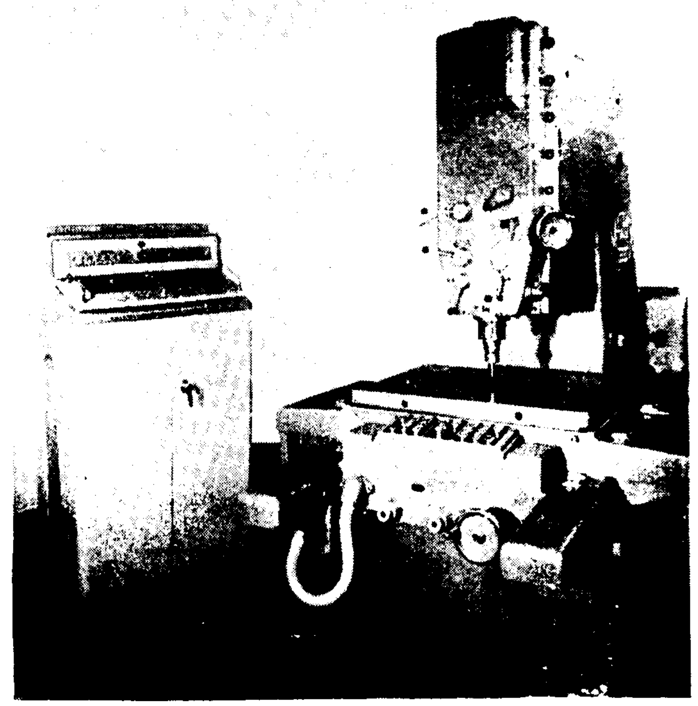


Fig. 5. Matrix No. 150 jig borer fitted with electronic linear measuring system developed by Mullard Research Laboratories. Table position set by dials on console (left) and indicated by lights above dials. Pushbutton controls on front of table (Coventry Gauge and Tool Co. Ltd.)

An item which can be used to effect continuous automatic control of size on throughfeed centreless work is the Scrivener micro-sizer. It is a device enabling the control wheel of a grinder to be advanced by a pre-determined distance varying from 0.0001 in. to 0.0005 in., and, when used in conjunction with pneumatic ring gauging, provides compensation for wheel wear and so permits continuous operation. Another unit, known as a synchronous timing device enables the final dwell or "sparking-out" period to be adjusted from zero to 10 sec.

This is a heavy piece with two opposing tapers and two parallel diameters, so that the considerable difference in size between the large and small diameters would involve opening the wheels more than 1in on release to achieve a continuous throughput. The idle time would thus be unsatisfactorily long.

In the arrangement illustrated, the pieces are loaded on to the sloping magazine A, the bottom end of which is in line with the tubular guide B. At the commencement of the grinding cycle, the lowest piece is fed along this tube by the pusher rod C, which advances it a distance of some 16 in. to bring it into a position exactly over the formed workplate D.

As the push-feed rod retracts, a pair of vertical lifting arms are raised; their upward movement is effected by the sliding cams E operating through the rack and pinion E1 and E2 on the outer of the two co-axial shafts. The simultaneous partial rotation of the tubular guide B, which places the workpiece in the V-pieces of the lifting arms, is obtained from a similar cam F, operating through its own rack and pinion F1 and F2, and the chain wheel and sprocket drive on the inner shaft at the rear of the grinding wheel.

When the piece has been lowered on to the workplate, the controlled-cycle movement of the machine comes into operation: the control wheel (not shown) advances the piece on to the grinding wheel and withdraws after grinding has been completed.

On the commencement of the next cycle, the finish-ground piece is lifted back into the tube in the reverse manner to that previously described, so that the incoming piece pushes the finished component to the discharge end of the tube where, in a production line, a suitable multi-jet air-gauging station could conveniently be located.

PROFILING

Already a large number of profiling or copying systems are well known, but it may be worth noting here some recent additions in this field.

Webster and Bennett Profiling Mill:— A 48 in. single Series DH vertical boring and turning mill with built-in electronic profiling equipment is offered by Webster and Bennett Ltd., of Foleshill, Coventry.

The direction of profiling and the feed is set. After initiation of a profile cycle the stylus (shown concentric

(Continued on page 16)

Standardisation and the Automotive Industry

By K. Subrahmanyam, B.E., M. Eng. (Michigan) A.M.I.E., M.S.A.E.
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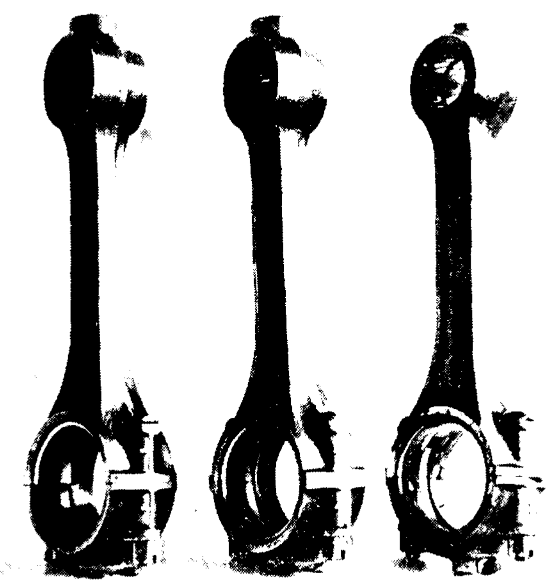
STANDARDISATION may be defined as a programme whereby standards are established by authority, custom or general consent, which become rules or models to be followed. Standardisation must fulfil a sound purpose. You never do it for regimentation. It is not the intent of standardisation to stifle creative ability or ingenuity. By standardising, you settle them by a consensus of those affected, but not necessarily forever. Standards are dynamic and must be revised as the need arises.

In view of the modern methods of production, standardisation is becoming increasingly important throughout the engineering industries; and it is essential, if costs are to be kept low, that designers adopt standard materials and use standard components in all possible instances. It is only by such usage that component and assembly manufacturers can arrange for long production runs and so eliminate the disruptive and costly effect of "specials".

India has yet no automotive standards. The indigenous automotive industry is in its infancy and has no original designs of its own. It follows the designs of foreign firms which are associated with them. Within the next three or four years the industry is expected to produce entire vehicles in India. Once we begin to produce vehicles in which all the components are indigenously made, our dependence on other countries from the material aspect would decrease. But one dependence on them will continue even after that as far as standards are concerned. All vehicles for which the designs are from USA, will be to American standards; those of German will be to German standards; and similarly in the case of vehicles of British and Italian origin.

Take for example the case of bolts and nuts. The nuts fitted on American designed vehicles do not fit on the bolts of the same size on those of British design. Even for the same bolt size, the ruling dimensions of the



Standard connecting rods.

(*Continued from page 15*)

with the tracer head) moves in towards the template. When the stylus contacts the template the output signal from the head, via the analyser, calls for a further increase in generator output and hence movement of the appropriate motorized slide.

When the stylus deflection reaches a pre-determined figure, a relay is energized and the output of the other generator causes the appropriate motorized slide to move the stylus, hence the tool, tangential to the given profile.

At this point, under profiling conditions, the complex signal from the head is analysed and split into two electrical signals equivalent to the mechanical displacements in the two axes. (It may be noted that the complex signal from the head represents the amplitude and direction of deflection of the stylus from its initially deflected position.)

These two signals are compared with a reference. The two resultant signals provide the control signals for adjusting the cross and vertical slides according to the change in output from the tracer head. As the tracer head is rigidly coupled to the vertical slide carrying the tool, a faithfully reproduction of the template profile is produced on the work.

B.T.H. Tracing Head.—The British Thomson-Houston Co. Ltd., of Rugby, have designed a wide range of electronic control equipment. It includes the automatic tracing head for machine tools. This unit and its associated equipment offers complete three-dimensional tracing with automatic control of any combination of three motions.—"*Engineering*", London.

Standards extend to performance : Brake testing on an Army Vehicle.

nuts on the British designed vehicles and American designed vehicles are different, consequently even the spanners will have to be different for operating them. In the case of German and Italian vehicles the bolts and nuts are of metric standards and have no interchangeability at all with those of British and American standards.

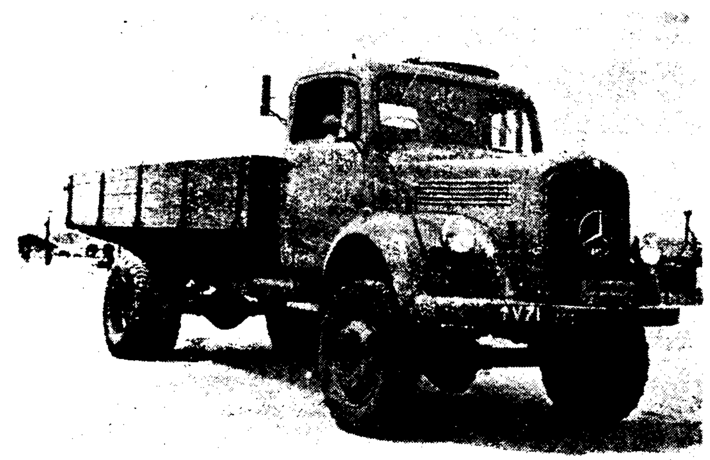
A similar situation exists in the case of splines, serrations, keys, gears and parts such as piston rings. These are all to different standards on different vehicles and not to any common standards applicable to all.

If we consider the method of attachment of various parts, such as carburettor flanges and distributor mountings, these are all found to different standards on the different vehicles. As a result the carburettor fitted on an American vehicle cannot be fitted on a German one, even though the carburettor is suitable in all other respects. In other words, there does not exist one set of automotive standards in India; we have instead some four sets of automotive standards all being used simultaneously. This is obviously a disadvantage to the public and must be rectified as soon as possible. Otherwise production becomes very expensive, the spare parts problem complicated, and ancillary industry, particularly that supplying raw materials, functions uneconomically as the volume of parts of any one type is very small.

There are three possible ways of righting this situation. In the USA the Society of Automotive Industries has laid down the standards for the automotive industry, and all the automotive manufacturers generally conform to it. The SAE Handbook which gives all such standards, is quite exhaustive and is an excellent reference book. It contains such details as the standard range of steels for the automotive parts and even the standard nomenclature for the different type vehicles and their components. In addition to the automotive standards, it includes a large number of "Recommended Practices" for various components. When it is found that is practicable for most of the automotive manufacturers to follow the recommended practices, these practices are made into standards for the whole industry to follow. The Society of Automotive Engineers is a very big organisation with vast resources in money, equipment and experienced automotive engineers. Unfortunately, there is no comparable organisation in India and it is not likely that such an association with enough prestige and resources would come into existance in the foreseeable future. We will therefore have to look for other ways of evolving automotive standards in India.

In England the Society of Motor Manufacturers and Traders has been doing considerable work in laying down standards for the automotive industry. These are widely used by all the vehicle manufacturers in England and many of them have been adopted by the British Standards Institution. The British Standards Institution has also evolved on its own many standards for the industry. The volume entitled "British Standards for the Automotive Industry" published by the British Standards Institution includes under one cover in precise or list form, all the current British standards and the SMM & T standards.

Some six years ago the number of firms professing to manufacture vehicles in this country was large. With the limited volume of business, most of these firms could make little if any profit. Consequently the indigenous automotive industry was not able to progress. The Government then stepped in and, after careful investigations, allowed only a few firms that undertook to produce entire vehicles indigenously, to continue. There are at present only six firms in India engaged in the manufacture of vehicles. Their progress towards giving the country a motor industry has been very



A German Truck made in India.

An Italian Car now made in India.

encouraging. Within the course of the Second and Third Five Year Plans they ought to be producing vehicles in which all the components are made in India. But unfortunately these six firms are not manufacturing the components to the same set of standards, but to standards of four different foreign countries.

It is unlikely that an association of the automotive engineers on the lines of the Society of Automotive Engineers of the USA or an association of the vehicle manufacturers on the lines of the Society of Motor Manufacturers and Traders of the UK, capable of undertaking the preparation of automotive standards for India, will come into existence in the foreseeable future. The only organisation that can fulfil this role is the Indian Standards Institution. We are all confident that the Indian Standards Institution, which has done such magnificient work so far will take up this additional task, and will evolve national standards for the Automotive Industry.

India has already made a decision to change over to the Metric System of weights and measures. In view of this decision, the automotive standards that will be prepared will naturally be on the basis of the metric system. This means that most of the American and British standards, to which the motor industry conform at present will have to be discarded. This would especially have a far-reaching effect on the metals industry. The sizes of all the ferrous and non-ferrous materials are at present in inches. The changes in the tooling in the metals industry to adopt metric standards is a large task which may take several years to accomplish.

This would create considerable difficulties in the automotive industry. Once the manufacturing plants are all tooled up to manufacture the parts to certain designs, any change over in the design would be very expensive and may even prove financially fatal to marginal factories. It may therefore happen that even if certain automotive standards are introduced by the ISI in the near future, they may not be followed by the Industry for ten or fifteen years, depending on the economic limit for re-tooling.

The uncertainties of the fluid and confusing early years of the automotive industry are over now. The six firms engaged in the manufacture of vehicles are firmly settled down and have clear cut manufacturing programmes. As such they are in a position to foresee the exact requirements of machinery required for their plants in the future. If standards for the Industry are laid down, the firms can order and obtain at least their future requirements of capital equipment to the new standards. Even if any of the standards cannot be followed immediately by some of the firms, they would at least serve as goals to be attained as early as possible. Indian firms will surely not be dependent on other countries for ever for vehicle designs. Sooner or later, we will be designing our own vehicles and before we do that, we have to have the standards ready so that designers have the requisite basic materials to draw upon.

A Jeep manufactured in India.

The Automotive Industry has great potentialities in this country. It provides the much needed road transport, which is at present woefully inadequate. Properly developed it can provide employment to millions in the manufacturing, sales, servicing and repair organisations. Let us hope that the Industry will grow in leaps and bounds and will soon take its rightful place in the industrial progress of the country.

AUTOMATION

By "Times" Technical Editor

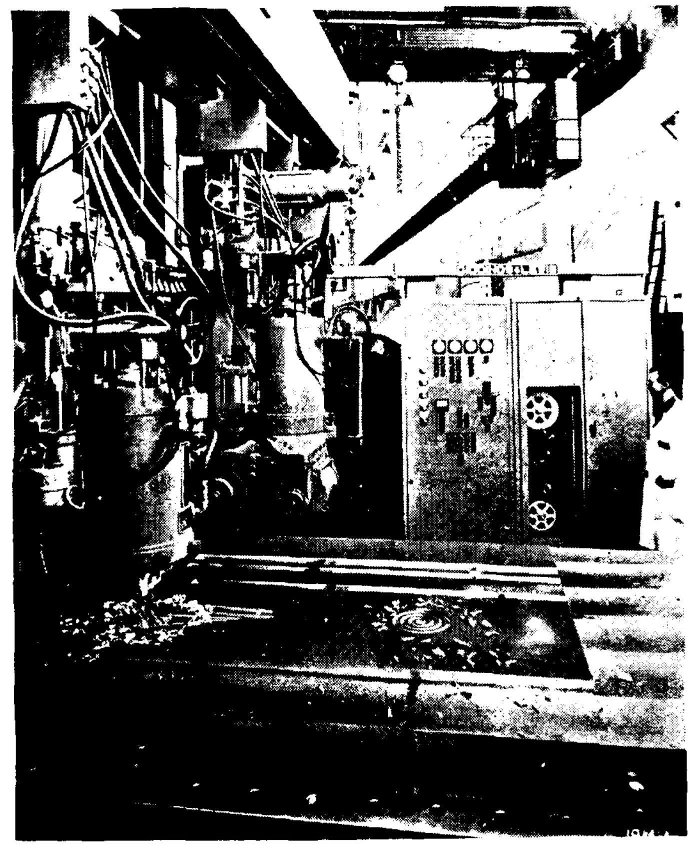
For every skill eliminated by the use of automated machinery, others will be created, production costs will be lower, profits will be higher and everyone will enjoy more leisure.

ALTHOUGH its history is brief, automation already has its own folklore. One of its most widely told legends concerns Walter P. Reuther, president of Congress of Industrial Organisations, and a Ford Company executive who were touring Ford's automated engine plant in Cleveland. As they strode past huge self-operating tools that bored cylinder holes, positioned connecting rods and bolted down manifolds, the Ford executive facetiously remarked: "You know, not one of these machines pays dues to the United Automobile Workers." Retorted Reuther: "And not one of them buys new Ford cars, either".

In 1950, when automation was just getting under way, Norbert Wiener, Massachusetts Institute of Technology mathematics professor and pioneer in the development of automated machines, forecast that automation would reduce wage earners to "slave labour", and bring on an economic crash that would make "the Depression of the thirties seem a pleasant joke." Now Wiener has changed his mind: man is becoming automation's master, not its slave. He cheerfully concedes that automation is "increasing man's leisure, enriching his spiritual life."

Coined only eight years ago by Ford executive vice president Belmar S. Harder, "automation" first described the automatic transfer of automobile parts from one metal working machine to the next. But its meaning has broadened as fast as its application. A few purists still claim that it should be applied only to completely automatic machines that feed back into themselves reports of how they are doing, and correct themselves if necessary. But most businessmen place under automation all automatic machines and processes, including the giant tools that follow directions punched on a tape, huge computers that make thousands of intricate mathematical calculations in a fraction of a second, gauges that check fractions of a hairbreadth with a tiny beam of light.

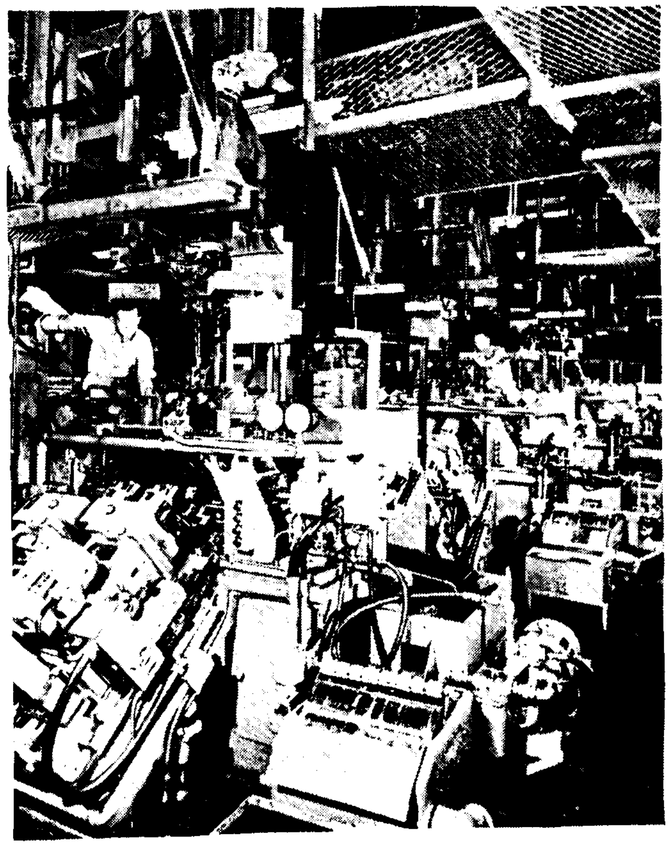
The growth of automation is impressive. Of the $720,000,000 spent by the oil-processing industry in 1955 for capital improvements, 15 percent went for automation. Manufacturers of automatic controls recently estimated that they have installed automated equipment in 100,000 U.S. manufacturing plants during



Precision and machining versatility of the new Giddings & Lewis Numericord System of Machine Tool Automation are shown by the "plunge", "channel" and "pocket" milling cuts performed by this Spar and Skin Milling machine under complete control of a numerically-prepared magnetic program tape. In addition to these cuts, the system's accuracy is demonstrated by the 4-inch radius Archimedean spiral seen in the right foreground of the aluminum workpiece. Behind this is shown the magnetic tape playback unit which controls table and both heads in feed, traverse, rise and fall. The system is capable of simultaneously controlling as many as five machine axes, in three dimensions and up to 22 auxiliary machine function. Even audio commands to the machine attendant can be included on the magnetic tape to alert him to tool change and machine inspection "stops" planned into the magnetic tape's machining program.

(Photograph courtesy of Giddings and Lewis)

the past few years, "yet hardly scratched the surface." After the broadest survey yet on automation's markets, the American Society of Tool Engineers reported that automation will account for 18 percent of metalworkers'



This is a battery of dynamic engine balancing machines which automatically balances all reciprocating parts in the Chevrolet engine plant at Flint, Michigan. It balances parts to a limit of one ounce, one-half inch off dead center.

(Photograph courtesy of General Motors Corporation)

equipment orders in 1956. In the aircraft industry one-fifth of all money spent for equipment will go for push-button machines; one-third of the automakers' 1956-57 equipment orders will be invested in automation. Among the items on U.S. industry's automation shopping list: 25,000 welding machines, 55,000 grinders and finishers, 200,000 machine tools.

Automation has been stimulated by prosperity. With wages constalty going up and skilled labour hard to find, many a businessman has turned to bigger and better machines to keep costs down and production up. Moreover, automation is most profitable in a time of full production: so much money is invested in the automated tool that a plant manager must keep it at work. In Jenkintown, Pennsylvania, for example, the Standard Pressed Steel Company installed a $ 140,000 automated furnace in its bolt factory. The furnace could be operated by one man instead of five; it boosted bolt production 133 percent to 2,100 pounds hourly. But unless it kept running continuously, it was not profitable.

The nation's most automated industries are chemicals and oils. If it were not for automation, the U.S. motorist would pay a much higher price for gasoline than he does. While the oil industry's average wage jumped from $ 1.87 hourly in 1949 to $ 2.47 hourly in 1955, automation boosted production so fast that the labour cost per barrel of finished products dropped from 28.3 cents to 23.7 cents. Refinery workers also benefited. For example, as production at Texas' McMurrey Refining Company increased from $ 7,500,000 of high-quality motor fuels a year to $ 22,000,000, weekly paychecks rose from an average of $ 82 to $ 114, and the total payroll increased. Said President Marvin McMurrey; "We have never had any trouble with our union people over automation, and I think the reason is that they realise that there would not be as many jobs available as there are now if we were not fully automated. If we went back to old hand production methods, we simply could not compete, and there would not be any jobs for any one."

For some industries it is not cost but quality of production that brings in automation. The airfoils of supersonic aircraft and guided missiles demand such close tolerance that the human hand is often incapable of milling and finishing to exact specifications. To end one time-wasting source of human error, North American Aviation installed an automated "skin mill" to mill one and one-half-inch aluminium slabs into F-100 wing panels with one one-thousandth-inch tolerances, found that the robot millers could make a pair of perfect wings in two and one-half hours against 20 hours for a skilled machinist with a possibility of error. North American's new skin mill has worked out so well that the U.S. Air Force has ordered 48 more for U.S. aircraft plants, will install some automated giants that can mill wing panels up to 12 feet wide and 45 feet long.

With the marvels of the automated factory has come the automated office, manned by electronic brains that set up orders, encode instructions to lesser machines, post accounts, and send out bills, write letters and produce profit and loss statements. One of the newest of the great brains is the $ 5,500,000 Bizmac, built by Radio Corporation of America, and now being installed in Detroit by the U.S. Army Ordnance Tank-Automotive Command to keep track of tank and auto parts all over the world. Operators who sit at Bizmac's console can store away on magnetic tape records of 155,000 types of spare parts, lists of vehicles that use them, detailed inventories in major depots from Japan to West German. If, for example, the Army needs to check world supplies of tank crankshafts, Bizmac will compile records no more than 48 hours old, bring forth the reply in three minutes, feed it out at a speed of 600 printed lines a minute. To print a new catalogue of spare parts, Bizmac's operator needs only to press the proper buttons, and Bizmac's 25 electric typewriters will produce pages ready for offset photography. Able as it is, Bizmac is only the prototype of even better computers *that will be capable of running entire factories. Tomorrow's great brain will start* machinery, feed in raw materials, switch from one product to the next as orders come in, convey parts to assembly lines, put them together, inspect, box, band and load finished products into freight cars and trucks.

Though automation has made a striking impact on U.S. industry, the great brain and the robotmachine will never make the human mind and hand obsolete. In some companies automation is not practical. One manufacturer decided to convert all the clerical work to automatic processing by means of punch card order blanks that could be fed into machines. But many of his customers ignored his punch card blanks, and the system broke down. He found that some orders were taking *five days to fill by automation, so he* went back to pencil *and typewriters.*

For reasons of labour relations many an industrialist makes light of reports that automation will eliminate jobs. But unless automation eliminates jobs, it is neither profitable nor practical. Detroit machine maker Charles F. Hautau claims that he can cut a man off the payroll for every $ 5,000 a manufacturer invests in Hautau's automation machinery. However, for every skill eliminated, others will be created and upgraded.

Oilmen already are complaining about the shortage of control panel operators for automated refineries; these technicians must be part engineer, physicist, chemist and mechanic. General Electric Company is training 28,000 employees for automation's better jobs, expects the company's average pay to rise 50 per sent to $ 8,000 in ten years.

Though automation will displace some workers, in the long run the U.S. economic problem will not be unemployment but how to stretch the U S. labour force enough to keep up with a population growth of 3 per cent yearly and a standard of living that grows much faster. With every new production climb will come new demands for shorter houses, more leisure time. Once automation reaches its full stride, the 30-hour week and the three day week end will not be far behind.

ALUMINIUM CONTAINERS USED ON BORNEO EXPEDITION

Standard aluminium containers such as are in regular use for the handling of food-stuffs in the country have recently proved entirely dependable, and virtually indispensable, under the gruelling conditions of an expedition into one of the hitherto unexplored regions of Borneo. They are of a range of general-purpose one-piece stacking containers made by Pressoturn Limited, the ones chosen being of 70 lb capacity, deep-drawn from 16 SWG Noral M57S sheet produced by Northern Aluminium Company Limited and made airtight and watertight by lids of the same material sealed with a rubber gasket and locked in position with clip fasteners.

The Oxford University Expedition to Borneo 1955-56, which has now returned from its exploration of the Usun Apau Plateau in Sarawak, chose these containers because of their lightness and robustness, their hygienic properties, and the protection they give against dampness and attack by insects. One hundred were required for use in transporting food, equipment and biological and zoological specimens.

Together with other equipment, some of the containers were borne up the Rejang River, and over the Pelagus rapids, in 60 ft-long canoes fitted with 25 h.p. outboard motors. Saving in weight was an obvious advantage especially since many of the porters were fully loaded carrying food for other bearing essential stores. In the air-drop of supplies the fifty aluminium containers that were used survived the impact very successfully and even when some of the parachutes failed to open, remained intact though they were badly distorted. In a second air-drop, which took place three months later when the expedition had moved to the northern side of the Usun Apau Plateau, the remaining containers were dropped with equal success.

Altogether six months were spent in the field, during which the members of the expedition were continually on the move accompanied by porters carrying supplies. At this stage, the containers proved invaluable being easily carried on the back.

Aluminium containers which for years have been used in Britain for the handling and storage of fish, meat and other foods, met the demands, not always conventional, of use in one of the jungles of the East.

Industry and Atomic Energy

By C. Dasarathy, L.M.E., L.I.M. (Lon.)
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THE twentieth century is the age of a number of scientific developments, the most important of which is the science of the atomic energy. Ever since the historic Geneva conference of 1955, considerable importance is being paid towards the peaceful and constructive uses of the atomic energy.

This article is written with an intention to describe about the peaceful uses of the atomic energy with particular reference to industry and is presented in the following sections.

(1) Introduction to Radio activity and its brief theory.

(2) Radio activity in mineral industry.

(3) The industrial uses of gamma Radiography.

(4) Utilization of nuclear energy for electrical power generation.

(5) Radio activity for special application.

(6) Nuclear proportion of Aircraft, Submarines, Ships and Rockets.

Introduction to Radio activity and its brief theory. Naturally occurring radio active elements such as radium on decay liberate L, B & r rays simultaneously. The (L) alpha rays are positively charged helium atoms (i. e.) Helium cations, the beta rays are electrons and the gamma rays are midway between light and X-rays since they have a few properties of both. Alpha rays are highly reactive and of short range and hence are not used for the normal industry. Beta rays have moderate range and can be accurately measured and hence are preferred for research purposes. Gamma rays are preferred for practical applications in process control, mineral separation and etc. because of their greater penetration and action at a distance.

Radio activity is independent of the molecular arrangement of atoms and as a matter of fact of every variable capable of affecting chemical substances. In a very real way radio activity is non-chemical attribute of matter and is a property of the nucleus of atoms.

The characteristic atoms of any chemical element may or may not have identical nuclear mass numbers even though the nuclear charge and electron configurations are identical. If the masses of the nuclei differ the atoms are turned isotopes of the element, i. e. nuclei of the element having different masses.

Isotopes are of two types, the stable and the radio active. Isotopes that occur naturally in the elements of the periodic table are the stable isotopes, but these must be isolated by some physical means like the electro magnetic separation and gaseous diffusion separation. Some of the important isotopes other than deuterium and U^{235} are Li^{6}, B^{10}, O^{18} and Hg^{198}. The main advantage of using stable isotopes in research is that there is no time factor to be worried about. The long term effects can be studied accurately since the materials do not decay.

Radio active isotopes are qualified by the type and energy of the radiation emitted on spontaneous decay or disintegration and by the half life t_H (i. e.) time taken for half the radio active atoms to decay. There are three main sources of radio active isotopes. Until the nuclear reactor was developed a cyclotron or other high energy particle accelerator was the only method of preparing such active materials in quantity. Now-a-days irradiation of samples with neutrons in a reactor is the main source of isotopes although several important substances are fission products which constitute the third source.

The extreme sensitivity available for analytica purposes is perhaps the main advantage possessed b Radio active isotopies. Amounts of the order of 10^{-14} g can be conveniently detected and these are too small fo observation and study by any other device. Radio metric counters count the decay of the individual atoms one at a time and because the smallest weighable speck of matter contains not less than about a thousand million million atoms, it is obvious that radio metric method under favourable conditions can measure quantities tha are smaller than can be measured by other methods o analysis, even by the very sensitive methods of colori metry or spectrography. The radiations from radi active isotopes of an element help the following of th movement of "Labelled" atoms among the stable one of the same element. The instruments normally employ ed to detect the ionizing events produced in gases o exposure to radiation are ionization chambers, propo tional counters and geiger-muller (G. M.) counters.

RADIO ACTIVITY IN MINERAL DRESSING

Because of the demands of the atomic energy for increased supplies of uranium, mineral engineers by their skill have been instrumental for a number of new developments.

Use can be made of radio activity in three ways.

(a) For the control of non-radio active plant processes

(b) As a mineral separating tool.

(c) As a research tool.

As a controlling device in practical operations, its functions are to evaluate certain operating factors and variables and to use this evaluation to guide machines and processes. As a mineral separating tool radio activity becomes the fundamental agency of mineral concentration. Using radio active devices for research jobs, we may enhance our knowledge of the physical and chemical properties of minerals or of the detailed mechanism or principles by which separating processes function.

Among the mineral dressing operations, flotation is one of the most important processes and with the advent of the radio active tracer study, considerable information has been obtained regarding the mechanism of the process.

Flotation in the briefest of terms may be said to be wet process where the valuable mineral is being separated from the useless gangue when the original ore body suitably crushed is suspended in a specially prepared fluid of definite chemical composition and agitated. Flotation chemicals like the activators, depressants, frothers and conditioners are suitably proportioned out and mixed with the fine crushed ore body. Later these are agitated in a separate machine constructed in the form of number of cells. The result is that a voluminous and stable foam or froth forms to which the less dense mineral gets attached and later along with the froth is removed, the denser gangue thus being separated.

Solid, liquid and gaseous phases are involved in flotation and the gas-liquid and the solid-liquid interfaces are the important ones. The phenomena of absorption play a prominent roll in flotation. Frothers and wetting agents are absorbed at the gas-liquid interface while collectors and other modifying ions are absorbed at solid-liquid interfaces. The nature of this absorption may be quite different for each system.

Flotation collection is associated with the extraction of the collector by the mineral from the acqeous solution in which the latter is suspended. The degree or the measure of this extraction was not available under normal flotation conditions since the quantities and concentrations met with were so small as to make chemical analysis by standard methods unreliable. But since all flotation collectors contain hydrocarbon chains and since radio carbon C^{14} is available, it is now possible to study the behaviour of any flotation collector.

A collector used in flotation operation is a heteropolar compound (i. e.) one part having an affinity for water and the other an aversion towards water. The collecting entity is deposited at the mineral surface by some form of exchange absorption. Very small quantities are involved and the estimation of such small concentration changes has until now being difficult. Labelled minerals of synthesised radio activity for eg. S^{35} in pyrite would aid in studying the nature of the exchange absorption by virtue of their extreme sensitivity for analytical purposes. Thus with the aid of radio active isotopes the mechanism determining collector absorption rates could be investigated.

An activator may be needed if flotation is to occur with some collector while a depressant prevents a collector from functioning as such. In short, certain ions exert a controlling influence on the absorption of a collector. The substance lime is a depressant for pyrite and this is used to prevent pyrite from floating with other minerals. Depression may be influenced in part by calcium as well as by the Hydroxyl ion. Experiments using radio active Ca^{45} have been done in which the Calcium absorption by pyrite was studied. The results show that Calcium ion is absorbed very extensively on pyrite and that this absorption of Calcium is greatly influenced by the presence or absence of Oxygen in the system. Thus the tracers study has established an important factor in flotation depression mechanism which though until now suspected could not be conclusively proved, namely the role of the atmospheric oxygen.

The next group of applications of radio activity to mineral dressing is to the mineral separating step itself. Radio activity techniques would be used along with the older processes like gravity concentration, magnetic separation, electrostatic separation and flotation. But up to now, these have been limited to sorting processes where particles are evaluated for activity and then sorted by a mechanical device, one at a time. But this point of sorting one at a time is a laborious one and hence seems to be suitable for only the coarser pieces.

In Canada a radio active process has been developed for the purpose of sorting uranium bearing pieces from non-uraniferous pieces. This process works well only under certain conditions and when cleanliness and absence of dust are maintained. The main principle of this process is based upon the natural differences in radio activity between uraninite (or pitch blende) and other minerals.

The ore is first size sorted. Each size fraction is then passed in a file, on a belt under a Geiger-Muller counter. Since each piece is of approximately the same size it affects the counting tube for the same length of time and hence the tube makes a crude analysis of each and every piece of ore. Based upon this analysis the counting tube either actuates a relay or does not actuate and the ore fraction goes to one lot or another. Thus based upon the composition, each piece is sorted and a mechanized decision is thus reached by the counter as to which pile the piece should belong.

But this process is rather limited in scope since there are few naturally occurring elements that are radio active. In fact, it is confined to minerals containing besides uranium the following elements, lutecium, thorium, rubidium and potassium. Of these elements only uranium and thorium appear to be fit for this purpose.

Still recently another process of an almost similar nature has been developed but here induced radio activity is used instead of natural radio activity. This process has been proposed for the concentration of coarse Beryllium ore pieces and a nuclear reaction specific to beryllium is being used here. This nuclear reaction between the incident gamma radiation and atomic nuclei produces neutrons. By controlling the energy of the triggering gamma radiation the gamma-neutron reaction can be made absolutely specific to beryllium.

The neutrons emitted by Beryllium are evaluated in neutron counting tubes and from then on the process is substantially the same as the first mentioned Canadian process. The apparatus is more complex than that needed for treating naturally occurring radio active ores. This latter process for Beryllium detection could be used to sort aquamarines or emaralds from waste even when they are included inside lumps of rock.

Other applications of radioactivity as applied to mineral dressing are communition, mechanical concentration, measurement of pulp tonnages and etc. With the aid of the mineragraphic technique it is possible to study mineral association, effectiveness of grinding circuits, location of tailing losses and etc. Radioactivity either induced by nuclear reactions or natural helps the study of the distribution of an element in different minerals for eg. Manganese Mn^{56} in willemite, franklinite and zincite or the localization of a mineral in a sample can be followed.

Radioactive isotopes were used in communition studies to follow the breaking of a particular piece in its normal environment of other pieces. This a marked improvement on the size distribution studies for the establishment of a relationship between product and feed pieces. The simple method utilising induced radioactivity to label specific pieces of material for use in crushing and or grinding research studies is every effective. Thus with this aid, it is quite possible to study the many variables in communiting operations such as characteristics of crushing devices for eg. a comparison between crushers, pulp density, millspeed, preferential grinding and particularly the effects of circulating load.

A heavily absorbed radiotracer of short half life giving a strong gamma emission could be used to evaluate the position of a sediment in a thickener. Along with appropriate reagent feeding devices or with port opening devices, this tracer could be used to keep the sediment level continuously at the most appropriate height.

In filtration, to evaluate the efficiency of displacement washing and to control the flow of wash water so as to maintain the displacement washing at the optimum level a radio nuclide could be used.

In flotation or leaching plants, radionuclides may be used to measure tonnages in complex interconnected flows, the pulp dilution and the time needed for the pulp to pass from one point to another. Information as to condition at a particular time could be had by adding a shot of radioactivity at a given point and time and following this addition by evaluation of the activity as a function of time at various zones in the circuit. Information and control under steady flow conditions could be had by feeding a steady stream of constant activity at a given point, then measuring and maintaining constant the activity at certain other predetermined observation stations.

INDUSTRIAL RADIOGRAPHY

The earliest known use of gamma rays as opposed to X-rays for radiography is the experiment made by Becquerel in 1896. By placing a piece of silver between some radioactive ore and a photographic plate, the outline of the silver was shown on the developed negative. Radium and Mesothorium were found to be the active constitutents of the ore. Sources of these elements have been used for radiography but to a rather limited extent owing to their high cost.

The earliest use of artificially made radio-isotopes for this purpose was made by Tenney using the cyclotron at the Ohio State University in 1943. Although a large number of gamma-emitting isotopes have been tried for radiography the types in practical use come down to six or eight. For the rest either the half lives are too short or the specific activity is not concentrated enough or it can only be made by a cyclotron reaction and is hence not adapted in routine production.

Iridium 192 has been used for the inspection of pipe welds and steel plates of thickness between ¼" and 1". Construction of boilers, plate work and pipe work have been quick to employ this new technique. The technique radiography has also been proposed for the non-destructive testing of light alloys or thin metal plates and assemblies. It is the one way in which the metal working industry can make real capital of fission products.

Right now castings still plague manufacturers because some times flaws that make the casting unacceptable are not found until lots of machining hours are put into the part. Taking X-rays of each is too expensive and takes too long. So only a small percentage of parts are checked. But with a high energy radiation source, all castings could be inspected on a production basis. As each casting on a conveyor line passes the radioactivity readings on an instrument like a Geiger-counter would show immediately whether the part is sound An inspector can reject bad castings before they are machined. Water works engineers and officials planning to build transmission mains using welded steel pipe can ensure about the safety of welds by conducting a radiographic inspection, a practice started in the gas industry.

Fundamentally, a radiographic method needs three elements:—a source of radiation, a sensitized film which will respond to the rays and the test specimen or object which is permeable to the radiation. Just as a photograpic film reacts to light, the sensitized film reacts to the radiations producing an image of the object on the film. In a typical weld, the difference in density between the weld metal and the surrounding solid metal can easily be distinguished. Such defects as gas pockets or slag inclusions are less dense than the remainder of the weld and appear as dark areas on the developed film. Any defect within the weld itself may be easily detected by an experienced radiograpic technician.

The advent of Cobalt-60 (one capsule is equivalent to 2.5 grams of radium) has eliminated many of the problems in field radiography. Not only is cobalt 60 more efficient than radium, cutting the exposure time one half to one third, but the extreme portability of the new technique (the radiographer is not encumbered with electric power cables or other accessories) and the simplicity of equipment needed, make cobalt 60 more practical than the x-ray technique. Service charges for cobalt 60 radiographic crews are usually well under half those for an x-ray crew for field work. The detection of one bad weld before pipe is laid pays for the total cost of inspection.

Hence gamma radiography is today a well established inspection process. The cheapness and practicability allows the smallest firm to use this method for process control. It is astonishing to see how many smaller firms which had no non-destructive testing equipment are now making use of cobalt 60 Iridium 192, Caesium 137 and Thulium 170 as sources for radiography.

UTILIZATION OF NUCLEAR ENERGY FOR GENERATION OF ELECTRICAL POWER

A few years back, people knew of the generation of Electrical power only in terms of the thermal and the

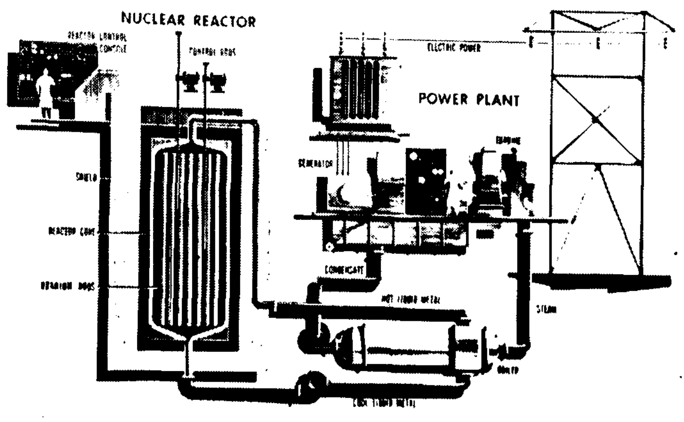

Fig. 1. The drawing shows the operation of a new type of nuclear power plant used to convert the energy created by nuclear fission into forms that can be used in industry and science. Carefully controlled by scientist at reactor console (far left), the nuclear reactor produces heat which, passing through a heat exchanger, turns water into steam. The steam then operates a turbo-generator which produces electrical power.

Hydroelectric source. Now this nuclear energy has come into the picture of electrical power generation. Of course it will take a certain time for this new energy to replace the older and well established thermal and hydroelectric power sources. Further it is a question of relative economics since the initial cost of a reactor, shielding material, a suitable heat exchanger, operational and maintenance expenditure would have to be cheaper or at least on par with the expenditure of a well

established thermal or hydroelectric power source for justification of the choice. But once it becomes cheaper to produce electricity from nuclear energy than from the conventional sources, one of the main determinants of the pace of advance will be the amount of new electrical generating capacity needed. A schematic lay-out of an nuclear power station is shown in Fig. 1.

The development of nuclear technology in Britain has now reached a stage when it can be applied to the large scale production of electrical power. The 1st power station built and switched on by Her Majesty Queen Elizabeth on October 17, 1956 is situated at Calder Hall, Cumberland, a model of which is shown in Fig. 2.

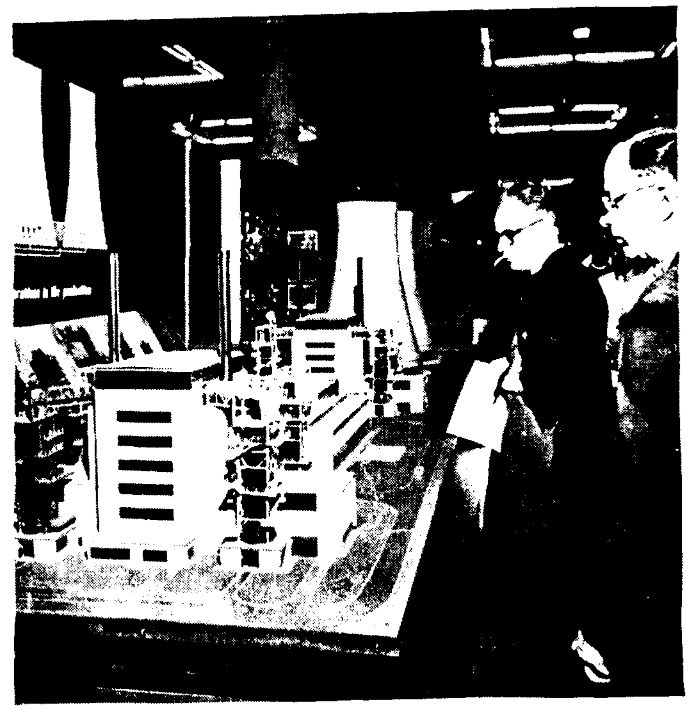

Fig. 2. A model of the British Calder Hall atomic-electric power plant was displayed at the First U. S. Trade Fair of the Atomic Industry held recently in Washington, D.C. The model was prepared by the United Kingdom Atomic Energy Authority. The plant produces 92,000 kilowatts of electricity. It contains two nuclear reactors which use uranium as fuel.

This power station derives its heat from graphite moderated nuclear power reactors and the heat will be transferred to steam generators by carbon dioxide under pressure. This power station cost more than £ 16500000/- and took three years and a half to complete. At present only about 10 megawatts, enough for the needs of a fair sized town is flowing from Calder Hall. This will be stepped up gradually until about 90 megawatts are produced early next year of which about 75 megawatts will go into the national grid. The difference between the Calder Hall total output and its contribution to the grid is taken up in running the station itself and also in processing spent uranium fuel to make plutonium for Britain's defence programme. The output and efficiency of the graphite moderated nuclear power stations can be increased by increasing the pressure and temperature and improving the heat transfer characteristics. The requirements of nuclear fuel for this task depends on the efficiency of utilisation of the fission energy of uranium. If a 33% utilisation could be obtained, one ton does the work of one million tons of coal.

These graphite moderated reactors have the great advantage of being able to use natural uranium fuel. They do not need supplies of enriched uranium from a diffusion plant. With these reactors in a single fuel cycle, it is expected to extract the heat equivalent of at least 3000 megawatts days per ton of uranium giving a heat equivalent of 10,000 tons of coal.

At the end of the first cycle, the fuel elements contain a substantial amount of plutonium together with fission products. The fission products will be extracted chemically and the uranium and plutonium can then be recycled. Alternatively the plutonium can be used as a feed to other types of thermal reactors such as water moderated reactor needing enriched fuel or fast breeder power reactors.

It is said that when a reasonable allowance is made for the value of plutonium produced as a by-product in graphite-moderated gas-cooled reactors, electrical power can be generated from them at an all-in cost of 0.6d per unit sent out. With the developments of better techniques, it should be possible to reduce the generating cost even further. The graphite moderated gas cooled reactor has tremendous advantages in that it is extremely safe in operation. It can employ natural uranium as a fuel and it does not demand the use of any exotic materials in its construction.

It is reasonable to think of nuclear reactors in an ascending scale of specific heat rating of their fuel elements. At the bottom of this scale is the graphite moderated gas cooled reactor. It is mainly a heavy land-based reactor, using low specific ratings but economically because it does not need to make use of expensive and exotic materials of construction. It can be regarded as the slow-speed reciprocating engine of the reactor world reliable and almost conventional in design.

At the other end of this reactor scale, is the fast fission reactor very much more high rated and using expensive and rare materials of construction. High ratings are needed to make the reactor economical. The fissionable material which it uses as a fuel is extremely expensive. It can perhaps be regarded as the gas turbine of the nuclear reactor world.

In between these two extremes are dozens of alternative types of reactors making use of fast neutron, intermediate neutron or thermal neutron velocities, using no moderator or light water heavy water Beryllium or graphite as moderators, using gases, water hydrocarbons or liquid metal as coolants in any combination that can be imagined.

The graphite moderated gas cooled reactor now produces electrical power at Calderhall and the fast reactor type is now being built at Dounreay.

The development of highly rated reactors is essential because reactors are needed to burn the by-product plutonium produced in the reactors of conservative rating which are build as the first step in the industrial programme. But still, it is a mistake to assume that the graphite moderated gas-cooled type has only a limited future.

It is commonly supposed that fuel costs will be negligible foı nuclear stations. This will not in fact be the case, however, unless

(a) A very high level of irradiation is achieved with the fuel elements, and

(b) The by-product plutonium is separated out for use as a fuel in other reactors and that credit is duly allowed for this.

The first regular commercial application of nuclear power will be for base load generation in countries which do not possess adequate supplies of cheap conventional fuels. These first stations must operate at high load factor but the progressive reduction in the cost of building and operating nuclear plant will lead to a steady extension of the field of application of nuclear power. But nuclear energy will seldom be a competitor to hydro-electric power. When hydro power is available on a large scale it will offer power at a lower cost than from any other available source. Only when these hydro resources have been fully developed should they be used for operation at lower load factors in conjunction with base load nuclear stations. But in regions where hydro power is available on a smaller scale however it should be developed, from the outset in partnership with nuclear power for the purposes of meeting the peak load demand.

RADIOACTIVITY FOR SPECIAL APPLICATIONS

In this sphere a few radically new developments have been reported.

Russian Metallurgists have used radioactive devices for the study of the descent of the charge in an operating Iron blast furnace. Until this new development, no accurate study could be done in this direction and hence no material solution could be afforded for the trouble created by a few iron ores of fine sizes which did not descend uniform by within the furnace, causing a jamming and clogging of the charge. When the ores did move within the furnace it was with explosive violence.

To investigate the movement of the charge down the shaft of the furnace, radioactive isotopes were introduced into the ore, coke, sienter and lime stone and the intensity of radioactivity was measured by counters at various places around and down the shell and then checked by determining the characteristic radioactivity in the Pig Iron and slag.

It was found that the speed of transit can be controlled within a wide range by changing various factors. The burden moves downward at a faster rate along the vertical axis of the shaft than at the periphery.

The upward movement of the gases was also investigated by introducing through one tuyere a radioactive inert gas and detecting its movement as noted above. It has been found that the velocity of gas through a blast furnace with a shaft volume of 40,000 cft. is 72-79 ft. per second.

Since 1951, many plants in the U.S.S.R. have used small capsules of radioactive cobalt Co^{60} to measure the wear of the hearth walls of blast furnace because of the descent of the charge. Such capsules were placed at various depths from the innerface of the hearth wall say 6″, 16″, and 30″ from the face—such groups being placed at 120° in the horizontal cross section at strategic elevation whereupon the wear is judged either by the appearance of Co^{60} in the pig iron or by measuring (outside the furnace) the intensity of the remaining radiation.

In the metal industry it is a problem to measure the solidification boundary of continuous cast metal. This has been measured in the case of Aluminium by two methods. Firstly by adding a small amount of radioactive gold to the casting the solidification boundary could be found by investigating the bars with autoradiographic methods. A second method which gave the same good result was to add traces of non-active gold and make activation analysis of the bar in question afterwards.

After last year's comet crash one avenue to be explored was to find out if the disaster may have come about by

spillage of fuel. Kerosene which is used as fuel was labelled in one case with palladium—109—acetyl—acetonate and in another with palladium—109—diethyl—dithocarbamate. Flight experiments were conducted in order to find if spillage occurred and if so whether the Kerosene got near parts of the plane where an explosion could occur. These experiments were extremely successful in excluding this possibility from the list of possible reasons for the crash.

The study of engine friction and wear have been made possible by radioactivity using radioactive piston rings. Radioactive iron is got by neutron irradiation in the reactor. These rings were installed in the engine and operated. If the lubricating oils are sampled, the weight of iron that wears off may be detected down to 10^{-5} ounce.

The amount of gear wear has also been measured by using radioactive methods. A pinion gear was made radioactive by irradiation for about a month in a thermal neutron reactor. The main isotopes produced in the metal were Fe^{55}, Fe^{59}, $Cr.^{61}$ & Co^{60}. The radioactive part was meshed in a gear with another similar driving gear and worked under loads of different magnitudes. The oil that was pumped through the gear box picked up radioactive particles worn from the radioactive surface. This oil was transported to a chamber with an attached geiger tube by a pump. A radioactivity comparison test in terms of counts per minute with and without the oil flow was made. A solution of ferric napthenate made from a tooth broken from the radioactive gear was used as a standard for comparison. The activity of the irradiated gear was determined each day the experiment was performed because the operation took a longer time than the half lives of some of the isotopes. Thus a comparison of the wear as with 2 different oils as a function of the load was got.

A similar experiment has also been done in Sweden. Machining tips of tungsten carbide were irradiated in a thermal neutron flux of 10^{12} in the Harwell England reactor for an hour. Tungsten isotopes W^{186} (76 days) and W^{187} (23 hours) were induced in the tips. Radiations were detected in metal chips cut from a steel sample. The degree of wear was plotted as a function of the time of cutting and from the resulting graph the differences in tool qualities were observed.

Three hundred U. S. Companies use radio isotope thickness gauges to measure the thickness of the metal, rubber, and plastics. The gauge works automatically as part of the manufacturing process keeping the thickness of a material uniform. In the manufacture of sheet copper, a saving of only 2% it is said would amount to a National saving of 9,00000/- dollars.

Antimony - 124 is being used to aid in the separation of different kinds of petroleum moving through pipe lines. When a pipe line is finished pumping one type of oil and wants to shift to another without interrupting the flow, some antimony - 124 is put at the beginning of the new batch. The antimony's rays detected by suitable instruments warn the pipe line operator at the other end that it is time to switch the concerned valves.

Iodine 131 is fine for detecting leaks. Added to the water in a buried heating system for example, it shows via geiger counter just where the water is leaking.

NUCLEAR PROPULSION OF AIRCRAFTS, SHIPS, SUBMARINES AND ROCKETS

If a reactor is to be installed in a mobile system, the main limitation comes from the weight of the shielding that must always accompany the reactor. Nuclear propelled machine has a very small fuel usage as compared to a gasoline propelled machine. A large sized gasoline propelled aircraft cannot fly at supersonic speeds and cover large distances mainly because of the excessive fuel weight. The nuclear plane would indicate a range essentially unlimited by weight or speed. Various research workers have established that reactor power systems are feasible for this use. The basic system may be thought of as follows :—

Heat is generated by fission in a reactor and this heat is taken up by some fluid and converted into kienetic energy of jet gas or propeller rotation. The structure

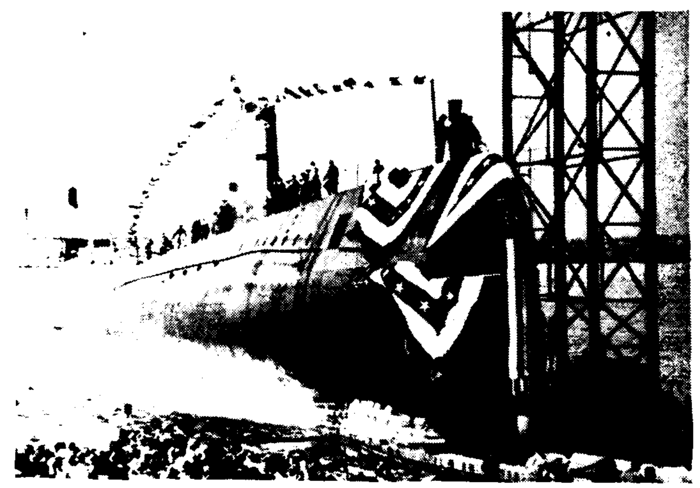

*Fig. 3. The launching of the submarine, the USS **Nautilus**, world's first atomic-powered vessel, opens a new era in the generation and utilization of power. It marks the first harnessing of atomic energy to power a submarine, pointing to future applications of atomic power to industry and the arts of peace. Here, the USS **Nautilus**, slides into the Thames River at Groton, Connecticut, during launching ceremonies. It required 19 months and a cost of $ 50,000,000 to build this history-making vessel.*

of the plane must be heavy enough to support the shielding and it must be possible to service it regularly under conditions of radioactive contamination. Barring these, the plane can be of the conventional design. The choice of the method of converting heat into thrust is dependant on a suitable reactor type fluid coolant, heat exchanger and engine systems. But it must be possible to establish a reliable operation under high temperature conditions and neutron bombardments. Of course the metal parts not moving is an advantage but this is offset by the particle displacement occurring in the metal crystal lattice structure by neutron or fission fragment bombardment. Very little is known about the strength of materials at temperatures in the range of 1000—2000°F particularly in the presence of neutrons.

Referring to a submarine, the shielding weight limitations in a submarine reactor are not as serious as for an airplane because of the relative weights of these two machines. The submarine reactor can be approximately regarded as a stationary system. A water cooled reactor was built where a water to water heat exchanger provides the steam for turbines which in turn drive the propeller shaft. This submarine thermal reactor is composed of enriched U^{235}. The 1st atomic submarine "Nautilus" has been launched in January 54 shown in figure 3.

Scientists have taken a long look into the future and come up with this picture of tomorrow's merchant fleet.

(1) Fishing vessels will be floating factories. All the steps involved in processing including the new atomic method of food preservation by irradiation will be carried out aboard 1 big ship that will remain at sea all year. The finished products will go straight from ship to market.

(2) Mining ships will drill oil on Continental shelves far from their sources of fuel and supplies.

(3) Rough weather will not be a cause of sea sickness on tomorrow's atomic vessel. Ships will simply submerge beneath the waves into the undisturbed subsurface water. Today's large vessels are unable to do this because conventional fuels need oxygen.

(4) Ice breakers will be able to smash through arctic ice packs without making the long return voyage for supplies each fall. They will be able to remain locked in frozen northern water all winter if needed, because space which would be used for fuel today can be used for food tomorrow.

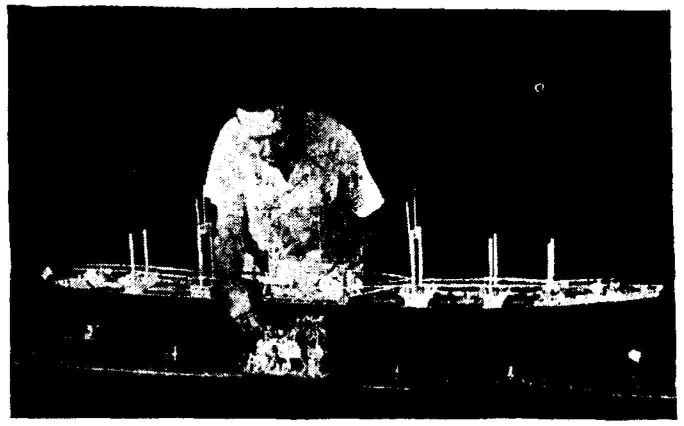

Fig. 4. President Eisenhower recently directed the U.S. Atomic Energy Commission and the department of Commerce "to proceed as rapidly as possible with the design and construction of the first nuclear-powered merchant ship". This model of an atomic-powered merchant ship was made by the Newport News Shipbuilding and Dry Dock Company, Newport News, Virginia. The model is for a ship of the Mariner Class—speed of 20 knots, over-all length of 560 feet. Placed beside the ship, in the foreground, is a model of the atomic engine that would be used to propel the ship.

(5) The merchant ships of 1980 may be much faster than those of today. The ships will be larger and therefore need larger cranks. Atomic ships will be able to go one to two years without refueling. Fuel will take up less space. The larger the atomic reactor the more economical the operation. A model of a nuclear propelled merchant ship is shown in figure 4.

The pioneer atomic ship may be either a large tanker, a dry cargo ship or a combined cargo passenger vessel. No definite type of reactor has been fixed upon but Scientists say the quickest to build would be a pressurized water system similar to that used on the "Nautilus". The ship will measure 595 feet, have a service speed of 21 knots, a cargo capacity of 12,000 tons and carry 100 passengers. It will have a net horse power rating of 20,000.

SUMMARY

Thus it is obvious that the advances already made and yet to be made in the Science of atomic energy if utilised for peaceful and constructive uses the people of the whole world would certainly be considerably benefitted. "The Era of Atomic Energy gives every promise of being the most glorious in the history of civilisation," predicts David Dietz, a leading U. S. Scientific writer. "With a plentiful supply of physical power, it should be an era in which the world is no longer divided into the 'have' and the 'have-not' nations. The causes of war ought to disappear forever. The Era of Atomic Energy may well become the Era of lasting Peace.

Some Recent Developments in British Engineering

By F. M. Davies

(Exclusive to "Journal of Industrial Engineering")

Recent engineering developments in the United Kingdom are of particular interest in the light of the visit of the British mission to advise on further extension of Indian heavy engineering manufacturing capacity. This article describes some of these developments. EDITOR

A series of electronic devices which will automatically perform vital routine analyses in the laboratory has been developed in the United Kingdom. The first instrument to reach commercial production is a meter for the automatic determination of moisture.

Its electronic system is so arranged that it will also automatically carry out the titration of chemicals. This is the measurement of the amount of any given chemical on the basis of the quantity of it required to cause a chemical reaction with a standardized solution of another chemical. The reaction, or end-point, of such titration measurements is shown by the lighting-up of a pilot lamp.

The makers—Baird & Tatlock Ltd., London—claim that the results achieved are equal to good manual titration. Every instrument in the series is of a type normally found in the analytical laboratory, but all have been adapted to at least partial automation. The skilled operator is thus relieved for other work for at least some of the time he would otherwise have to spend on routine but highly skilled operations.

The firm claims that the instruments will also enable considerable laboratory analytical work to be done by an unskilled operator, since, in general, the more difficult part of the technique necessary has been made automatic through an electronic system of measurement and control.

This is but one example of recent engineering development in the United Kingdom. There are many others.

ANTI ROLL FIN

Fishing fleets and users of other small craft, for instance, will be interested in a new type of anti-roll fin produced by Vosper Ltd., of Portsmouth. The firm claims that the fins give an 80 per cent. reduction in roll. They have already been installed in three vessels, and orders have been received for fins for a yacht of 250 tons and a vessels of 600 tons. As the fins have been designed for fitting and removal by a diver, they can be removed for inspection or maintenance without the need to enter drydock. Of low aspect ratio (small outreach), so that a saving of weight and space can be ensured, the fins are non-retractable.

A high-pressure hydraulic system, actuating small rams which work similarly to the undercarriage-retraction equipment of aircraft, operates the stabilizing fins. It is stated that the fitting of stabilizers to existing vessels need cause little rearrangement, and there would be no need to allocate a special compartment for the actuating gear.

Two new gas heaters, designed for use in industrial premises, are being produced by William Sugg Ltd., of London. The first, the Raymaster radiant heater, is for suspension from the ceiling; the second, the Halcyon convection model, may be fitted on a wall or behind it, with special ducting to the area to be heated.

The firm states that the Raymaster is particularly suited for lofty buildings, normal fixing height being between 9 ft. and 10 ft. from the floor, and no flue is required. In the convector model, the passage of air through the heating surfaces is aided by an electric fan.

CEMENT-HANDLING EQUIPMENT

Now in production is equipment for automatically transporting cement from the site where it is mixed to the point where it is to be used. Pneumatically operated, the equipment will transport the mixed cement 1000 ft. horizontally and more than 100 ft. vertically. It is claimed that it will convey up to 35 cu. yds. per hr. through a 6 in. pipeline.

The pressure cylinder, which will hold $17\frac{1}{2}$ cu. ft. of cement, is located at the mixing point, and the cement poured into it through a hopper at the top. Compressed air, stored in an air receiver, is then admitted to the top of the cylinder through a valve, and the cement is forced through the pipeline. Regulation of the air pressure in the cylinder governs the cement's speed of travel.

At the delivery end of the pipeline, a discharge box separates the cement and the air, and a central baffle within it divides the flow of cement into two streams which are re-united before the final delivery. Velocity is thus arrested and the force of discharge reduced. Pipeline is supplied in sections 10 ft. long and 1 ft., 2 ft., 3 ft., and 5 ft. sections and bends are also available. Blaw Knox Ltd., London, manufactures the equipment.

FUME CABINET

For many years the danger of explosion from handling perchloric acid and the toxic effects of hydrofluoric acid have been predominant in the minds of chemists and laboratory assistants. As a result of considerable research into the effects of these and other aggressive chemicals on conventional wood and metal fume-cabinets, Turner & Brown Ltd., of Bolton, Lancashire, has produced the "Turbro" Cabinet, types 3 and 6.

The main structure of the cabinet is in BX Cobex rigid vinyl tube, reinforced with metal. Rigid ½ in. polyvinylchloride sheet is employed to form the side of the back panels. A stainless-steel tank (optional) can be incorporated to form the working level. The tank is insulated from the polyvinylchloride with glass wool; Bunsen burners and hotplates may, it is claimed, be used with complete safety.

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One of the tests to which the box was subjected was to be run over several times by a three-ton Army truck. The box was unharmed, and its electrical performance unimpaired. It was also found that it will stand up to snow, ice, sleet, and rain in the field, and that its performance is satisfactory in temperature conditions ranging from -60°F to +125°F.

The box, which has one 80-ampere outlet socket and three 13A outlet sockets, is capable of distributing 10kW of lighting load, sufficient for the dugouts and tents of a divisional headquarters in the field. The supply is normally taken from a 27.5kVA field generating set, the distribution panel of which carries socket outlets and plugs moulded from the same high-impact Bakelite material as the junction box.

These comprise altogether six 80A single-pole outlets and plugs, four neutral points and plugs, and two 13A standard-socket outlets.

An important feature of the design of the box and of the distribution panel is that a high-impact Bakelite cover is permanently chained to each outlet, and screwed over it when not in use. The plugs provided also carry a threaded protective sleeve which enables the engineer to screw the plug right home, rubber seals on the socket and plug ensuring a waterproof joint.

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When the problem of switching over to flow-line production was first approached, the primary difficulties encountered at the time were those of "transfer mechanisms"—that is, the movement of tubes from one process to the next. These problems were overcome by the firm's own technical development department. The flow line operates at 55 tubes per min.

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The system flight-tested by Normalair employs a liquid-oxygen converter of 5 litres liquid capacity, giving a gaseous supply equivalent to that provided by six standard 750-litre storage cylinders. Converters of other sizes are being developed. The components of the system fall into two distinct groups, the only installational requirement being location of them such that the pipelines connecting them are as short as possible.

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A battery-operated instrument designed for geological surveying, mapping, and prospecting for radioactive ores and for the examination of mine workings has been developed in conjunction with Britain's Atomic Energy Research Establishment. When the instrument is used in conjunction with the associated beta probe unit, assay work can be carried out in the field. The equipment, by Ericsson Telephones Ltd., of Beeston, Nottingham, is known as the "1368" Field Ratemeter.

The instrument is particle counter which incorporates a junction-type transistor and four Geiger-Muller tubes. The counter rate is shown on a 50-microampere indicating-meter calibrated in milli-Rontgens per hr. Five ranges available in the instrument cover count rates of 0 to 25 milli-Rontgens per hr. An accuracy of either 10 per cent. or 2 per cent. can be chosen by operating a selector switch, and the speed of response of the instrument depends on the accuracy chosen.

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The total weight of the equipment is 28 lb., which includes the Ratemeter, probe unit, with extension handle, headphones, sample holders, filling-funnel for assay work, tools, spare parts, and canvas haversack, the complete supply being contained in a light-weight-alloy suitcase. The Ratemeter itself weighs 8½ lb.

WIRE ROPE TERMINALS

A new form of terminal, designed as an attachment to wire ropes of any known specification, has been produced by the Tulloch Construction Co. Ltd., of Sutton, Surrey. Known as the Tulcon Terminals, they consist of compact assemblies of three simple units which, when assembled, form a terminal locking the wire rope to the assembly, thus forming a connection which cannot come apart. The assembly comprises a sleeve, to accommodate a given size and diameter of wire rope; a plug, which is inserted to separate and hold the strands of wire pressure in the cylinder governs the cement's speed of travel.

At the delivery end of the pipeline, a discharge box separates the cement and the air, and a central baffle within it divides the flow of cement into two streams which are re-united before the final delivery. Velocity is thus arrested and the force of discharge reduced. Pipeline is supplied in sections 10 ft. long and 1 ft., 2 ft., 3 ft., and 5 ft. sections and bends are also available. Blaw Knox Ltd., London, manufactures the equipment.

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rope; and a terminal which can be made to suit any given application.

The sleeve and the terminal are made of forged alloy steel, and the insert of shell cast gunmetal. The complete assembly, therefore, provides a strong terminal designed to exceed the strength of the wire rope to which it is attached. The advantages of simplicity, strength, speed of assembly, and economy are claimed by the firm. The terminals can be fitted by unskilled labour using a hammer, spanners, and vice. They will withstand hammering, vibration, or other industrial hazards. An inspection hole is provided in each terminal to ensure that the attachment is secure. Standard ranges offered at present range from $\frac{1}{8}$ in. to 1 in.

NOVEL GLASS-WORKING MACHINE

Capable of producing a very wide range of laboratory glass-ware, a laboratory glass-working machine has been perfected in Britain. The laboratory glass-blower usually employs simple hand tools and relies upon a high degree of manual skill to form glass into the complex forms needed in the laboratory. The problem of speeding up such work and making it more economical was studied by the British Coal Utilization Research Association.

Tests have shown that a prototype machine, designed and built at the association's laboratories, is more versatile than the conventional glass-working lathe, and can deal with all but the larger and heavier work in either soft or hard glasses. It is so designed that a semi-skilled operator can handle specialized work which would otherwise take the time of a more skilled glass-blower.

As it was realized that the machine could have many applications outside the association's own laboratories, commercial production was decided upon. Edwards High Vacuum Ltd., of Crawley, Sussex, working closely with the association, has developed and is now manufacturing a production model.

DIESEL-ELECTRIC SHUNTING LOCO

A Diesel-electric shunting locomotive of new design, for heavy use, has been developed by the Yorkshire Engine Co. Ltd., Sheffield. It is being made in two models, one of 200 hp. the other of 400 hp. The machines are fitted with Rolls-Royce Diesel engines and British Thomson-Houston transmission equipment, and they are complementary to each other in that the power equipment of the larger model duplicates that of the 200 hp. model.

The larger model has a weight of 48 tons and a wheelbase of 11 ft. Its starting tractive effort is 30,000 lb., and at a continuous rating speed of 8 mph. has a tractive effort of 13,100 lb. Maximum permissible speed is 23 mph.

Two sets of power equipment are arranged, one on each side of the central driver's cab, and they are linked to one set of controls for multiple working. Should one power set break down—or for light-duty working—the locomotive can be worked effectively on the other set.

The 200 hp. model of the new design are built in 0-6-0 and 0-4-0 types, weighing 30 tons. They have a maximum tractive effort of 18,000 lb. and a continuous tractive effort of 7,400 lb. at 7 mph.

FOR PRODUCTION OF SCREWS

New equipment for automatically feeding screws to the head of a portable driving tool is being produced under the trade name Pneuma-Serve. It is operated from the normal factory compressed-air supply at a pressure between 70 to 90 lb. per sq. in. The device consists of a hopper holding a supply of screws (enough for 5 hrs. to 8 hrs. operating), with an elevator and magazine where they are selected individually and delivered to a cut-off plate or shuttle.

Compressed-air feeds the screws from the shuttle to the portable driving-head through a tough plastic tube. The driving-head may be attached to any standard power driver. If an air driver is used an armoured plastic tube is coupled alongside the feed tube, or flexible cable if an electric driver is preferred. A third line, connecting the head to the hopper, is a signal tube which synchronizes the operation of the hopper with that of the driving-head. The driving-head is fully mobile up to 20 ft. from the hopper and can operate at any angle.

The machine can be produced to drive screws of large variety up to $1\frac{1}{4}$ in. maximum length. Advantages claimed for the tool are that screws can be driven four times faster than by conventional methods; and that it eliminates handling of screws, reduces wastage and operator fatigue. Manufacturers are Guest, Keen & Nettlefolds (Midlands) Ltd., Screw Division, of Birmingham.

RETRACTABLE MAST

An interesting development by Mitchell Engineering Ltd., of London, is a mast which consists mainly of a three-sided articulated chain wound flat on to a drum when not in use. An electric motor operating through a gear reduction unit unrolls the links from the drum and, as the links travel through curved guides, the two outer

sections swing inwards and join together to form a rigid triangular mast.

The mast can be raised vertically at 15 ft. per minute to a maximum height of 50 ft. The over all dimensions of the complete unit with the mast retracted are: width-5 ft. 2 in.; length-8 ft. 10 in.; height-7 ft. 6 in.; weight-$2\frac{1}{2}$ tons. The mast dispenses with time-wasting erection tackle, such as ladders and scaffolding, and has many uses, both indoors and outdoors, where men have to work aloft up to heights of 50 ft.

It can be used for the following purposes: repair and maintenance of street lights and overhead power systems; cleaning of walls, roofs and skylights; the inspection and servicing of aircraft and hangars; work on ships' hulls in drydock; fire-fighting towers; television and motion camera towers.

TOOLBIT HOLDER

It is essential, if maximum value is to be obtained from the ground surface of a toolbit, that a really flat surface is provided upon which it can rest. A British firm—James Neill and Company (Sheffield) Ltd., of Sheffield—claims that this is achieved in its Eclipse model, by providing a carefully machined groove with relieved corners. This grove, being open, is easy to keep clean and free of swarf and provides the accessibility necessary for accurate positioning of the tool.

An effective means of securing the toolbit is also necessary and with this holder a clamp-plate of patented design provides both downwards and sideways pressure so that the toolbit is clamped rigidly between the angle of the groove and the angle of the clamp.

BARIUM TITANATE TRANSDUCERS

The Research Laboratories of the General Electric Company Ltd., London, have developed miniature barium titanate accelerometers and strain gauges which are proving extremely useful in the field of vibration testing. They are said to have many advantages over previous methods of vibration testing and measurement, are inexpensive, reliable and simple to operate. Their small size enables them to be used in a variety of circumstances where it would be impossible to use more bulky equipment and they are extremely sensitive and will work efficiently over a relatively wide range of temperatures and vibration frequencies.

The two new devices are Type E Barium Titanate Accelerometer and the Barium Titanate Vibration Strain Gauge. The former can detect and measure shocks over a wide range of operating conditions. It is effective at any temperature between -50°C and $+100^\circ$C. If this temperature is exceeded the piezo-electric properties can be restored by repolarization.

The Vibrations Strain Gauge was originally developed for measurements of blade vibrations on rotating turbine wheels, but it has many other applications to similar problems. It is 2,000 to 3,000 times as sensitive to alternating strain as a typical wire resistance strain gauge, the firm claims.

COIL WINDER

A coil winder has been developed, the principal feature of which is its ability to accommodate 12 reels each of 6 in. diameter with a winding range of from 20 to 46 steel wire gauge. The machine has a travers from $\frac{1}{16}$ in. to 6 in. with a maximum effective winding length of $18\frac{1}{2}$ in. An automatic cut-out operates in the event of wire breakages. The maximum coil diameter is $4\frac{3}{4}$ in. and the minimum $\frac{5}{8}$ in.

In changing from one gauge wire to another, the operator or setter can see the required setting from a small dial. The coil winder is driven by a 1.25 bhp. alternating-current motor with electric clutch control ensuring smooth acceleration in speed from 0 to 2,500 revolutions per minute. It has a predetermined electric revolution counter with a Warner electric brake on a mandrel headstock to ensure accurate control and prevent over-running. The device has been developed by Westool Ltd., County Durham.

GEARED POWER PRESSES

Another British firm has developed 100-ton geared power presses for use with its special tooling. The machine takes tooling up to 36 in. left to right by 13 in. front to back by 23 in. shut height. The ram moves on four precision ground pillars which guides as close as possible to the tool and ensure accuracy of ram travel throughout its 8 in. stroke and 9 in. adjustment.

The press has an air cushion enclosed in the ram which operates a top pressure pad in the tooling. A positive bottom knock-out is driven directly from the crankshaft so as to eject the component during the upstroke of the press for mechanical or air unloading, and to return the ejector pad leaving the die clear for component location as the press stops at the top of the stroke.

The reciprocating weight of the ram and tooling are fully balanced by air cylinders, and the action of the connecting rod is taken through a large section plunger which is separately guided so that tilting forces cannot be transmitted. The press frame is of extremely strong, rigid construction. The drive from a 10 hp. high-torque motor is transmitted to the flywheel through a variable-speed drive and the clutch is of radial key design operated by a treadle through a single stroke mechanism. The speed of the press can be varied between 25 and 50 strokes per minute. The firm concerned is Turner Brothers (Birmingham) Ltd., of Birmingham.

NEW COMPARATOR

A new comparator for checking internally threaded components is in full production by the Coventry Gauge and Tool Company Ltd., of Coventry. Simple in construction, it is similar in principle to an expanding screw plug gauge, consisting of two master threaded gauging segments, the expansion or contraction of which actuates a sensitive dial indicator graduated in 0.0001 in. divisions. This dial indicator shows the relationships of the part being measured to a master setting ring.

The gauging segments are mounted on two members which pivot on two hardened steel balls housed in conical settings and held in place by tension springs. Movements of the segments are directly recorded on the dial indicator. The comparator is operated by pressing together the two members, which in turn bring the gauging segments sufficiently close to each other to be inserted into the component. The spring-loaded members are then gently released and the segments engage with the thread, at the same time actuating the indicator. Constancy of pressure against the threads is thereby ensured, and makes experience unnecessary in judging an acceptable fit when conventional gauging methods are employed.

An eccentric contact pin actuates the dial indicator and enables the zero to be adjusted to the most convenient reading position. The normal range of the comparator is from $\frac{3}{8}$ in. to 1 in. diameter, but special segments can be supplied for fine threads down to $\frac{1}{4}$ in. diameter.

MULTI-PURPOSE STRADDLE CARRIER

Recently seen in London was a straddle carrier which, since it obviates the need for cranes and overhead gantries, can be put to a number of uses. The size of the loads which it can handle with ease can be judged from the fact that an average saloon car finds ample parking space under the huge vehicle.

An indication of the speed at which the carrier can operate was seen in tests which demonstrated that it could pick up from ground level, transport a distance of 220 yds. and set down a load of $7\frac{1}{2}$ tons, 23 ft. in length, and return unladen to the starting point in an inclusive time of 80 sec. It is thus possible to pick up at the rate of 300 tons per hour and move the loads a distance of 220 yds. Manufacturers are British Straddle Carrier Company Ltd., of London.

DIESEL ENGINE FACTORY AT VISAKHAPATNAM

The Government of India were exploring the possibilities of starting a Diesel Engine Factory at Visakhapatnam. The factory would be mainly concerned with the manufacture of marine diesel engines and for that reason, Visakhapatnam would be selected for the location of the factory. The project, to be run by the State, would cost them about three to five crores of rupees.

* * *

KORBA PROJECT

Production of coal in a pilot quarry in the Korba Project in Madhya Pradesh was expected to begin early next year. As a result of the drilling so far carried out it was possible to plan for opening of three open cast mines and one underground mine. Work on the underground mine was expected to be started very soon and according to present expectations coal would be touched in April 1957. Work on the other two open cast mines would also be taken in hand in a few months when the machinery, indented for, would arrive. A team of Russian experts had just arrived in the country to study the Project Report prepared by an Indian team for coal mining in the Korba region. The team would advise generally on the mining methods to be adopted for the speedy and economic working of the mines and the type of machinery to be used.

Treatment and Utilisation of Waste Waters from Cotton Textile Mills

By R. Rajagopalan and S. C. Pillai

Department of Biochemistry, Indian Institute of Science, Bangalore

THE subject of textile wastes has received considerable attention at the industrial centres of the world, and a number of investigators have made valuable contributions. Snell[1] reported that the biological method of sewage purification, such as the bio-æration or the intermittent trickling filters, could be applied for the purification of textile waste. The experiments of Rudolfs and Setter[2] indicated that textile waste retarded but did not prevent sludge digestion.

It has been generally found very difficult to treat sulphur dye wastes, but the observations of Miles and Porges[3] would suggest that these could be purified by the activated sludge process when sufficiently diluted with domestic sewage. Eldridge[4] did not, however, recommend the treatment of textile waste along with sewage since the industrial effluent required separate chemical treatment. The observations of Gotaas[5] would also suggest that preliminary treatment of textile waste (neutralisation, chemical precipitation and æration) might be necessary before addition to sewage for treatment by the activated sludge process or on trickling filters.

Horton and Baity[6] observed that textile wastes could be efficiently treated by recirculation through trickling filters, although the removal of colour would be slow; and that weak wastes could be mixed with sewage while strong sewages needed chemical precipitation. He emphasised that textile waste should be equalised before discharge into sewers. The experiments conducted by Isjurova[7] showed that dyes from textile waste had no special injurious effect on the micro-organisms.

Apart from the studies on the treatment and disposal of textile wastes, a number of workers have examined the possibility of recovering from them sulphur and vat dyes and caustic soda.[8,9] Milinskii and Setkina[10] carried out studies on the utilisation of the wastes from (starch) sizing and treatment of vegetable fibres for growing edible yeasts. Mohlman[11] recorded that fibres in waste waters from textile and carpet works caused the formation of a thick scum in digestion plants at sewage works, and that at one works the sludge conditioned with ferric chloride and burnt lime contained 50 per cent fibres on dry weight. Reviews of the work done on the subject in different parts of the world, including that done in India, are available.[12-15] Although very valuable information is available in literature, there is still necessity for further work on a few aspects of the problem for application at certain centres.

THE CONDITIONS IN INDIA

The textile industry is now probably the largest single industry in India discharging millions of gallons of liquid wastes. In places like Bombay, the textile wastes eventually find their way into the sea. In places like Cawnpore, situated on the banks of big rivers, the wastes are discharged into the rivers. The latter are polluted, but the volumes of water, even during dry weather, are so large that the effects are not very considerable. In the case of inland towns like Ahmedabad having large numbers of mills, the problem of waste disposal is much more difficult. Ahmedabad has probably the largest number of mills in India doing all the operations, dyeing, bleaching and mercerizing at the same time. The river in the neighbourhood (Sabarmati) has a negligible flow during dry weather, so that any large quantity of waste discharged into it would putrefy and become offensive.

In addition to the ultimate disposal of the wastes, there are other problems connected with it. The wastes have to be carried in hume pipes, and care has to be taken that the wastes do not attack the pipes. The wastes in the mills consist mainly of two types, the dye house and bleach house wastes, which require proper treatment before they are discharged into the sewers carrying domestic sewage. Ahmedabad, for example is a rapidly growing town and it is growing around the mills. Most of the mills have, if at all, very limited space for putting up any elaborate purification plant. The sewage-textile waste mixtures require further careful study at the outfall, to recover, if possible, anything valuable or, alternatively, to use it for agricultural purposes.

EXPERIMENTS

It was found that the wastes which were predominantly alkaline at the mill end were converted into alkali bicarbonate either on standing for some time or after admixture with domestic sewage. The bicarbonate and the other alkali salts acted on the hume pipes and caused corrosion. With a view to preventing this and to removing suspended and colloidal impurities, a system of treatment involving the use of equal quantities of burnt lime and gypsum was proposed by Dr. V. Subrahmanyan (who is now the Director of the Central Food Technological Research Institute, Mysore). As a result of this treatment, the alkali bicarbonate was converted first into carbonate and then precipitated as chalk. The sludge carried down the bulk of the suspended and colloidal matter, leaving a clear supernatant or effluent which was conducted into the sewers. The effluent carried sufficient amount of calcium to eliminate the risk of corrosion of the pipes.

It was found that (i) so far as the protection of the hume pipes was concerned, mere treatment with gypsum was sufficient ; (ii) gypsum alone did not produce any large amount of sludge because most of the alkali was in the form of bicarbonate ; (iii) gypsum-treated waste did not form any fresh sludge on admixture with domestic sewage ; and (iv) gypsum-treated waste on being spread on land did not render the soil alkaline.

The Municipal authorities at Ahmedabad were primarily interested in using the mixed wastes (after treatment and admixture with sewage) for growing crops on their extensive farm. As this appeared to be feasible and as direet recovery of dyes and chemicals did not prove economical, attention was directed to the agricultural utilisation of the wastes treated at the mills.

In view of the foregoing observations and the possibility of simplifying the process of treatment by using gypsum alone, further experiments were carried out comparing gypsum treatment with lime-gypsum treatment. Apart from studying the effect of treated wastes on the pipes, their effect on crop growth was also followed. The possibility of treating the textile waste-sewage mixture by a system of ærobic purification was also studied.

Action of the wastes on hume pipes. Experiments were carried out to study the usefulness of gypsum in preventing corrosion of hume pipes. The trials were conducted with the mixed dye house and bleach house wastes as obtained from a local mill. The samples of the wastes, after treatment, were kept for varying periods in specially constructed cement troughs. The waste liquid was treated with powdered gypsum at the rate of 4 cwts. for 100,000 gallons (i. e. about 2 gms. per gallon). A control series was also run by keeping the untreated waste in the troughs. In a third series of troughs, distilled water was kept ; this was done to find out how far distilled water dissolved out calcium from cement. Samples of the supernatants in each series were taken out at intervals and analysed for their calcium contents.

It was observed that while the calcium content of the untreated textile waste went up from 1.4 to 5.7 parts per 100,000 on storage, that of the gypsum-treated waste was not affected. As expected there was no dissolution of calcium by distilled water. These observations showed that treatment of the waste with gypsum was useful in preventing corrosion of the pipe to a considerable extent. It may perhaps be mentioned in this connection that sewage and sewage gases may affect the materials used in the construction of purification plants under certain conditions.[16-18]

Relative efficiency of gypsum, burnt lime and a mixture of gypsum and lime in equal amounts in the treatment of textile wastes. The earlier experiments at Ahmedabad, using a mixture of gypsum and burnt, lime (at the rate of 4 cwts. of each of the chemicals for 100,000 gallons of the waste) for the treatment, indicated that considerable amounts of sludge were produced in the treatment tanks as also in the pipes conducting the treated waste. With a view to preventing the formation of excessive amounts of sludge and at the same time checking the dissolution of calcium from the pipe system, trials were conducted by treating the waste with gypsum alone (at the rate of 4 cwts. per 100,000 gallons), burnt lime alone (4 cwts. per 100,000 gallons) and a mixture of gypsum and lime (4 cwts. each of the chemicals per 100,000 gallons). The results of these and other trials with mixtures of textile waste and domestic sewage showed that treatment of the waste with gypsum was more efficient than burnt lime or the mixture of gypsum and lime not only in controlling the sludge formation and protection of pipes but in bringing about oxidative changes in sewage-textile waste mixtures. It may be pointed out in this connection that gypsum is by far cheaper than burnt lime.

Effect of æration of mixtures of treated and untreated textile waste and domestic sewage, with and without activated sludge, on the oxidative changes in the media. Experiments were carried out by mixing the textile waste and sewage in the proportions of 1 : 1 and 1 : 2 and blowing air through the suspensions. The treatments of the textile waste included (a) gypsum, (b) burnt lime, and (c) a mixture of equal amounts of gypsum and lime. The treated and untreated textile wastes were mixed with detritus-free sewage and ærated in conical flasks (2 litres capacity). Samples of the supernatants were taken out at periodical intervals and analysed for oxygen absorption from permanganate (3 minutes and 4 hours), free and saline ammonia, albuminoid nitrogen, nitrite and nitrate nitrogen. The resulting sludges were examined under the microscope.

The results showed that the textile waste when mixed with domestic sewage in the above proportions and ærated had no appreciable effect on the clarification of the media and on the oxidative changes in them. The results also indicated that the textile waste (from the local mill) when mixed with sewage in the above proportions could be purified by the activated sludge process.

Further studies on the effect of increasing the concentration of textile waste in sewage (e. g. one of sewage and two of textile waste) indicated that the oxidative changes in the media were adversely affected. This was a useful indication bearing also on the utilisation of textile waste along with domestic sewage for crop irrigation.

Vegetation experiments with sewage-textile waste mixtures. Pot trials were carried out with French beans, ragi, (a local variety) and fodder jowar, irrigating the crops with textile waste (untreated and treated with lime and gypsum) and mixtures of textile waste and sewage. The effect of dilution of textile waste, before and after the treatment, with tap water was also studied. In addition to the treatment of the textile waste with lime and gypsum singly and in combination, the waste liquid was passed through gypsum lumps of different sizes (2″, ½″ and ⅛″) and the effluents from these beds by themselves as also admixed with sewage were used for the irrigation of crops. The object of the latter treatment of the textile waste was to find out whether such a simple treatment would give satisfactory results so that it might be adopted by the mills.

The results of the pot trials showed that (a) the response of the crops to untreated textile waste was poorer than to tap water irrigation ; (b) there was no improvement in the response of the crop when the untreated textile waste was diluted with tap water in the proportions of 1 : 1 and 1 : 2 or even after treatment of the waste liquid with burnt lime alone or powdered gypsum alone ; (c) the adverse effect of the untreated waste liquid was, however, considerably mitigated by (i) treatment with lime and gypsum in combination and (ii) by passing the original liquid through a bed of gypsum of ½″ size ; and (d) the effluents obtained on treatment of the waste with both lime and gypsum as also those from the gypsum bed, when mixed with domestic sewage (1 : 1 or 1 : 2) for the irrigation of the crops, gave better yields.

Residual effect of textile waste in soil. The pots in which French beans were grown were set apart for studying the residual effect of the waste and other related treatments on the succeeding crop (fodder jowar). The soil was rested for three months after the harvest of the first crop, and jowar seeds (six seeds per pot were sown). Tap water was used for the irrigation of the pots. A week after the germination of the seeds, the seedlings were thinned down to three per pot. The crop was harvested after two months. The yields from the different treatments showed that although the textile waste alone had an immediate deleterious effect on the crop, its effect on the subsequent crop was not adverse and was even beneficial to some extent. But its cumulative effect has to be ascertained by continued observation.

SUMMARY AND CONCLUSIONS

The experimental work briefly described above bring out a few points of interest which are particularly applicable under the conditions obtaining at certain industrial centres in India. For instance, at Ahmedabad, the textile trade effluent may be treated as indicated above and utilised along with the domestic sewage for crop production. The extensive land adjoining the present sewage farm there could be irrigated with the large volume of sewage and treated textile waste (over twenty million gallons a day), and sufficient quantities of sugarcane and fodder could be produced for maintaining a moderage-sized sugar factory and for maintaining a good dairy herd which would provide milk and other dairy products to the industrial town which is rapidly increasing in population.

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Radiographic Inspection in Industry

By A. C. Bhattacharya, A.M.I., Prod. E., Kanchrapara.

Specially contributed to "Journal of Industrial Engineering"

INVISIBLE flaws render every known engineering material thousands of times weaker than it will otherwise be. Apart from this, hidden imperfections like defects in castings, cracked forgings, etc., of semi-finished products are responsible in many cases for great production losses, wastage of man hours and resultant increase in manufacturing costs of such products. In the absence of any scientific means of deducting such flaws, the engineer and metallurgist of the past had to face considerable difficulties.

The difficulty was somewhat removed with the advent of X-ray radiographic inspection which provided the means to see the condition of the material below the surface and thereby led to the possibility of eliminating a high percentage of such losses as are caused by the machining of castings with blow holes or porous castings, the rolling of faulty billets and use of insecurely welded joints or cracked forgings in assemblies.

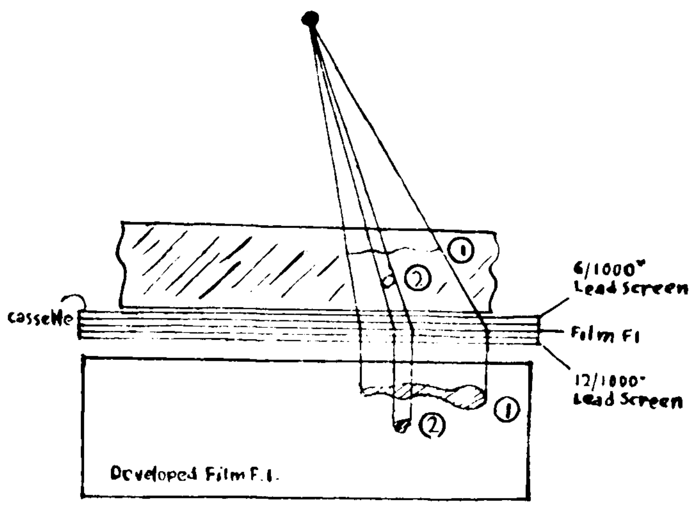
This method, at the preliminary stages, was extensively used for the routine inspection of wooden æroplane components for defective joints and of castings of relatively light section for internal defects. The most important feature of this kind of inspection is that it is a non-destructive test.

At the introductory stages, the method had certain limitations mainly arising out of the non-availability of apparatus capable of generating X-rays at voltages higher than about 100 kV. It was only with the advent of equipments having high continuous ratings at voltages as high as 400 kV, that the importance of X-ray examination became recognised in the industry. With the recent developments of X-ray equipments working on potentials of 1000 KV[3] and 2000 kV, its scope has widened further and full value realised to-day.

X-RAY EXAMINATION

The X-ray examination comprises two different systems. One is known as "Fluoroscopy" and the other is "Radiography". The first system employs a screen coated with a material such as zinc-cadmium-sulphide which fluoresces when excited by X-rays, making the image of the object thus visible. The examination is required to be carried out in a dark room and is applied when relatively coarse defects are being sought. This is mainly used for lower grade light alloy castings and for plastic assemblies, the apparatus forming a part of the assembly line inspection.

A new device, known as X-ray Image Intensifier, has recently been designed. This increases the brightness of a fluoroscopic X-ray image with the result that many of the existing limitations including the necessity for carrying out the inspection in a dark room, have been

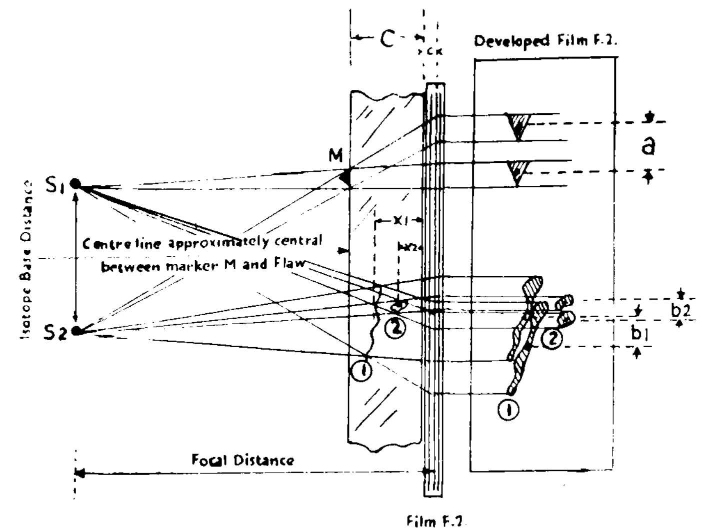


Diagramatic Sketch: set up of radiographic exposure

eliminated. Further the increased brilliancy has resulted in a substantially improved perception of faults and visual inspection of thicker objects. It has also made possible to work with lower output of the X-ray generator.

The mechanism of the device comprises a curved fluorescent screen in close contact with a photocathode mounted in an evacuated glass vessel. When the X-rays are received on this screen after passing through the object to be examined, the fluorescent radiations produced in it release electrons from the photocathode. The "electronic image" is reproduced on a reduced scale by the electric field between the photocathode and a perforated anode on a small viewing screen. Due to the high speed of the electron and the reduction in the size of the picture a very bright image is formed on the screen, which is observed through a simple microscope.

Besides visual inspection, photography of the produced image is also possible with an extremely low exposure times due to the increased brilliancy. In general the



DIAGRAMATIC SKETCH EXPLAINING RADIOGRAPHIC EXPOSURE

Image Intensifier offers important advantages for inspecting in daylight and provides for better fault recognition and dispenses with the necessity of taking pictures where the same is considered either expensive or taking too much time.

RADIOGRAPHY

When a permanent record of inspection is required to be kept, the X-ray image is recorded on the photographically sensitive material specially prepared as X-ray film thus producing a "radiagraph." Depending on the material and the kind of information required, either one of these two methods is selected.

Other than in case of light alloy and plastic specimens, it is possible to reduce the exposure time by exposing the film between intensifying screens consisting of either a thin layer of calcium tungstate or a very thin (0.004 in. - 0.006 in.) lead foil mounted on card. The lead intensifying screens are generally favoured to the salt intensifying screens in view of the fact that there is some amount of loss in image definition with the latter.

Following the exposure the photographic image is recorded permanently by carefully handling and processing of the films.

Unfortunately the application of X-rays to production inspection is possible only to a limited measure. Apart from the fact that an X-ray installation is expensive to operate and maintain, it generally requires a special building, incorporating a crane and other work handling devices to which the workpieces are brought for radiographic examination. Further it requires supply of outside energy and carries in its own system currents of high potentials requiring costly protective insulation and careful handling.

The above difficulties associated with the X-ray installation, led to the search by the engineers of some other source of electromagnetic radiations to replace X-rays. In about 1930, it became that gamma-rays arising from radium and radon also belonging to the electromagnetic spectrum and their wave-length range overlaps that of X-rays. The difference between the two is that whereas X-rays extend over a continuous range of wavelengths, gamma rays are emitted as linespectrum.

The initial results were no doubt very encouraging but this method had certain limitations too for which it could not make much headway either. The handling difficulties of the natural radio-active substances radium and radon associated with the high cost of radium restricted the use of this new technique to a few large enterprises only.

With the development of atomic research brought about by the exigencies of the Second World War, hundreds of radio-active isotopes have been made available to industry. These isotopes representing the peaceful uses of atomic energy in industry, are now being used in a number of manufacturing plants in U.S.A. to tabulate production, to measure the tolerances of precision parts, to determine the quality of machined products and castings, etc., apart from their varied medical uses.

GAMMA-RADIOGRAPHY

Several from amongst these large number of radio-active isotopes have proved very suitable to provide an economic source of gamma radiation. Their introduction into this field of applied science together with the availability of comparatively inexpensive and easy to operate equipment has made Gamma-radiagraphy a very widely accepted technique for the non-destructive inspection of materials.

Gamma rays have a penetration equivalent to that of the X-rays generated by 1- or 2- million volt units, which are more powerful than most of the equipment employed in industry at present. The equipment for handling the sources of gamma radiation can be made readily portable facilitating thereby the inspection of large workpieces at site.

The radio-active isotopes generally available for the purpose include cobalt—60, Iridium 192, tantalum—182, radium, radon. New additions to the range are Thulium—170 and Cæsium—137. The properties of these isotopes are given in the table below :—

Element	*Gamma energies in mega Electron volt.*	*Half life period.*
Radium	2.2, 1.8, 1.1, 0.6, 0.3 etc.	1600 years
Randon	2.2, 1.8, 1.1, 0.6, 0.3, etc.	3.85 days
Cobalt—60	1.3316 & 1.1715	4.95 years.
Iridium—192	.61, .60, .58, .29, .13	74.5 days.
Tantalum—182	1.1, 1.2	117 days.
Thulium—170	.084	127 days.
Cæsium—137	.66	33 years.

The half life of an isotope is the time in which the activity of the isotope is reduced to half its original value. The unit for measuring the activity of an isotope is the Curie, which is roughly equivalent to the strength of 1 gramme radium. To explain the half life further, it may be stated that a source of Iridium—192 of 1 Curie activity to-day will be reduced in its strength to 0.5 Curie after 74.5 days.

The exposure time in gamma-radiography is directly proportional to the strength of the isotope, and therefore with advancing decay of the source the exposure times are proportionately extended.

...n of a Welded Seam of a Boiler.

Cobalt—60 is the most popular isotope for most industrial applications at present. The gamma rays generated will penetrate metal sections up to 20 in. thick. Before its introduction, tantalum 182 was most widely used. Iridium—192 provides a degree of contrast similar to that obtained with the small industrial X-ray machines, and this isotope is therefore most frequently used for the inspection of metal sections up to 1½ in. thick. Radium has little to commend it in preference to cobalt—60 as a source of gamma-radiation being very expensive. The small half-life period of Radon restricts its use considerably although the smallness of the source provides virtually a spot focus.

Thulium—170 is successfully used for Aluminium from 0.25" to 1.25" thick and stainless steel from 24 gauge to ¾" thick. The range of thickness for Cæsium—137 is from 0.65" to 1.75" in steel. The greatest advantage in its use that it will not need renewal over very long periods having a half-life of 33 years.

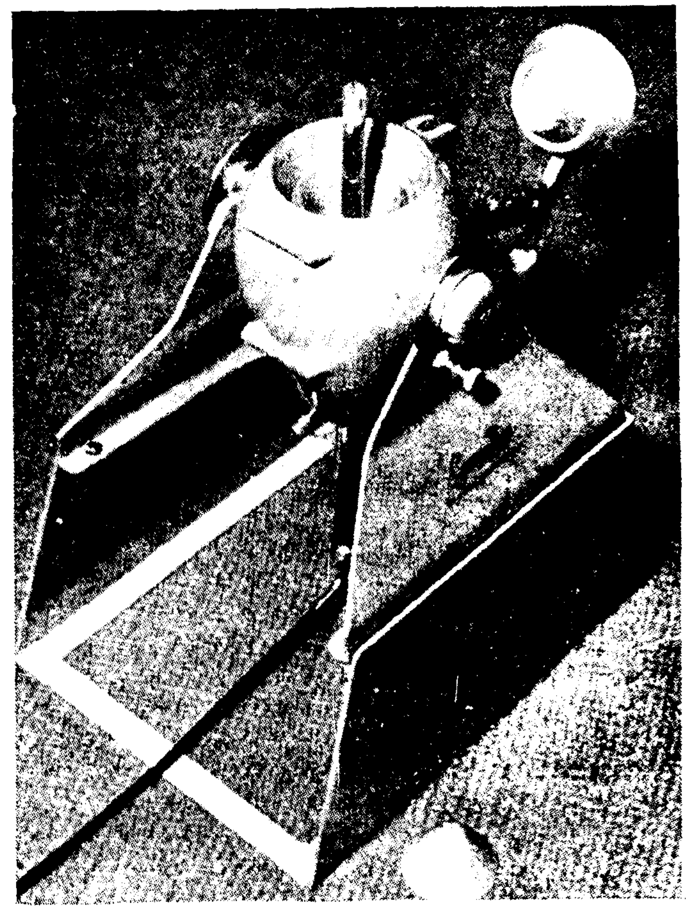
Arrangements of specimen and film for both gamma and X-ray radiographic exposure are almost the same excepting that in case of the former neither the salt intensifying screen nor the blocking arrangement is used. This blocking or obscuring of details near edges is not required due to the absence of scatter in Gamma—radiography where halation effects on films are negligible. It is therefore possible to radiograph widely different thicknesses in a single exposure.

DISTINGUISHABLE FEATURES

Among the distinguishable features which have made gamma—radiography and its equipment very popular are the low first cost, complete mobility and compactness, no external power supplies, safety to operators, low running costs and high resolving power.

The source of radiation in case of gamma-radiography is on isotope capsule. For protection of the operations and for exact control of exposure times the isotopes are contained in projectors. These are either containers of lead encased in bronze castings or tungsten containers into which the isotope capsules are fitted by means of isotope holders.

The only maintenance required for the gamma-ray equipment is the re-heating or replacement of the isotope itself. By re-heating, isotopes are generally brought back to originals strength. Moreover isotopes themselves



The Gamma-rays Machine with Remote Control for Panoramic Exposure.

are cheap. Dry batteries in the radiation control require however occasional replacement but expenditure on that score is also not much.

Another mentionable feature is that when the isotope holder is pushed forward, the isotope becomes fully exposed as a result of which gamma-rays are emitted in all directions into space. This makes panoramic exposure possible to facilitate the examination of batch work and circumferential welds in a single operation.

STEREO-RADIOGRAPHY

Stereo-radiography represents an important development of radiographic techniques as it provides the means of detecting the position of faults in the thickness of the examined specimen.

While it is possible to make stereo radiographic exposures with both X-rays and gamma-rays, it is with the former that the technique becomes very complicated.

The principle involved is as shown in the diagramatic sketch reproduced elsewhere. If two gamma-ray sources (S1 and S2) are used simultaneously at a distance from the material under test, with the suspected area reasonably central, twin pictures both of the faults 1 and 2 of the marker M will be obtained on the radiographic film and the depth of the flaw in the specimen ascertained by simple trigonometry, applying the law of similar triangles as indicated below :—

$$\text{Depth of flaw 1}: \quad X_1 = \frac{b_1}{a}(C + c) - C$$

$$\text{Depth of flaw 2}: \quad X_2 = \frac{b_2}{a}(C + c) - C$$

The two sources used are normally of different strengths, but if they are of equal strengths one is shut off before the other, in order to ensure that the picture is not overcrowded with flaw pictures of equal contrast.

INDUSTRIAL USES OF RADIOGRAPHY

Radiography has made a considerable impact on methods of non-destructive examination of workpieces. In the field of inspection of welds, an indication of its value is revealed by the fact that following its introduction, the percentage of welds on German railway bridges requiring repair fell from 15 per cent to 1.5 per cent within a year. Apart from this, its value in attaining and maintaining a high standard of welding is more than recognised to-day. Random checks on routine welds afford an opportunity to bring into light the faulty workmanship and subsequent adoption of correct technique by the operator.

In addition to routine inspection, it has a very wide scope in welding research as well. An investigation made by Sack on the metal drop formation in the electric welding are may be quoted as an instance in point. This investigation revealed that when using coated welding rods, the metal drop does not fall until it has attained the diameter of the rod coating.

In the inspection of castings, radiography plays no less an important part. It has to-day eliminated the waste resulting from machining the faulty castings. Detection of shrinkage defects, blow holes etc. is easily possible with this method. In addition to this, the method reveals those defects which may not be found

Radiographic Examination of Small Workpieces

while machining but which might lead to failure of the casting in service.

The technique is also applied extensively in foundry control as a means of improving the quality of the castings. In this case it is employed for inspecting pilot castings so that the foundry technique may be altered where necessary for producing satisfactory castings before embarking on bulk production.

Radiography is by no means limited to the examination of welds and castings, but has also been put to manifold uses such as detection of faults in forgings and billets, moulded products of hard rubber, wood and plastics, insulating material, electrical condensers and cables, rubber tyres, aircraft and automobile parts and food, in wireless valves, etc.

It may thus be realised that in industry and research, the applications of radiography are extremely diverse and numerous. The tremendous scope offered by this technique, when fully taken advantage of, will eliminate a number of losses to the betterment of engineering as a whole.

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POWER STATION ON THE SEA

Construction of a 10,000 kw. steam-turbine power station is nearing completion in the Caspian, 100 km. from the shore. The station will supply power to the Baku off-shore oil-fields. These oil-fields have been built on steel trestles whose total length tops 100 km.

The structures erected there, apart from the oil derricks, include blocks of well-appointed houses, a House of Culture, two libraries, shops, dining-halls and other utility-service and cultural establishments. Trestle bridges connecting the oil-fields with the shore are heavy with traffic, and many ships moor at their landing stages. A whole archipelago of steel islets for boring wells has appeared out on the sides of main trestle highways.

Until recently the oil-fields have been receiving electricity from diesel units. The new power-station will make the off-shore Caspian oil-fields' power supply much cheaper.

Rubber as a Stress-carrying Material and Some Design Considerations

By S. W. Marsh, A.M.I.Loco.E.

INTRODUCTION

RUBBER as a stress-carrying material is being increasingly used in the engineering industry at the present time, and many designers find that problems which once could only be solved by the use of relatively complicated mechanical devices can now be overcome more simply by using rubber. This paper is intended to give some indication of the mechanical properties of rubber, its behaviour under stress and, what is just as important, some of its shortcomings. It is not intended to refer more than is necessary to the compoundings of rubber as this is the sphere of the chemist more than of the engineer. It is a subject in itself and its many aspects are dealt with fairly thoroughly in the literature already available.

Until a comparatively short time ago the use of rubber in engineering applications was rather restricted, and it was only prior to and during the last war that a real attempt was made to use to full advantage the properties peculiar to rubber. The development of methods for the bonding of rubber to metal opened up entirely new fields and made possible the use of rubber in hitherto unknown capacities. The provision of standardized specifications for rubber is still far from being satisfactory, and, while the engineer would undoubtedly welcome any move to bring rubber into line with other constructional materials, it is uncertain when this will be achieved.

STANDARDIZATION

There is, however, an attempt on the part of some rubber manufacturers to cut down the number of mixings in their own Works and to standardize on a number of qualities for specific applications. So far little on a national scale has been done, although a measure of standardization has been achieved by the Admiralty and certain other Government departments working in conjunction with official rubber committees, for example, T.G. 25A. A number of the larger engineering companies are now trying to safeguard themselves against variations in supplies by laying down a number of physical tests to which rubber mouldings and bonded units must conform. These normally specify minimum tensile strength, minimum elongation under a given load, maximum compression set or recovery under given conditions, and in certain cases where the rubber is to be in contact with oil or other swelling agents the maximum permissible increase in volume for time of immersion at a fixed temperature. These tests may be based on the United States standards as laid down in the American Society for Testing Materials Proceedings, or on those specified by the British Standards Institution. It is desirable, however, for the rubber chemist to be able to compound his materials to suit individual applications as an engineer may meet with a set of conditions outside the normal and it is of undoubted advantage to be able to make the material meet the conditions rather than have to try and alter the conditions to suit available materials.

There are other factors which make the standardization of rubber qualities a difficult problem. For some reason or reasons which would appear to defy logical explanation a rubber mix of identical constituents, compounded and cured under apparently the same conditions in two different factories, sometimes shows considerable variations in the physical characteristics of the vulcanized product. Conversely, to produce rubber mixes with the same physical properties from the Works of different manufacturers it may be necessary to vary details of

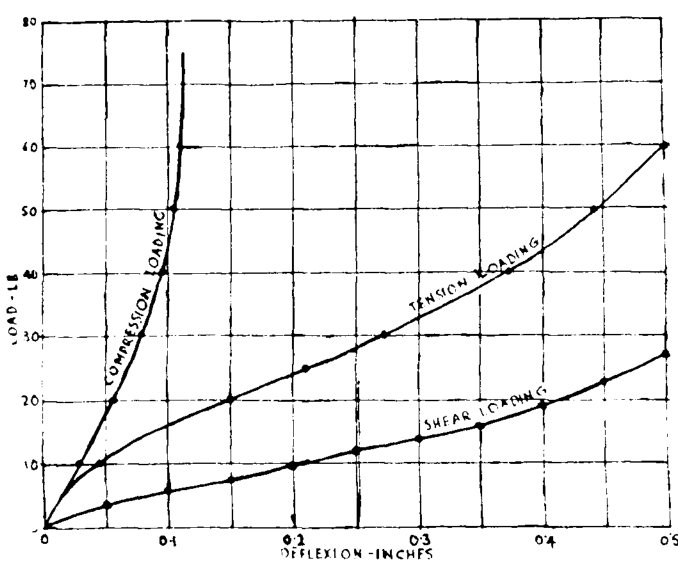

Fig. 1—Typical stress/strain curves for rubber.

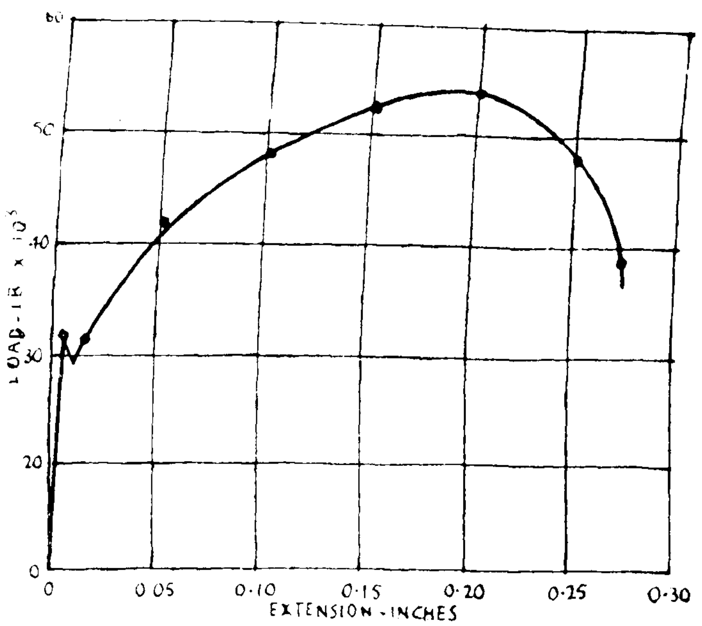

Fig. 2.—Typical stress/strain curve for steel.

compounding; in the same way the modulus values for rubbers of a given hardness may vary between one manufacturer and another. The question of relationship between hardness and modulus is more fully dealt with in a later section of this paper.

PHYSICAL PROPERTIES

Before discussing the general physical properties of rubber compounds it might be as well at this point to make clear a matter which, while it may seem elementary, does not seem to be fully appreciated by a surprisingly large number of engineers. Rubber in its raw state has little physical strength, is more plastic than elastic and is very sensitive to changes in temperature. Compounding ingredients are added, primarily to bring about vulcanization, to increase elasticity, to augment tensile strength, to increase resistance to abrasion, and so on. Vulcanization is brought about by the application of heat to rubber compounds containing proportions of sulphur, organic accelerators and other specific ingredients, all of which play their part in the vulcanizing reaction.

For the production of moulded natural rubber, synthetic rubber or bonded parts, the elastomer is usually contained in mild steel dies or moulds which are closed under hydraulic pressure and heat applied by means of steam-heated plattens, which are an integral part of the vulcanizing press.

The time and temperature of vulcanization, or cure, have to be carefully adjusted to the volume and reactivity of the particular rubber mixing being handled. Vulcanizing conditions govern to a large extent the ultimate physical properties of the vulcanizate, and close control is, therefore, of great importance.

Rubber, in its physical behaviour differs very much from the more orthodox engineering materials. This can, perhaps, be most clearly demonstrated by reference to a typical stress/strain curve for rubber and comparing it with a corresponding curve for steel (see Figs. 1 and 2. It will be noted first of all that rubber has no yield point in the accepted sense of the word. It will be seen, too, that nowhere does the curve become a straight line and that the modulus, to all intents and purposes, varies continuously with the applied stress. At the lower end of the curve, however, up to approximately 25 per cent. deflexion on the original dimensions, the modulus is fairly constant, and in the great majority of practical applications, fortunately, deflexions do not exceed this figure. Modulus curves for rubber qualities stressed in shear, tension and compression are shown on Figs. 3*a*, 3*b* and 3*c*. The rubber qualities are the same as those giving the stress/strain curves shown on Fig. 2. Average modulus values for good quality rubbers, such as would be used as dynamic applications, are given in Table I.

TABLE I

AVERAGE MODULUS VALUES FOR GOOD QUALITY RUBBERS

Rubber quality	*Shore hardness*	*Average modulus values in lb. per sq. in.*	
		Compression modulus	*Shear modulus*
A.D.4	38/42	270–280	80–85
A.D.16	50/54	365–385	105–115
A.D.24	58/63	540–560	125–140
A.D.30	67/71	740–760	185–195
A.D.36	77/81	1,000–1,300	270–290
D.Q.6	56/60	450/470	100–110

The term modulus, of course, refers to "Young's Modulus of Elasticity" and not to the "modulus" often used by the rubber chemist to denote the load required to stretch a piece of rubber of known section to a given percentage of its original dimensions, for example, 600 lb. at 300 per cent. This latter term is in common use in the rubber industry and may prove to be very misleading to the uninitiated.

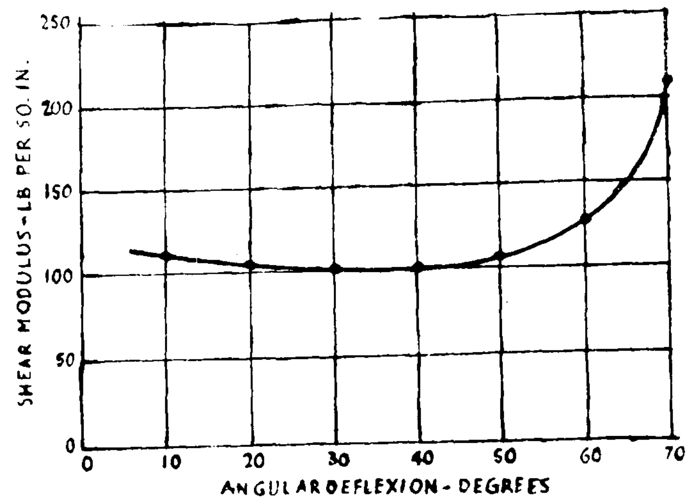

Fig. 3a.—Modulus curve—Shear.

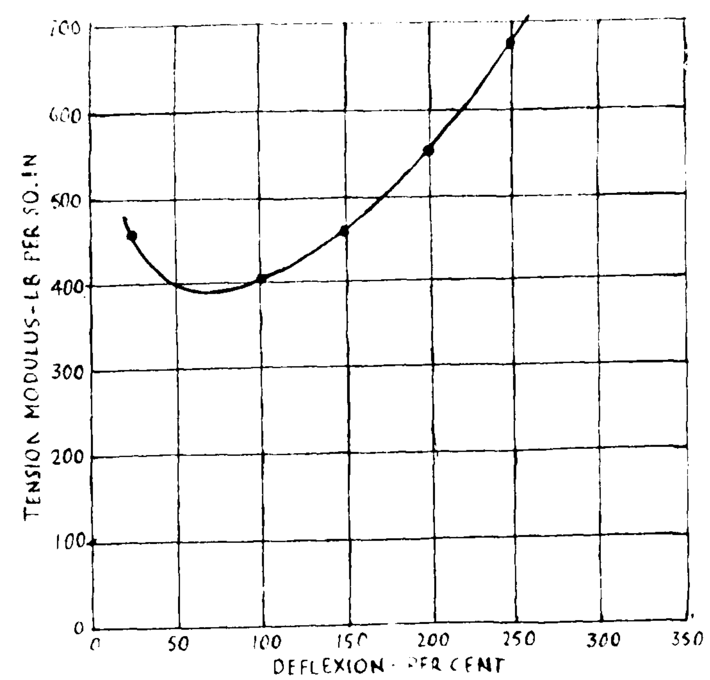

Fig. 3b.—Modulus curve—Tension.

HARDNESS MEASUREMENT

Rubber qualities are often specified in terms of their hardness value. There are a number of different hardness measuring instruments in use, but the most common in this country are the "Shore Durometer" and the "B.S.I. Hardness Tester." The "Shore Durometer" is probably the most widely used but suffers from the disadvantage that it is rather inaccurate and difficult to calibrate satisfactorily. In the hands of an inexperienced operator very misleading results can be obtained. The "B.S.I." instrument, on the other hand, operating on the dead weight principle, is more accurate and its use in Britain is becoming increasingly common. A hand-type "B.S.I." instrument is also available. While hardness may influence to some extent the general physical properties of a rubber, it is important to realize that there is no direct relationship between "hardness" and other properties, such as "modulus." The modulus of any specific rubber is entirely dependent on the compounding of the mix and two rubbers of the same hardness may have entirely different modulus values. This is demonstrated in Fig. 4, where the stress/strain curves for four rubber mixes, having the same hardness values but different moduli, are shown.

Curve "A" shows the stress/strain curve for a rubber compounded to give high resilience. This mix has a relatively high content of raw rubber to the other compounding ingredients.

Curves "B1" and "B2" show stress/strain curves for rubbers compounded to show high tensile strength, and maximum resistance to abrasion. This type of mix has a lower content of rubber than that for curve "A" but has a higher content of reinforcing carbon blacks. These curves demonstrate too that the modulus can vary even in compounds destined for similar applications. Curve "C" is that of a rubber compounded on a low cost basis. Its tensile strength is not high and it has a low hydrocarbon content consisting mainly of reclaimed rubber diluted with inert fillers.

USES OF RUBBER

In designing a rubber unit which is to function under conditions of stress, the following points have to be considered :—

(a) Before any consideration can be given to the use of rubber, the condition of service must be considered, such factors as temperature to which the unit will be subjected and the likelihood of the rubber being in contact with oils, etc., etc.

(b) Space available for the fitting of a unit and consideration as to whether sufficient rubber can be employed to carry the loads, under permissible conditions.

(c) Whether to use the rubber in compression or shear or both.

(d) Stress changes likely to occur from dynamic loading.

(e) Ease of moulding and mould design generally.

Rubber is best used as a stress-carrying medium either in a unit made on the "pre-stressed rubber

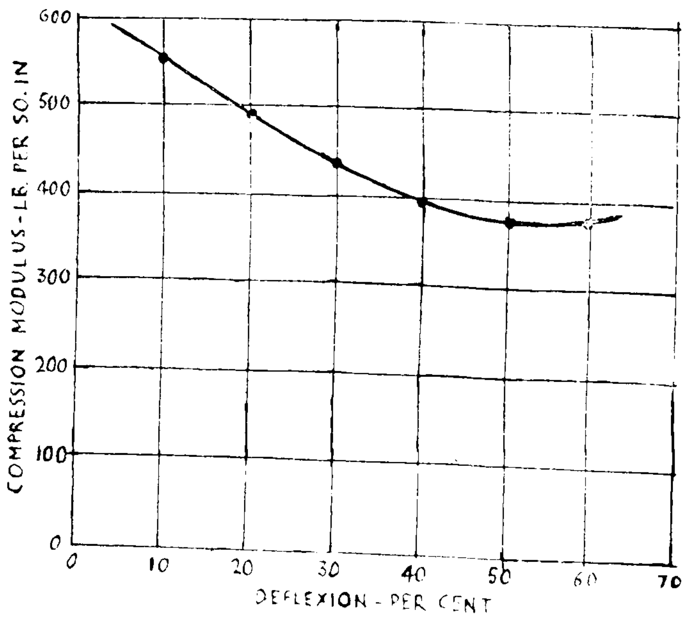

Fig. 3c.—Modulus curve—Compression.

principle" or in a component of "Bonded" type. A unit using "pre-stressed rubber" is typified in the "Silentbloc" bush. It comprises inner and outer metal sleeves with the rubber in a stretched condition between them. The rubber component is moulded in the form of a bush, and when assembled between the sleeves is considerably extended in its original dimensions. The rubber is held in position by the frictional resistance between the rubber and the metal parts and it is found that if the outer sleeve is removed the rubber rolls back to its original dimensions, as moulded. The accompanying diagram (Fig. 5) shows a "Silentbloc" rubber in its free moulded condition alongside an assembly containing the same rubber unit. Anti-vibration mountings for carrying machinery and other equipment are made on the same principle, but the design of assemblies using rubber in this way is restricted to the basic form of construction described above.

In a bonded unit the rubber is firmly anchored to the metal parts, and the design is not subject to the same restrictions imposed on the pre-stressed form of construction. A variety of bonding techniques may be used, including brass plating the metal parts, or using proprietory bonding cements. There is a wide divergency of opinion as to which is the better method, but practical experience of both methods seems to indicate that for most engineering units where high bond stresses are likely to be encountered the brass plating method gives superior results. The bond obtained in this way is non-thermoplastic. It will be well perhaps to point out here that the bond between the rubber and the metal takes place during the vulcanization process.

Very careful process control is necessary when rubber is to be bonded to metal; under commercial operating conditions bonds having a strength of 1,000 lb. per sq. in. in tension can be obtained, while an average value of 700 to 800 lb. per sq. in. on test can be relied upon.

When using bonded units the most common method of carrying load is by placing the rubber either in compression or in shear. Rubber functioning in tension is seldom employed in general engineering practice and is confined to a few specialized applications of theoretical rather than practical value.

There are two different schools of thought on the use of rubber in compression and shear. It is claimed for rubber used under conditions of shear, that greater deflexions can be obtained than with rubber used in compression. Against this, however, a greater area of rubber for a given load must be used as the unit loadings which can be carried by rubber in shear are much lower than those allowable with rubber in compression. It was claimed for rubber used in shear that sound isolation of machinery could be achieved much more effectively, but it has been shown that equally effective noise reduction can be obtained with well-designed compression mountings.

There is little doubt that the use of rubber in compression offers many advantages. Used in this way, much higher loadings can be supported for a given effective area of rubber. Another point in favour of the compression unit is, that in the possible event of bond failure the unit can usually continue to function, whereas in shear mounting the bond has to be relied on completely, and any failure would mean complete breakdown of the unit. While present-day rubber-to-metal bonds have reached a very high degree of consistency there may be a doubt at the back of the engineer's mind, particularly when failure means stoppage of production equipment. Safety devices can, of course, be incorporated in the design, but they usually complicate matters and increase cost. The same remarks which apply to units used in shear apply when the rubber is used under conditions of pure torsion.

The unit loading which can be applied to a rubber section functioning in compression, shear or torsion depends, to a large extent, on the nature of the application, where there is likely to be variation in stress in the rubber, or whether it will be subject to stress variations over a wide range.

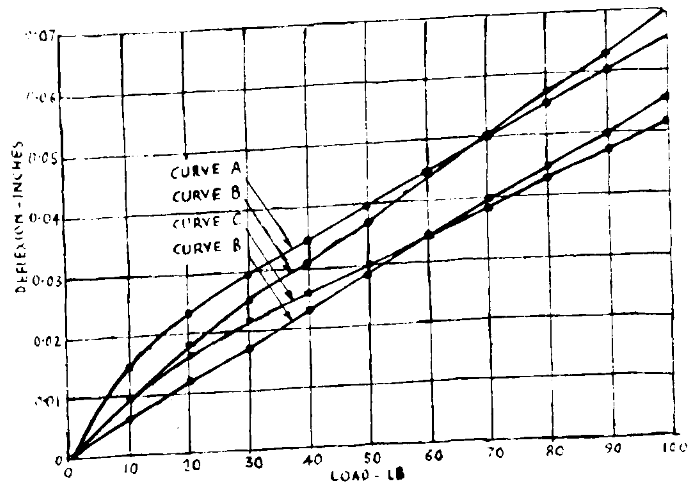

Fig. 4. Stress/strain curves for four different rubber mixes.

Using rubber in shear the maximum permissible stress consistent with reasonable life in service of the unit, is of the order of 55 to 60 lb. per sq. in. and where conditions are likely to be arduous calling for continuous flexing of the section 30 to 35 lb per sq. in. is a safer figure to work to. These figures may appear very low in relation to the ultimate strength of the rubber, but they are based on results obtained over a wide variety of applications. In some articles published in the United States of America higher stress figures are quoted for applications which are stated to have been thoroughly tested in service, but the author has not corroborated the figures quoted, and would feel apprehensive of any design based on them.

Using rubber in compression, however, stresses up to 500 lb. per sq. in. are permissible for normal applications, and loadings up to one ton per sq. in. can be dealt with as shock or momentary loads without fear of failure. Even higher stresses have been applied without apparent detrimental effect upon the rubber, but at loadings of over 500 lb. per sq. in. the effects of permanent set may become pronounced under continuously applied loads.

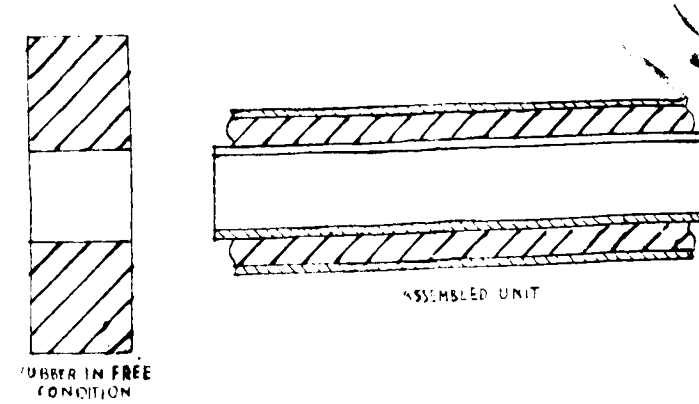

Fig. 5. A pre-stressed rubber component before and after assembly.

RUBBER BONDING

Fig. 6 shows a rubber-to-metal bonded sandwich subjected to a shear loading. For normal applications the value of "θ" should not exceed 15° to 30° with a maximum value under shock conditions of 30°. The actual linear deflexion of one plate relative to the other can be obtained from the expression :—

$$d = t \tan \theta \text{ inches}$$

"t" being the thickness of the rubber section in inches.

The following formula gives the angular deflection for a given section and is reliable up to a value of $\theta = 30°$. Over this figure the combined tension shear effect becomes more marked, and the formula becomes unreliable.

$$\theta = \frac{57.3F}{AS} \text{ deg.}$$

where θ = angular deflexion in degrees.
,, A = cross-sectional area of the rubber in square inches.
,, S = shear modulus of the rubber in lb. per sq. in.
,, F = the applied load in pounds.

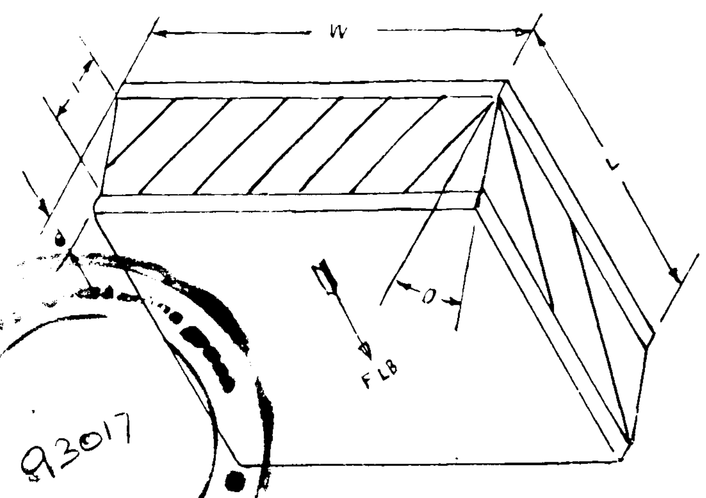

Fig. 6. Rubber-to-metal bonded sandwich.

Fig. 7 shows a circular bonded sandwich subjected to a torque loading, and here the value of "θ" should not exceed 10° to 15°. This is to a certain extent controlled by the thickness of the rubber, and the angle B, between the two plates along the axis of the sandwich, should not exceed 30°. The formula for the value of "θ" is in this case :—

$$\theta = \frac{583Tl}{N(D^4 - d^4)} \text{ deg.}$$

where θ = deflexion in degrees.
,, T = the applied torque in.-lb.

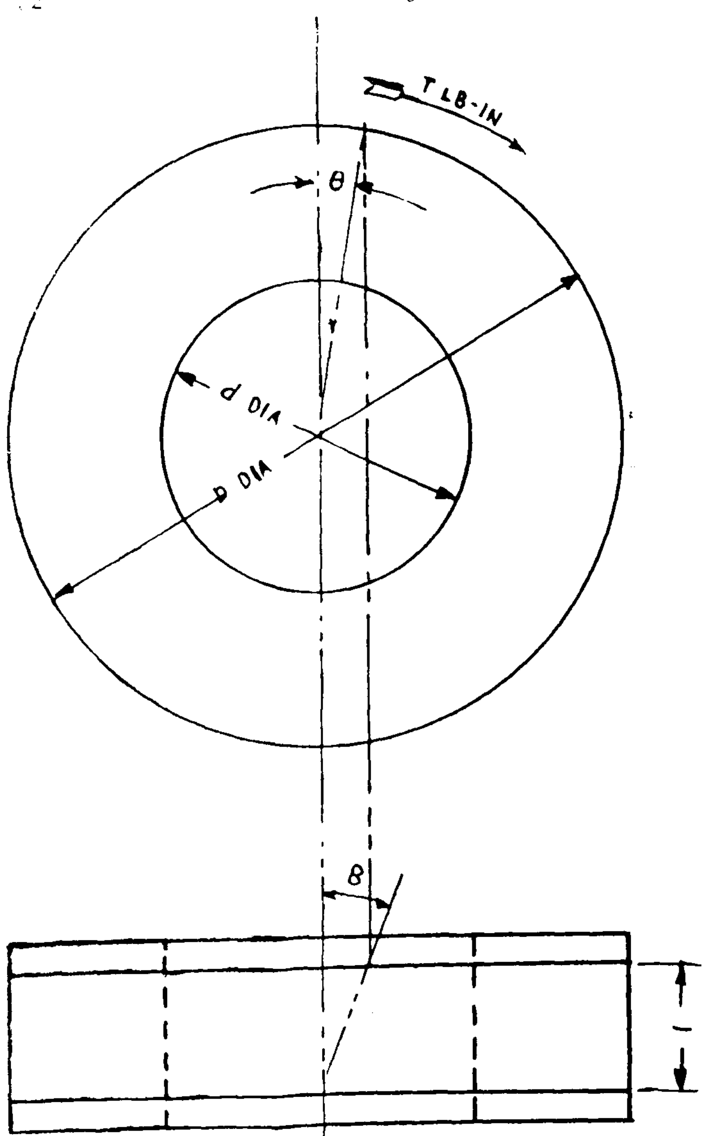

Fig. 7. Circular bonded sandwich.

where l = the thickness of the rubber section in inches.

,, N = the shear modulus in lb. per sq. in.

,, D = the outside diameter of the rubber in inches.

,, d = the inside diameter of the rubber in inches.

The torsional stiffness of the section is given by :—

$$C = \frac{\pi . N(D^4 - d^4)}{32l} \text{ in.-lb. per radian.}$$

where N = the shear modulus of the rubber.

,, D = outside diameter of section in inches.

,, d = inside diameter of section in inches.

,, l = thickness of section in inches.

,, C = torsional rigidity in in.-lb. per radian.

PERMISSIBLE DEFLEXION

The allowance deflexion of a rubber unit under compressive loading is rather more difficult to define, but is best expressed in terms of percentage deformation on original dimensions. In practice a deflexion of 15 to 20 per cent. maximum forms a good basis for calculation, though under shock conditions this figure can be exceeded. It will be remembered that earlier in the paper mention was made of the fact that above 25 per cent. deflexion the "modulus" value became more inconsistant; moreover, swelling of the rubber increases the effective area resisting the load. Both these factors combine to cause "hardening" of the rubber and result in a rapid increase in the slope of the load-deflexion curve.

The following formula gives a reasonably accurate forecast of deflexion up to 25 per cent. :—

$$d = \frac{Ft^2}{AEQ} \text{ inches.}$$

where d = deflexion in inches.

,, F = the applied load in pounds.

,, t = the free thickness of the rubber section.

,, A = the cross-sectional area of the rubber in square inches.

,, E = the compression modulus in lb. per. sq. in.

"Q" is an empirical value based on practical observation of results and might be termed a "shape" factor. Its value is :—

(a) For a rectangular sandwich, the length of the shortest side in inches.

(b) For a circular sandwich, the diameter in inches.

(c) For a circular sandwich with a hole at its centre, the difference between the outside and inside diameters in inches.

The ratio $Q : t$ should not exceed 5 : 1.

Very careful consideration has to be given to the stress range over which the rubber is expected to work, as this has a considerable bearing on the life which can be expected from the unit. One condition under which rubber does not give satisfactory results is a combination of relatively high deflexion with rapid oscillatory motion, or again over a wide range of rapidly varying stresses. A rubber oscillated at speed with a high degree of deflexion tends to build up heat internally due to hysteresis losses in the rubber, and in extreme cases the heat

build up may be so great that a blow-out will occur. This can best be explained by referring to some actual applications in which trouble has been experienced due to working under conditions similar to those outlined above.

APPLICATIONS

In the development of solid tyres for tracked fighting vehicles during the early part of the war, a great deal of trouble was experienced due to heat build up in the tyre. These vehicles were operating at tyre loadings and road speeds which were much higher, than anything

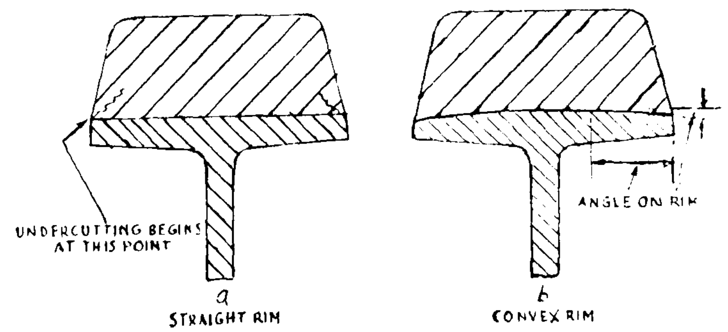

Fig. 8. Wheel rim design.

previously experienced on solid tyred vehicles. The difficulties experienced were eventually overcome to a large extent by the rubber chemists who produced improved tyre stocks having low hysteresis losses. It was also found that there was a maximum value for the load per inch width of tyre face which could not be exceeded with safety.

Another type of failure that was encountered fairly frequently was undercutting of the rubber tread under running conditions. Here failure commenced at the extreme edge of the wheel rim and developed rapidly into a cut running inwards and upwards towards the centre of the tyre. This was overcome by carrying out extensive experiments on the design of the wheel rim itself. The rim shape which gave the best results was found to be convex, and practically eliminated undercutting under controlled load conditions. The type of rim which gave undercutting and the convex rim are illustrated in Figs. 8*a* and *b*.

Another unit which failed due to rapid stress variation and high deflexion was the bonded shear mounting used on oscillation screens for coal cleaning. Here the screen was mounted at four points on rubber sandwich-type mountings and was oscillated on them. The top plate of the sandwich was attached to the screen and moved with it, while the bottom plate was attached to the supporting framework and remained stationary. On paper the stress in the rubber section was well within safe limits, as was the deflexion, but the life in service was found to be very short due to failures commencing close to the bonding surface. The failure in this case could have been overcome by increasing the thickness of the rubber section, thus decreasing the value of "Q" the angle of deflexion, but this in turn rendered the screen unstable and produced a marked tendency for it to bounce when run up to operating speeds. It was found that when the screen was oscillated in a free unloaded condition, failure still occurred after only a very short period of running.

On the other hand, it has been found that a bush of the "Silentbloc" type, or a bush of similar design in which the rubber is bonded to the inner and outer sleeves, instead of being stretched into position, can give prolonged service life. A good example is the automobile spring shackle bush. Here the outer sleeve is held in the spring eye while the inner is anchored to the shackle pin, and due to spring movement the inner and outer move relative to one another rotationally. On oscillation tests it was found that there was little difference between the bonded bush and the bush using "pre-stressed" rubber, so far as performance was concerned. One type of bush was oscillated through an included angle of 30°, 15° each side of the neutral position, while carrying a radial load of 900 lb., which was equivalent to between 500 and 600 lb. per sq. in. on the projected area of the inner sleeve.

Bushes run under these conditions showed no signs of failure after many hours of continuous oscillation, equivalent to approximately 50,000 miles service in the road springs of a motor vehicle, and all the time they operated under extreme conditions of load and deflexion. In this instance the type of rubber used and the design of the rubber unit were important factors, as was the case with solid tyres. It was found that, to eliminate the same type of undercutting as was experienced with tyres, stress concentrations at the extreme edges of the bond had to be eliminated. This was done by relieving the stresses on the rubber at this point by modification to design as shown on Fig. 9. Figs. 10 and 11, Plate 1, and Figs. 12, 13, and 14 Plate 2, show four different causes of bond failure and may be of some interest.

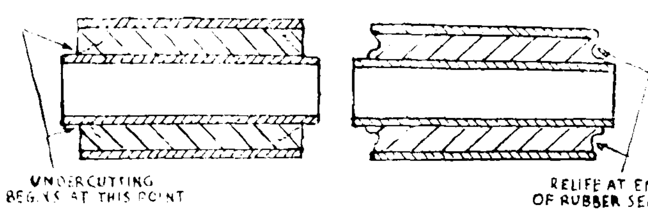

Fig. 9. Automobile spring shackle bush.

The fault in Fig. 10, Plate 1, was traced to porosity in the surface metal. Non-adhesion of the brass to the metal often accompanies this fault and is evident in the sample, although only to a small degree.

PLATE 1

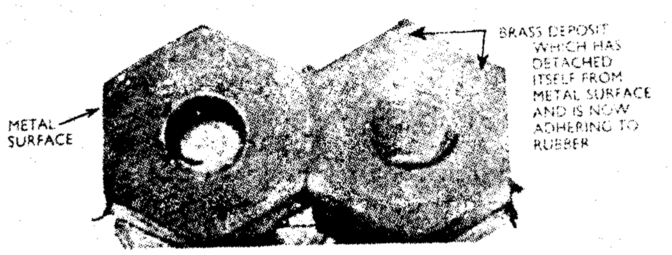

Fig. 10. Bonding Failure due to Porosity of the Metal Surface.

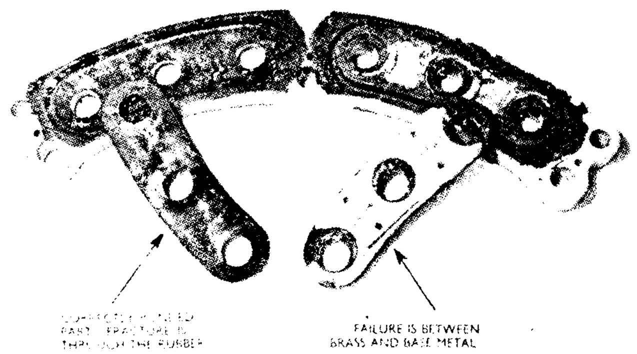

Fig. 11. An Example of Failure between Brass and Base Metal.

Fig. 11, Plate 1, illustrates a chronic case of loose brass. All the brass has come away on the rubber. Loose brass can arise, in addition to the case as shown in Fig. 10, Plate 1, when the metal surface has not been completely freed of grease, scale and other impurities or if the current density at which the article is plated is too high.

In Figs. 12 and 13, Plate 2, the brass has been deposited on a clean surface but is not of the correct composition. The rubber, therefore, has peeled away from the brass. Such a failure can also arise from a substandard cement being used or a cement which has not been properly applied.

In Fig. 14, Plate 2, failure has occurred between the cement and the rubber. This is usually due to the thin layer of cement curing before the large mass of rubber settles down and is vulcanized.

Another instance of a rubber component subjected to continuous oscillation under load is the anti-vibration mounting. These will give prolonged life in service, but here the oscillations, though sometimes rapid, are usually of small amplitude. It will be seen, therefore, that in any unit subjected to dynamic stresses, variation in direction and amount of deflexion should be kept to a minimum, and in no circumstances should exceed the values given earlier in this paper.

Neglecting the initial stress due to static loading, it has been found that rubber working over a stress range of from 20 lb. per sq. in. to 35 lb. per sq. in. will give an infinitely longer life in service than one working over a range of from 20 lb. per sq. in. to 50 lb. per sq. in. The dynamic modulus of rubber as with other materials differs from the static modulus and while it is impossible to give exact values, as the modulus varies with the speed and amplitude of vibration, an average value for dynamic modulus is from 2.5 to 3 times the value of the static modulus.

In the design of any rubber section, particularly in a bonded unit, there are a number of things which should be avoided as far as possible. Possibly the most important is the elimination of sharp corners at the edges of bonding areas, and all projecting lips on metal parts. It is at sharp corners and points of high local stress concentration that failures commence, and on projecting lips there is always a danger of the rubber doubling over when distorted under load and consequently cutting or tearing at these points. Wherever possible trapping of the rubber, when being compressed, should be avoided. It should be allowed to distort freely and take up its natural contours under load. Rubber is for all practical purposes incompressible and any tendency to trap the rubber and restrict its free movement will upset the calculated deflexion of the section. There are, of course, applications in which the incompressibility of rubber can be used to advantage. For example, a sealing strip or ring can be designed so as to give a small initial deflexion and can then be trapped in a channel section or other form of groove. To render the seal effective, however, the small initial deflexion is an essential feature, as otherwise very poor sealing qualities would result.

Another bad feature of design which can, in many cases, give trouble is the inclusion of acute angles in the rubber section. For example, a rectangular or triangular hole will tend to crease at the corners when the rubber is distorted, giving high concentrations of stress at these points which will in time cause the rubber to tear. As far as possible, smooth contours on internal or external surfaces should be aimed at.

PLATE 2

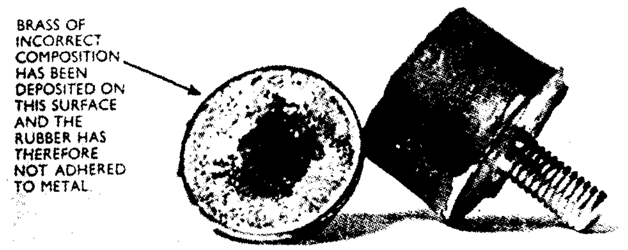

Fig. 12. Bonding Failure due to Incorrect Brass Composition.

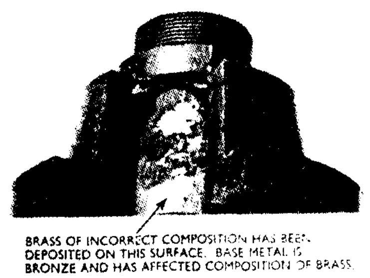

Fig. 13. Another Example of Failure Caused by using Brass of Incorrect Composition.

Fig. 14. Failure between Cement and Rubber.

In the design of bonded units, so far as ease of moulding is concerned, the primary object should be to concentrate on simplicity of form; complicated forms require complicated moulding equipment, and in very few cases are really complex shapes justified in the light of subsequent performance. Complicated contours, particularly on internal surfaces, may mean loose parts or inserts in the mould, and, not only do these increase the handling problems in the press shop and increase the likelihood of accidental damage, but they are expensive to produce. It should always be borne in mind that moulds have to be handled at temperatures around 300° F., and the operators wear heavy insulating gloves. These circumstances indicate why it is desirable to avoid complicated and intricate moulding equipment. Simple moulds, also, lend themselves more readily to mechanical methods of handling and stripping which in large quantity production has obvious economical advantages. The same remarks regarding complicated forms apply to metal parts which have to be accommodated in the mould. The fact that these have to be accurately made within specified tolerances on locating dimensions is a point which often does not seem to be fully appreciated by engineers. The greater the tolerances on the dimensions of the metal parts, the greater must be the clearances in the mould to receive them, and any gaps between the mould and the metal parts will fill with rubber during moulding. Accurately made metal parts greatly assist the rubber manufacturer and in the long run provide the engineer with a cleaner and cheaper finished article.

Where the rubber phase is concerned, it is advisable to maintain a uniformly thick section as far as is possible. In a unit which combines thick and thin sections there is a tendency for the rubber to be in different states of cure throughout. The thin section may be fully cured before the thick, or if the thick section is fully cured the thin may be heavily over-cured.

SYNTHETIC RUBBERS

So far no mention has been made of the various types of synthetic rubbers which are available to the engineer. Generally speaking these synthetic rubbers do not possess the load-carrying capacity of natural rubbers, especially under dynamic conditions. Certain types of synthetic rubbers on a basis of static tests have physical characteristics which compare very favourably with natural rubbers, but when subjected to dynamic stresses they do not stand up so well. They suffer from the defect of having a higher permanent set, and mountings made from synthetic rubber show under load a tendency to settle over a period of time. There is no doubt, however, that they form a useful and most essential addition to the range of rubbers available to the engineer. Their resistance to swelling in oils and their ability to retain their physical properties at higher temperatures are well in advance of what is obtained from natural rubber compounds. They are also most useful to the chemical engineer for lining tanks and other equipment, owing to their ability to withstand the action of a wide range of chemicals at relatively high temperatures for prolonged periods. Oil seals made in synthetic rubber can give long and satisfactory life.

APPLICATIONS CLASSIFIED

With regard to the wider application of rubber in engineering one can only generalize as space does not permit to go fully into every aspect. I would, however, like to mention one or two applications and in doing so suggest dividing them into the following classes :—

Rail Transport	Road Transport
Aircraft	General Engineering

Rail Transport. Papers and even books have been published dealing with the use of rubber in rail transport, the foremost of them being Sanders' Miscellany of Springs, Volume 1, which gives one complete chapter to rubber.

As is generally known, rubber springs for buffers, drawgear and auxiliary suspension have been used on the railways for many years and are still considered by many as the best means of shock absorption; but rubber is now taking a more prominent place as a means of mounting auxiliary machines in the under-frame to insulate the body from vibrational shocks and, in the case of motor coaches, to mount instruments in the body, and for resilient gear wheels, also for mounting such machines as compressors, exhausters, dynamotors, M.G. sets, H.T. frames and alternators. Serious thought is now being given to the use of rubber in centre pivot and resilient road wheels.

Road Transport. Most engines are now mounted on rubber units. Rubber is also used, incorporated in spring bushes, front suspension bushes, suspension springs, propellor shafts, and in body mountings, amongst other projects. Rubber is now being tried out as a resilient element in clutch plates and in starter units.

Aircraft. Many complicated details are now made in rubber, or bonded rubber, such as engine mountings, instrument mountings, magneto couplings, starter couplings, radiator mountings, tank mountings, rudder buffers, air seals, oil seals, special rollers for supporting controls, snow guards, and so on.

General Engineering. The rubber industry is being called upon more and more every year to mount machines on rubber in order to damp out vibration and reduce noise. Mountings can be adapted or designed to function either in compression or shear, depending on the application, to deal with loads ranging from ounces to hundreds of tons.

Research is being carried out even now on the use of rubber for insulating buildings against shock impulses emanating from forging hammers and power presses.

Rubber has by no means reached anything like its full state of development and application and can still be regarded as being in its infancy compared to the more orthodox engineering materials. Continual development is taking place within the rubber industry and the outcome of these investigations should be more and more reliable compounds. Present-day rubbers as a known quantity are far in advance of those produced even ten years ago, and in another decade there is no doubt that even greater developments will have taken place. In some spheres rubber is already an accepted medium for the absorption of vibration particularly as regards the mounting of machinery and in the transmission of power from the power unit to its driven members. In others rubber is rapidly coming into its own, particularly in the textile industry, where it is beginning to replace other materials in the processing of yarns, with a marked degree of success and increase of efficiency over existing materials.

The designer of rubber units is faced with many problems of widely divergent nature not only in the applications which have to be dealt with but in estimating the performance of the rubber itself in service. When using rubber there are so many variables to contend with that it is often difficult to predict the performance of a given unit with any degree of accuracy. One has to reckon with a wide variety of compounds, the effect of permanent set, high—or low-temperature effects, and many other conditions all of which may affect the eventual service life of the rubber.

It is hoped that this paper will give engineers at least some indication of the basic principles of the application of rubber to engineering and some of the problems involved in the design of units.

ACKNOWLEDGEMENTS

The author would like to acknowledge the encouragement given by the Directors of the Andre Rubber Company in the preparation of this paper and their permission to present it.

A NEW INDUSTRY PROPOSED IN DURGAPUR

Messrs. Associated Cement Company Ltd., (Bombay), Vickers Ltd., (London) and Babcock and Wilcox Ltd., (London) announced that they had concluded arrangements for the formation of a company to be known as A. C. C.-Vickers-Babcock (Private) Ltd. The new company plans to build a heavy engineering works in the vicinity of Durgapur, West Bengal. The products to be manufactured would include cement-making machinery, mining machinery, large pumps, heavy gears, steam generating plant of all types, pressure vessels, cranes and mechanical handling equipment. The construction of the proposed works will commence as soon as Government of India's approval is obtained.

EDITORIAL NOTICE

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Influence of size, shape and notches in test specimens in timber

By A. C. Sekhar and B. S. Rawat

Officer-in-Charge, Timber Mechanics Branch, Forest Research Institute, Dehra Dun.

Exclusive to "Journal of Industrial Engineering"

INTRODUCTION

As timber is a biological material not being produced under any controlled conditions, its mechanical and physical properties vary not only from species to species but also vary from tree to tree in the same locality, and to some extent even within the same tree. Wood is a non-homogeneous substance with elastic properties distinctly different in three principal directions, namely longitudinal, tangential and radial. In addition, wood is not perfectly elastic and has exhibited elasto-plastic behaviour when measurements of stress and strain are taken over continuous periods and cyclic loads. It has also exhibited dependence of its mechanical properties on factors like specific gravity, moisture content, temperature etc. It has also shown dependence, on size and shape of the material, notches in the test specimens, rate of loading and state of stress whether dynamic or static. The effect of various influences with special reference to Indian tropical woods has not been studied with the emphasis, which it demands. For this reason and with a view to study the inherent nature of wood in relation to mechanical stresses some of the various effects experimentally observed as due to factors such as sizes, shape and notches in test specimens are discussed in this paper. In the present paper as theoretical discussion is attempted owing to complexity of the material as already mentioned above and for which reason techniques of measurements on stress distribution in wood have not yet been fully developed.

NOTCH EFFECTS

In standard tests for timbers (4, 5) specimens for Izod tests, shear, tension and cleavage, contain some type of notches. In the investigation on Notch effects mention may be made of W. Rein (6) W. Kuech (7) Buernheim (8) and Kraemer (9). The work of these and others have been discussed in detail by F. Kollmann (1).

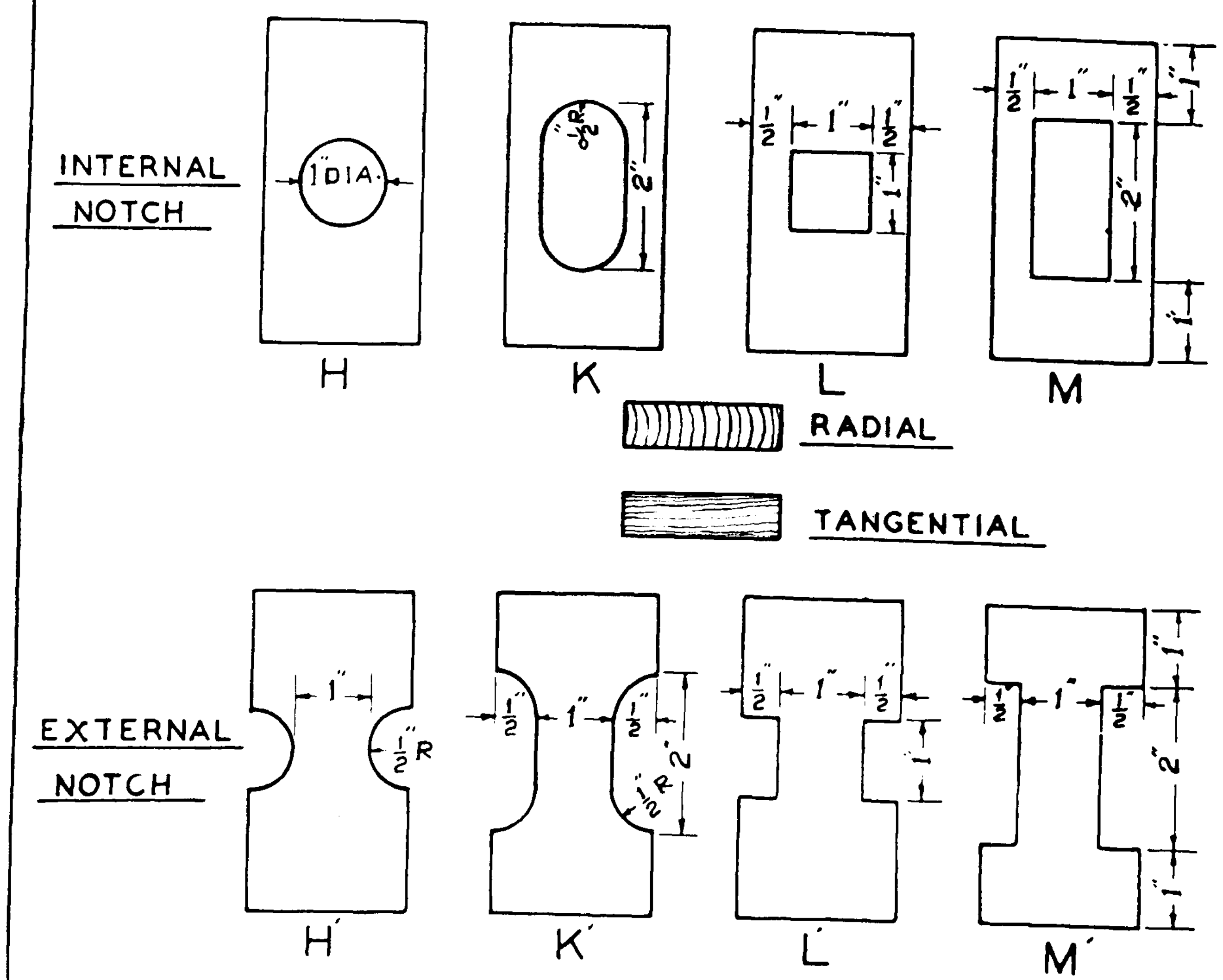
W. Rein has investigated tensile specimens of solid wood and laminated wood with edge notches and internal notches. The ratio of stress in notched specimen to the stress in full cross section has been designated by him as the Notch-factor and reciprocal of this has been taken as Notch-Sensitivity. According to him the notch-factor varied between 0.77 and 0.84 in the case of solid woods, and between 0.52 and 0.7 in the case of laminated woods.

At the Forest Research Institute for standard Izod tests three types of notches have been made and compared with a specimen without any notch. The different types are (A) 90° V-notch with a sharp corner (B) 90° V-notch with a round corner of $\frac{1}{8}$" diameter and (C) a key-hole notch. As required in the standard procedures the blow is given on radial surface. Results of tests done nearly on about 140 species from different localities and in three different conditions, (green, air-dry and kiln-dry) have been fully discussed by A. C. Sekhar and D. D. S. Negi. (3). It has been observed that most uniform and consistent results were obtained in the case of the key-hole notch, exhibiting the minimum scatter when plotted against specific gravity. The following table indicates the notch factor in the different cases:

Table 1

	Green	Air-dry
A. 90° V-notch with a sharp corner	0.92	1.02
B. 90° V-notch with a round corner	1.01	1.05
C. Key-hole notch	1.01	1.00

From the above table, it is also evident that a key-hole notch seems to be the best for getting accurate results in green and dry conditions but on the whole it appears that the notch form has not got much influence. Comparing A and B above it appears that notch sensitivity is higher with a sharp edge apex of the notch, as was also observed by F. Kollmann. With the variation of angle in the A type notch, it was observed in some experiments that in timber of low shock resisting ability like *Calophyllum tomentosum*, *Adina*, *Cordifolia*, there is no significant variation at all but in the case of tougher woods like *Anogeissus latifolia* there is a possibility of increase in Izod value with the increase of notch



F I G. 1.

angle, more clearly beyond 90°. The Izod values are slightly lower on the average when the blow is given on the radial surface than when it is given on the tangential surface. In the case of tougher timbers it is only 6 to 7% lower while in the case of some brittle timbers it is 15 to 18%.

The effects of notch in Impact tests are complicated as even some very tough woods (which show a greater plastic region) exhibit some brittle fractures when the load is applied rapidly. In this connection F. Kollmann (1) has pointed out that "Structural Internal Notch Effects" may obscure effects of slight external notches in material like wood. This has been further justified by some preliminary investigations on fatigue problems in wood done by the authors.

In experiments on evaluating shear in various Indian species it is a common practice to employ two types of specimens (A) a specimen of $2'' \times 2'' \times 2\frac{1}{2}''$ with a notch $\frac{1}{2}'' \times \frac{3}{4}''$ in a corner just sufficient for the loading head to be rested on it and (B) a cube of $2'' \times 2'' \times 2''$ without any notch. It has been observed in general that the values of maximum shearing force is about 6 to 10% higher in the case of cubes than in the case of corner notched specimens. It has also been observed that the shear value on the tangential longitudinal plane, is slightly higher than the shear values on the longitudinal radial plane.

In addition to the standard tests experiments on compression with internal and external notches of circular, oval, square and rectangular shape in the Radial and Tangential planes have been done in *Cedrus deodara*, *Terminalia tomentosa*, and *Terminalia paniculata*. Fig. 1 shows the size and shape of the specimens with the internal and external notches and Table 2 indicates the Notch-Factor in the different cases. From these experiments it seems that with regard to compression in wood Notch-Factor is slightly more when the notches are made on the radial surface than on the tangential surface specially in the tough woods. In the case of tougher woods Terminalia tomentosa and Terminalia paniculata, the notch-factor for square and rectangular notches is slightly more than the circular and oval notches in the case of internal notches and reverse in the case of external notches irrespective whether they are tangential or radial. But in the case of cedrus deodara the notch factor for square and rectangular is higher than that for circular and oval in the case of internal-radial notches and external-tangential notches and lower in the case of internal-tangential and external-radial. Neither in the experiments of W. Rein nor in the experiments of W. Kuech on bending tests, the influence of notch form could be established but the latter's experiments have indicated that notch sensitivity is greater in tension than in compression.

EFFECT OF SIZE AND SHAPE

About 20 species of various densities have been tested on a constant span of 28″ but varying depths of 1, 2, 3, and 4 inches keeping the width constant. It has been generally observed that with the decreasing span depth ratio between 28 and 7 the Modulus of Elasticity and Modulus of Rupture have decreased in value roughly according to the following formulae :—

$$\text{M of E} = \text{KR } 0.22$$

$$\text{and M of R} = \text{KR } 0.10$$

Where R is the ratio of span to depth K is a constant depending upon the species. Between the twenty species tested "K" has been found to vary from 350 to 1100 in the case of Modulus of Elasticity and from 1900 to 9800 in the case of Modulus of Rupture. Based on these formulae, the observed and calculated values have been found to lie close on a 45° straight line when plotted on a graph sheet.

But in the case of dynamic experiments on some woods it has been observed that Modulus of Elasticity increased with decrease of span from 28″ to 16″ on a cross section of $2'' \times 2''$ pieces, and also with the decrease of breadth from 2″ to 0.75″ on a constant span of 16″. However with change of depth from 0.75″ to 2″ on a constant span of 16″ a minimum value is generally reached when the ratio of span to depth is between 10 to 14.

Some experiments were also done on evaluating crushing stress at Elastic limit in the tangential direction perpendicular to the grain on two sizes of specimens, (A) on $2'' \times 2'' \times 6''$ standard specimen with the compressive load in the central 2″ position and (B) cube of $2'' \times 2'' \times 2''$ only. It has been generally observed that the values in the case of cubes are about 8% lower than in the case of larger specimens.

In the determination of Izod values in wood it is customary to express the values in ft.-lbs. for breaking a standard specimen of $7/8'' \times 7/8'' \times 5''$ with a key-hole notch of $\frac{3}{8}''$ depth. The specimen is held in a grip at the notch with a cantilever of 3″ projection. Variation in Izod values with variations in thickness and breadth of the effective material behind the notch have been studied by F. Kollmann and A. C. Sekhar (2) for three species *Anogeissus latifolia Stereospermum suaveolems* and

Terminalia bialata. Although Izod values cannot be taken as a basic mechanical property of the material as Modulus of Elasticity etc., Izod values on standard specimen give data for comparative purpose. Variation in breadth and thickness may cause considerable variation in Izod values, the general trend being :—

$$I = Kd^n \text{ or } K'b$$

Where K, K' & n are the constants depending upon the species, and d & b are the thickness and breadth of the effective portion of the material under test. The following table indicates toughness values and the respective constants for standard sized specimens in the three species mentioned above.

Species	*Toughness* (in. ft. lbs. Izod value)	*K*	*K'*	*n*
1. *Anogeissus latifolia*	21.0	100.6	30.0	1.842
2. *Stereospermum suaveolans*	10.5	42.4	15.0	1.875
3. *Terminalia bialata*	5.5	24.85	8.2	1.792

CONCLUSION

The effect of notches and size of specimens in timber testing has been discussed with reference to Indian timbers. The information is indicated in some cases and fairly exhaustive in other case. Considering once again the nature of the material with its elastic and plastic properties distinctly different in three principal directions and the results obtained so far even with Indian timbers there is evidence to believe that effect of notches in mechanics of wood is important and requires to be studied more exhaustively.

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Table 2

Species	*Type of notch*	*Moisture content* %	*Sp. Gr. at test*	*Notch Factor*							
				Circular		*Oval*		*Square*		*Rectangular*	
				Radial	*Tang.*	*Radial*	*Tang.*	*Radial*	*Tang.*	*Radial*	*Tang.*
Cedrus deodara	Internal	17.5	0.458	0.90	0.93	0.90	0.90	0.94	0.88	0.93	0.92
Terminalia tomentosa	Internal	13.6	0.861	0.94	0.83	0.92	0.76	0.99	0.83	1.04	0.77
Terminalia paniculata	Internal	14.2	0.772	0.95	0.93	0.89	0.95	1.04	1.01	0.98	0.95
Cedrus deodara	External	17.5	0.458	0.94	0.93	1.08	1.10	1.06	1.10	1.01	1.08
Terminalia tomentosa	External	13.6	0.861	1.07	0.84	0.99	0.92	0.97	—	0.90	0.86
Terminalia paniculata	External	14.2	0.772	0.90	1.09	1.07	0.99	1.01	1.00	0.87	0.88

Baan Hofman Dredgers are Serving the World

By Th. Van Gent., Rotterdam

Exclusive to "Journal of Industrial Engineering"

DREDGING Material is in use in many places all over the world under different circumstances and climatic conditions. Always and everywhere dredging operations are an initial step in the cultivation of virgin soil or the improving of existing waterways.

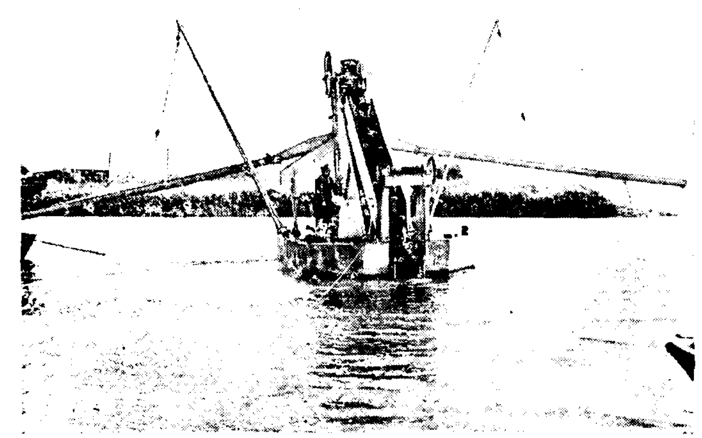
It all began in the latter half of the 17th century when somebody in Holland hit on the ingenious idea of dredging shallow riverbeds by means of a floating dredging apparatus, which in those days consisted of a raft equipped with a hand-operated bucket.

This so-called 'dredging-raft' was, in fact the forerunner of the modern dredger. It is not surprising that at present Holland boasts an industry which produces dredging material of world-wide renown. For even at school Dutch children are taught that one fifth of their country is below sea-level; thus every Dutchman realizes the necessity of fighting the ever threatening water, a fact which inspired a French wit to remark that 'God created the world, except the Low Countries, which were created by the Dutch themselves'.

The Dutch dredging material industry can therefore truly be said to have been born from dire necessity, a circumstance which induced the industry to turn out products as perfect as technical progress could make them. This development went hand-in-hand with a considerable and continuous progress in dredging technique.

Bigger and better dredgers of improved efficiency were constantly being designed and built. Then, almost without warning, Dutch dredging experts suddenly realized that, although the industry was capable of constructing any dredger of large capacity, no provisions had apparently been made for the manufacture of small dredgers, suitable for operating in the narrow canals that have to carry surplus water from low-lying 'polders' towards the sea.

It was then discovered that there was an immense field of application for midget dredgers, not only in Holland and several other low-lying countries, but also in tropical and sub-tropical regions, where small machines of this type can be usefully employed for work on estates, plantations, rice-fields, and in canals, creeks, etc.



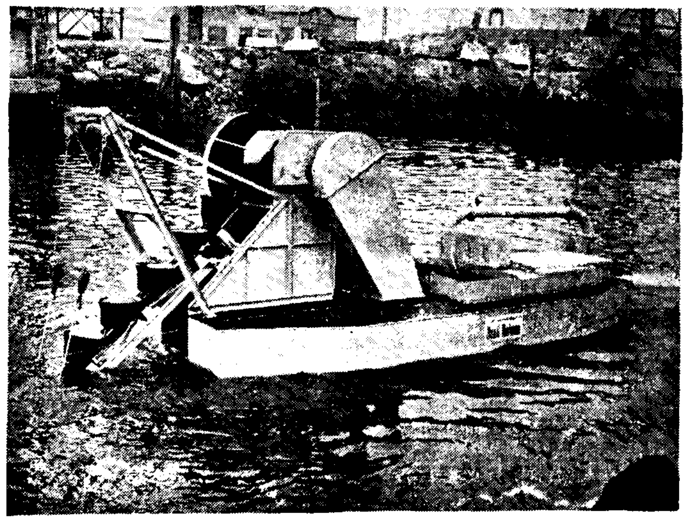
Baan Hofman 35 L Bucket Dredger with a capacity of 40 m. 3 per hour.

It is only natural that the Netherlands, where a large proportion of the available land lies below sea-level should make a determined effort to meet this world-wide demand.

Consequently, in addition to the construction of other dredging equipment, midget dredgers have become a specialty of Dutch engineering. Obviously, such midget dredgers have to meet a number of special requirements. They have to be of the smallest possible dimensions and capable of dredging extra-ordinarily channels.

Other essential features are: Maximum manoeuvrability and minimum draught without loss of stability Finally, initial expenditure and running costs should be low. This led several Dutch engineering firms to carry out a series of experiments, but most of them were unable to produce material capable of satisfying the requirements in every respect. However, a yard succeeded in producing dredgers eminently suited to solve the special problems involved.

In fact, the director of this concern N. V. Machinefabriek en Reparatie-Inrichting Baan Hofman of Gorinchem (Holland) undertook long journeys to widely different countries, including Indonesia, where there was a pressing demand for small dredging equipment. He



Baan Hofman 20 L Bucket Dredger with Discharge Pump.

studied all aspects of the diverse problems and the results of his studies are that this firm now produces midget dredgers in various sizes. These conform to the highest standards and are suitable for operation in the tropics. The efforts of the builders have not been restricted to dredging equipment to suit Dutch preference and requirements alone, because, besides the Netherlands, there are other low-lying countries in the world where midget dredgers can be usefully employed. Indonesia with its plantations and irrigation works for the ricefields, is an example.

In September 1953, a contract was received by Messrs. Baan Hofman from the Indonesian Government, calling for the construction of 28 midget dredgers.

This order included two 10″—cutter suction dredgers, two 14″—cutter suction dredgers, fourteen 15—litre-bucket dredgers and ten 35—litre bucket dredgers.

The bucket dredgers, which can be delivered in various dimensions, and with bucket capacities of 15 litres to 1000 litres, are equipped with long or short chutes or conveyors to discharge the dredged material over both or either side or over the stern into barges moored to the dredger. Generally speaking, this type of dredger is suitable for the dredging of almost any kind of soil.

Therefore, we will only list the most common types of soil which can be efficiently handled by dredgers of the bucket type.

(a)	Liquified clay or loam	very good dredging soil.
(b)	Plastic clay or loam	good dredging soil.
(c)	Packed clay or loam and free flowing sand	fair dredging soil.
(d)	Packed sand with or without loam	poor dredging soil.
(e)	Tightly packed sand or loam	very poor dredging soil.

Another dredger with a lot of possibilities, especially and those piaces, where there is a large distance from dredgers to discharge dump, is the *Bucket Dredger with Discharge Pump.* This dredger is capable of dealing with practically the same kinds of soil as the conventional bucket dredger.

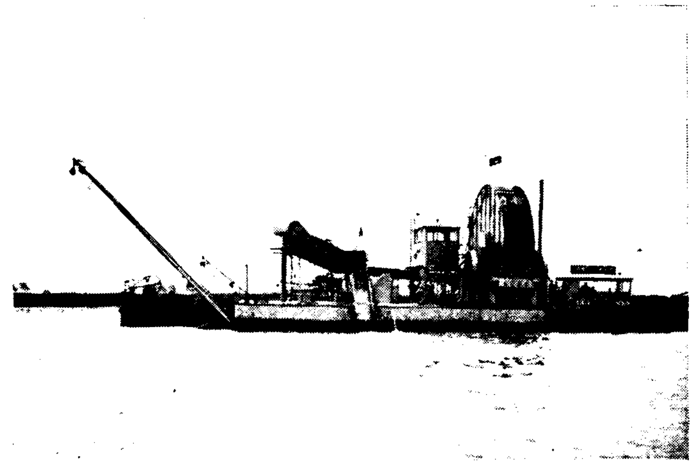
A small type of this dredger can easily be transported on a trailer without the necessity of dismantling it partly or completely, as this type is only 7 metres long and 3 metres wide.

Equipped with a 53 Hp. engine this dredger has a capacity on solids of 26 cubic metres per hour. Its minimum dredging depth is 0.75 mtr. and the maximum dredging depth is approx. 3 metres, and besides the discharge distance is 175 metres.

Below decks of the dredger the sandpump, driven by the main engine by means of strings is installed. The pumphousing as well as the inlet opening of the pumpcover are provided with interchangeable linings.

When a bucket of the bucketchain reaches the top of the main gallows, it tumbles and the load of clodded clay falls on the bottom of a small hopper situated in the lowest part of the hull, where by the force of the collison the clay bursts into small clods. The outboard water is pumped with force into the hopper and the water and

The Cutter Suction Dredger " Makasi "



Dry Sand Suction Dredger with a capacity of 960 m3 per hour.

clay are then whirled together causing the pieces of clay to disintegrate further so that the clay can be sucked up by the sandpump.

In case the clay is very cohesive, a sharply edged grating, doing the initial cutting, can be fitted above the hopper bottom.

An example of the possibility of constructing fairly large dredgers is given by the delivery of the Cutter Dredger 'Makasi', recently delivered by her builders, the Baan Hofman Engineering Works Ltd., Gorinchem, Holland. The 'Makasi' is intended for service in the Belgian Congo.

Dredgers of this type are equipped with a cutter installation. For each kind of soil an appropriately shaped cutter can be constructed.

The 'Makasi' is composed of nine separate pontoons, in order to facilitate transport over land.

The nine pontoons are in themselves an interesting subject. The two central pontoons amidships accommodate with the complete machinery, f. i.:

central pontoon nr. 1	houses the pump installation, driven by a 450 Hp. Diesel Engine, a small Diesel Engine Set with generator and compressor.
central pontoon nr. 2	is mainly occupied by a 220 Hp. Diesel Engine, coupled to a 50 Kw. generator for the supply of electric power, and a 90 Kw. generator for the cutter engine and monitor pump.
side pontoons (fore)	serving as day-accommodation, for workmen.
side pontoons (centre)	serving as storerooms.
side pontoons aft	accommodate the fuel tanks.
transverse pontoon astern	accommodate the two ballast water tanks and one drinking water tank.

Finally, the 'Makasi', which has an output of approx. 400 cub. m/hour is fitted with a ladder of special design, which facilitates dredging down to a depth of 14 metres. The heavily constructed powerful engines guarantee a very long discharge distance.

The new Baan Hofman Dry Sand Suction Dredger combines the properties of two dredgers in one craft, as it dredges the sand and delivers it dry and, when a mixture of sand and gravel is dredged, separates the component parts of the mixture and delivers them separately. A prototype of this type of dredger has been in full use during one year without showing any sign of wear. If desired the new type of dredger can be constructed by the conversion of an existing vessel.

The dredger works as follows: Dirt and gravel are eliminated by a sifting plant mounted over the sand pump and are then removed via a tip-chute. Sand and water pass through a gutter into the well, from which the water flows off through stand pipes. An elevator conveys the clean sand from the well, transferring it through a tip-chute into barges or other vessels alongside.

Of course it is quite impossible to mention all types of dredgers, so we restrict our enumeration to the three dredgers mentioned. In addition to this equipment all other types can be supplied, such as barge unloading dredgers, dipper dredgers, grab cranes, rock breakers, hopper barges, tugs.

It can truly be said that the combined power of the Baan Hofman Engineering Works Ltd., and R. S. Stokvis & Zonen N. V. sole exporters, can solve the world's dredging problems, when these are submitted to their specialists.

Charles Cooper (Tipton) Limited—England

(From A Special Correspondent)

TODAY, Charles Cooper (Tipton) Ltd., are leading manufacturers of Cold Rolled and Hardened and Tempered High Carbon Spring Steel Strip and Umbrella Ribs with extensive factories at Tipton, England and with business contacts throughout the length and breadth of the world; but eight years ago its very existence was no more than an idea in the mind of the person who is now Managing Director, Mr. Charles Cooper.

The following brief history, therefore, describes the amazing growth of this very young Company, and is a tribute too the Spirit of True Craftsmanship that has influenced the work of Charles Cooper (Tipton) Ltd., throughout its eight years of existence.

HOW THEY STARTED

The formation of Charles Cooper (Tipton) Ltd., commenced with the acquisition of approximately 30,000 sq. ft. of space, consisting of an old packing workshop, a weighbridge hut and three minute offices, the whole with access to Locarno Road, Tipton.

Mr. Charles Cooper, who, since leaving school had taken an interest in the metallurgy of steel, having worked his way from a junior laboratory assistant at a steel rolling mill up to the position of Metallurgist and then to Works Manager, decided to open on his own account in the fall of 1948, and so rented the ground and buildings referred to above.

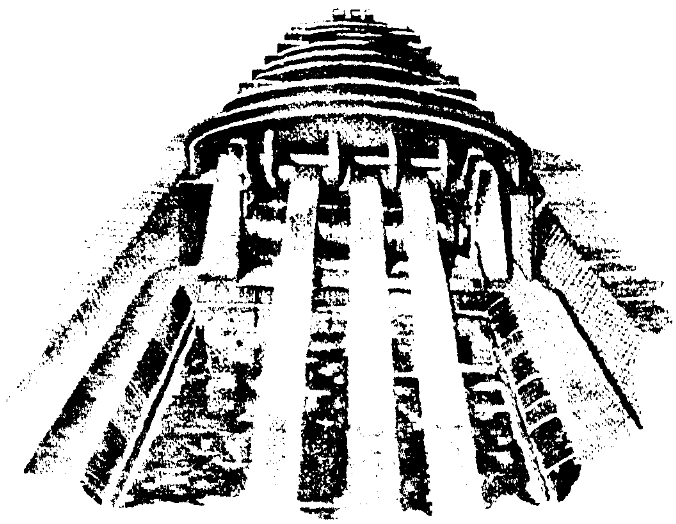
Charles Cooper (Tipton) Ltd., came into being on 1st January, 1949. Power and drainage were installed in the building which had been a packing shop and the first hardening and tempering gas and electric furnace was put into action.

Orders were hard to come by but these increased as steel quality was maintained, and all-out efforts were accomplished by the Company which at that time consisted of seven individuals—staff and Employees.

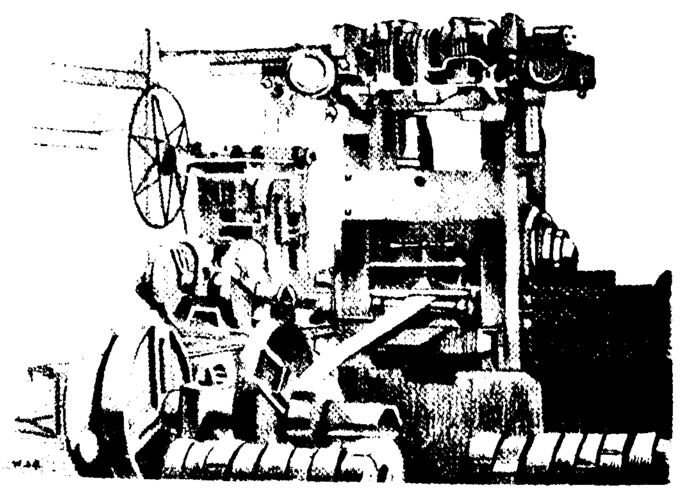
HOW THEY PROGRESSED

Eighteen months later, with the arrival of more equipment, the first factory extension took place, followed two years later by further extensions, which were utilised straight away for the installation of cold rolling mills. Henceforth, the Company could process its own cold rolling—thus ensuring the correct fine tolerances required in addition to hardening and tempering.

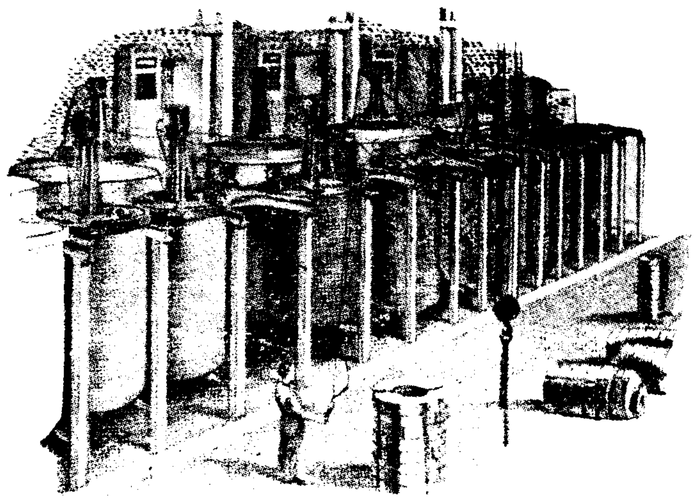
The Company continued to expand production and increase the sales initiative, so that the whole business became well balanced to include a very large number of customer friends from whom have come increasing demands for the Company's steel.



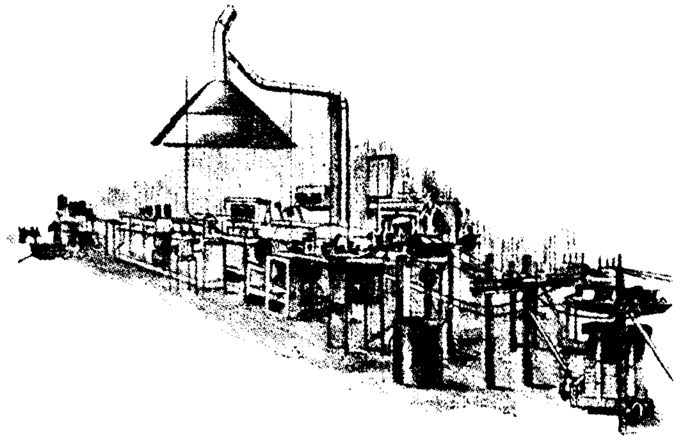
Pickling Plant.



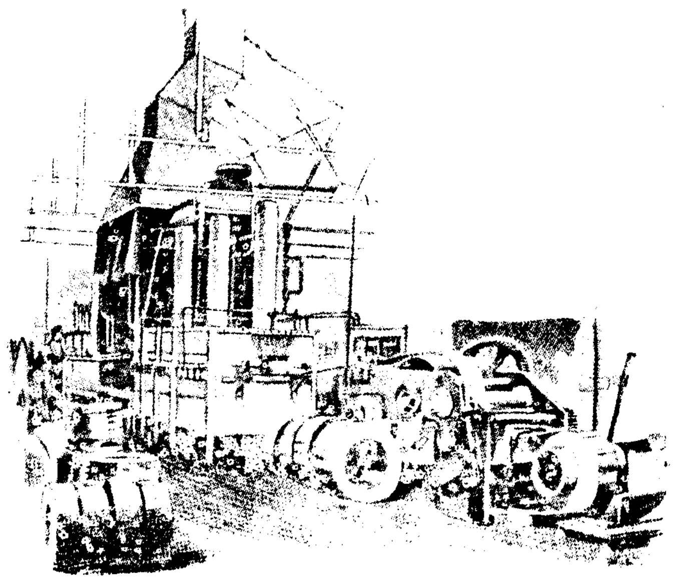
Cold Rolling Plant.



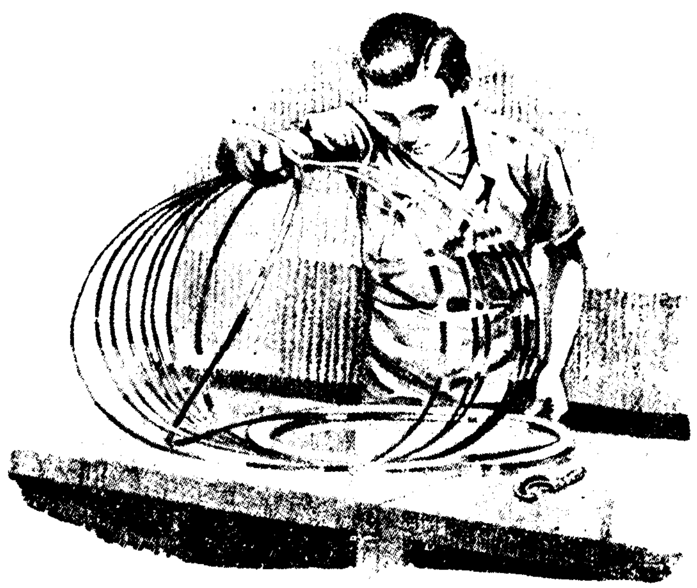
The bank of Annealing Furnaces.



Automatic Umbrella Rib production line.



One of the Hardening and Tempering Furnaces.



Final Inspection before packing.

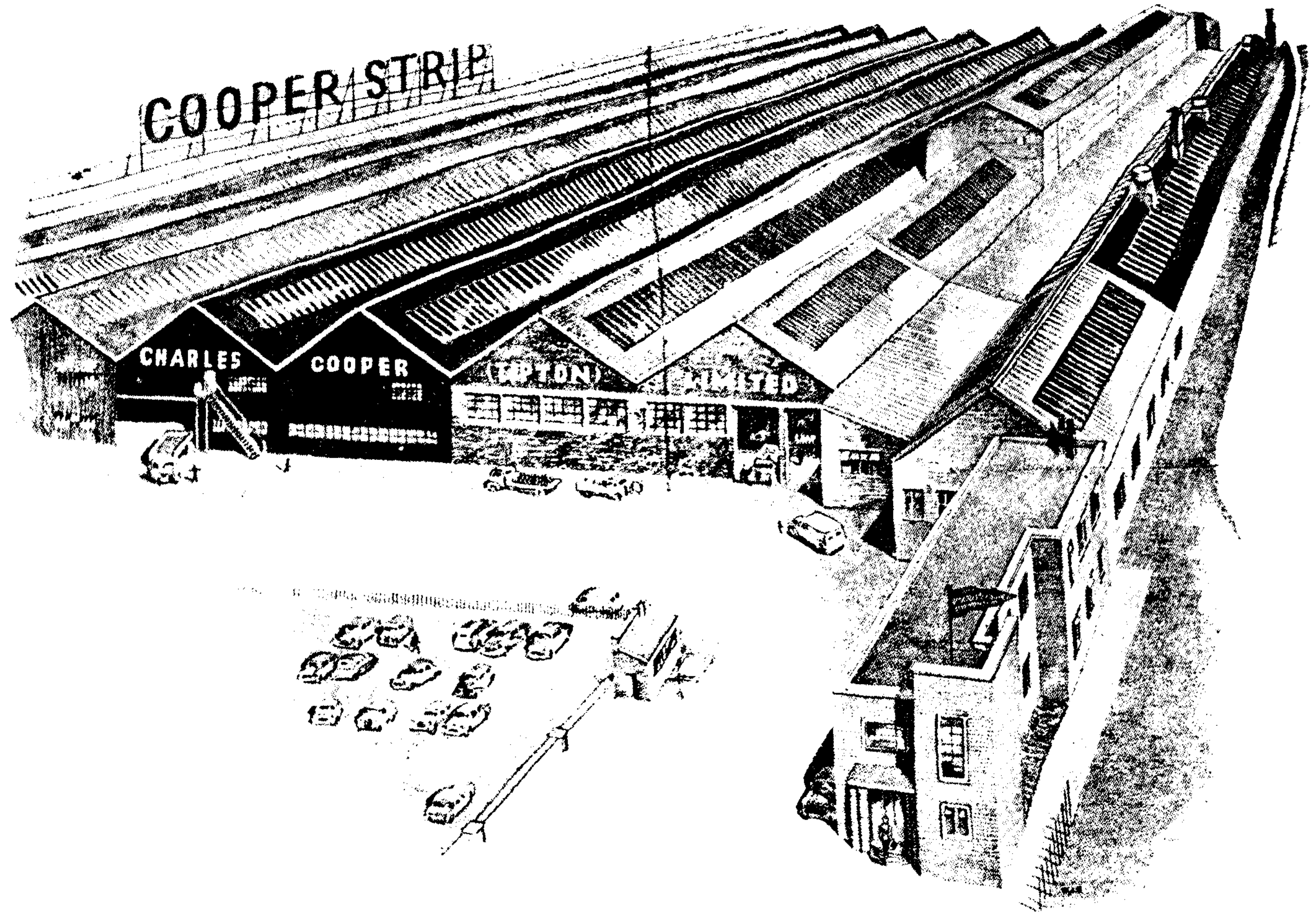
Early last year, the Company succeeded in contracting to purchase a further large area of covered space containing modern factory buildings. By this time every inch of existing space had been built upon through further extensions and utilized by modern machinery and furnaces. There was little hope of developing this new availability for some years, because the Company had stretched its finances to the uttermost and was embarrasingly undercapitalized.

So in May 1955, negotiations were opened between Charles Cooper (Tipton) Ltd., and Firth Cleveland Ltd., resulting in the latter absorbing the former, so that the firm became an important unit in the Firth Cleveland Group, whose activities place the whole concern within the first 50 major industries in the Country.

The additional space acquired in 1955 is now being fully developed for completion in 1957 to make it likely that the Company will be the largest single unit producer of its specialized class of steel strip in the United Kingdom and having the most modern rolling mills, steel pickling lines, annealing furnaces, hardening and tempering furnaces and all ancillary equipment.

WHAT OF THE FUTURE

The achievements just mentioned are great enough but they do not end there. Further large extensions and improvements are planned in order to keep abreast of changing production methods and thus ensure satisfaction for the very many customers with whom the Company have the honour to serve. These customers are found, not only in the United Kingdom, but



An aerial impression of the extensive factory of Charles Cooper (Tipton) Limited.

throughout the manufacturing countries of the World. They constitute a variety of producers manufacturing all types of Saws, Clock Springs, Measuring Rules and Tapes, Trowels, various types of Knives, Gramophone Springs, Umbrella Frames, Piston Rings—to mention only a typical few of the formidable number covering all aspects of industry.

CONCLUSION

The policy of Charles Cooper (Tipton) Ltd., has always been to maintain standards. The products of the Company have long had a reputation for quality and workmanship, and by maintaining those high standards all who are associated with the Company are in some way sharing in its success. Therefore, the brief history would be incomplete without reference to the craftsman at his bench, rolling mill and furnace, of whom some boast continuous service since the inception of the Company. Most hold the priceless gift of traditional craftsmanship, others have quickly acquired the skill; but all blend into one efficient whole. The future could not be in firmer, surer hands.

BURMA—DEMAG COLLABORATION FOR STEEL MILLS

The trainees have come to Jamshedpur to acquire practical know-how so that they can eventually fill responsible positions in the steel plant and rolling mills that are being constructed by M/s. Demag of Germany at Ywama, 15 miles from Rangoon. This Mill, which is fast nearing completion, will have an initial capacity of 18,000 tons of steel ingots per year, and this tonnage will be converted into sheets and other flat products. It will have a 12-ton furnace and ancillary equipment to produce sheets and steel wires. This mill will mark the beginning of the iron and steel industry in Burma.

As steel men of Burma, they are conscious of their heavy responsibilities and look forward to playing their part in the first-ever steel mill in their country.

Electric Spark Erosion as applied to Metal Machining

(By A Technical Correspondent)

THIS latest metal-machining method solves successfully one of the most important problems in modern production technology which at present faces technologists in connection with the growing automation and mechanization of machine production. Mechanization of the very expensive and skilled tool production presents the greatest problem to all technologists. With a steadily increasing production, more and better tools are required, especially moulding tools, such as dies, forms, cutters, drawing tools, etc. Chipless metal working in mass production is one of the most highly productive technological branches requiring, at the same time, the most perfect tools the majority of which have hitherto been made by the hands of skilled toolmakers.

By means of copying machines the production of these tools has been partly speeded up and mechanized, however, the production procedures and possibilities have, fundamentally, not been altered. Hand-finishing of these tools, taking up most of the production time, has remained unchanged.

Electro erosive machine working enables these tools to be made of materials of higher strength, toughness, also of heat treated (hardened) materials or cemented carbides.

This was not possible with production methods employed so far. The use of cemented carbides for moulding tools envisages great savings of tools, highly alloyed tool alloys, investments (by more efficient exploitation of the machines—shorter interruptions in the production cycle necessary for changing tools), these tools having a life many times longer than tools made of tool material; the greatest advantages of electric spark erosion machining lies in the fact that the engraving process of shapes in tools can be fully mechanized.

With this machining method the metallic material is removed by the thermal and pressure effects of numerous short-time electric spark discharge. As these numerous short-time electric spark discharges (duration about 10-4 seconds) take place in a dielectric fluid medium (paraffin, etc.), the material is affected only in a very thin layer without diminishing its strength, on the contrary, a fine wear-resistant thins layer is created. This method is very efficient and by means of roughing steps on the electro-erosive engraving machine it is possible to remove

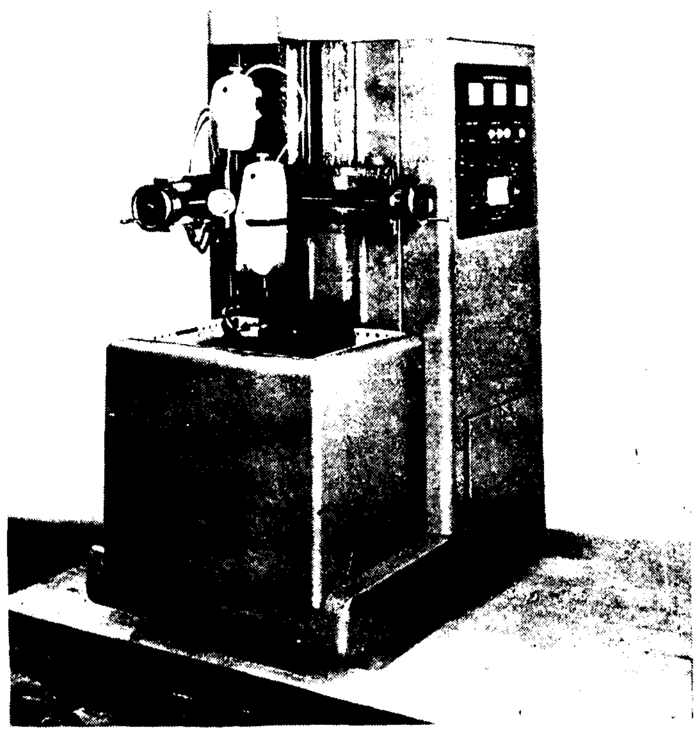


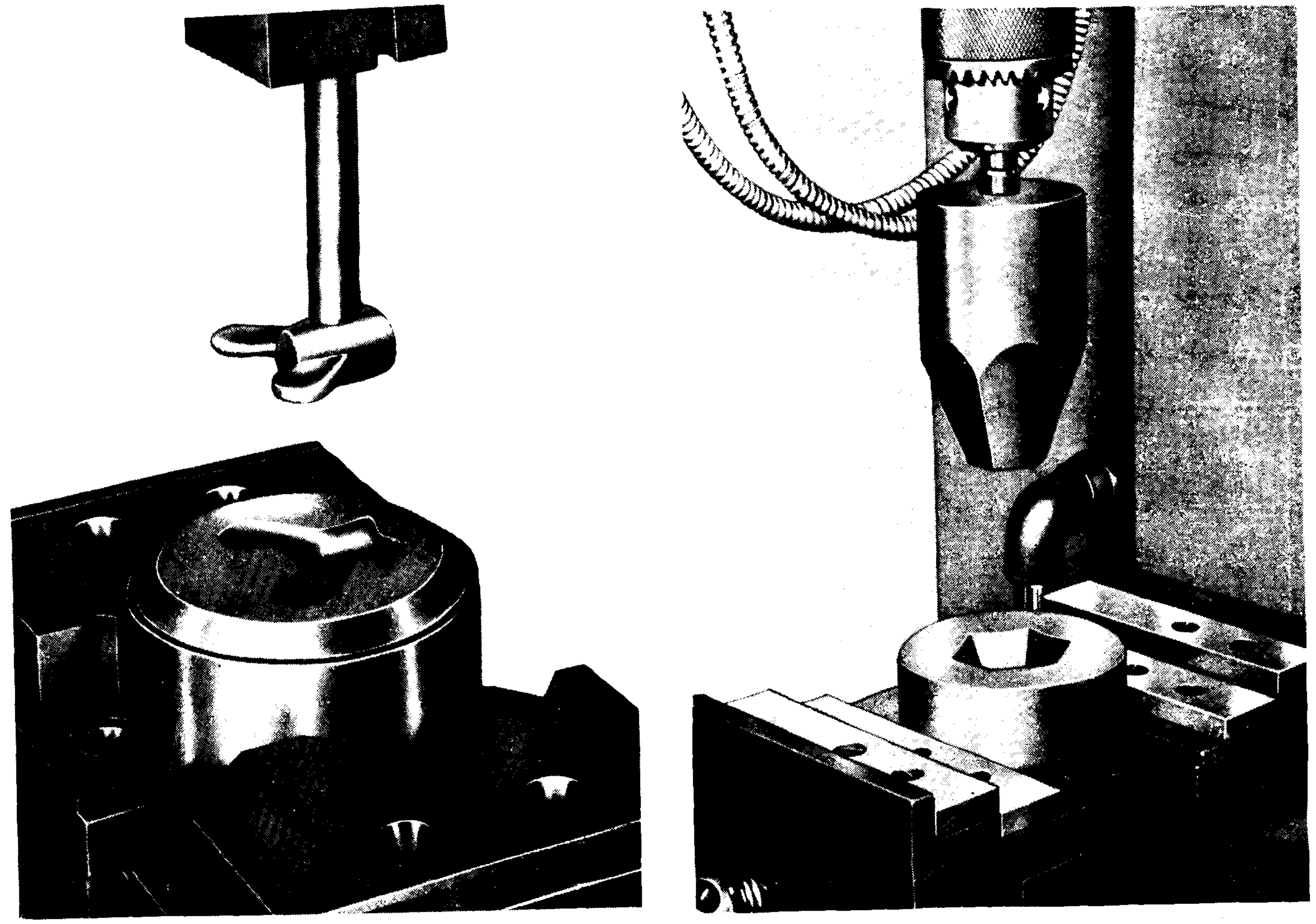
Fig. 1. Electric Spark Erosion Engraving Machine VJK-2.

up to 350 mm^3 per minute of tool material, and on the anodo-mechanical source even up to 3000 - 5000 m^3 per minute of tool material.

By means of machines manufactured by the Czechoslovak machine industry one of the most fundamental requirements of modern technologists has been solved, i. e. to engrave efficiently the most complicated forms into the hardest and toughest materials while mechanizing this process to the highest degree.

One of the most efficient electro erosive-machines is the Electric Spark Erosion engraving machine VUMA VJK 2 (Fig. 1).

This machine serves to sink any shapes into any material of all classes of strength and toughness including cemented carbides. It reduces many times the manufacturing time of moulding tools such an dies, forms,



Sinking of a die on the Electric Spark Erosion Engraving Machine VJK-2.

cutting tools, drawing tools, female drawing tools, moulding bars, turbine blades, etc., it allows the quick repair without annealing effects of worn dies, drawing tools and other tools without injuring the quality of the tool, by means of simple spark engraving of the shape to the required dimensions. It engraves shapes up to an area of 10.000 mm^2 and above according to the shape of the component. As electrode (tool) it uses a moulding of brass, aluminium, and cast-iron for cemented carbide. For a larger series of tools also powdered materials of the above mentioned metals.

The spark machining process on this machine is fully automatic so that the set electrical parameters are automatically maintained. The mechanical parts of the machine are of rigid construction provided with accurate cross-supports which can be precisely adjusted.

Another electric spark erosion machine operating by the same method is the Electric Spark Erosion Micro-Drill VUMA VJ 0.3 (Fig. 2.)

It serves for producing the smallest hair apertures of from 0.05 to 0.5 mm. into the hardest material and cemented carbides.

It has a great importance for the making of holes into injection nozzles, gas burners, fine female drawing tools, bearings of measuring instruments, etc. All mechanical methods so far used make this process very difficult, and require expensive tools. By employing the Electric Spark Erosion method this operation is reduced to a few seconds.

Normal tungsten wire is used as tool. The holes are made with an accuracy of up to 0.01 mm. according to selected electrical parameters.

The problem of cutting high-strength materials is very often encountered in production.

This problem is successfully solved by electric spark erosion anodo-mechanical saws, where low voltage (about 24 V) electric spark discharges cause the main

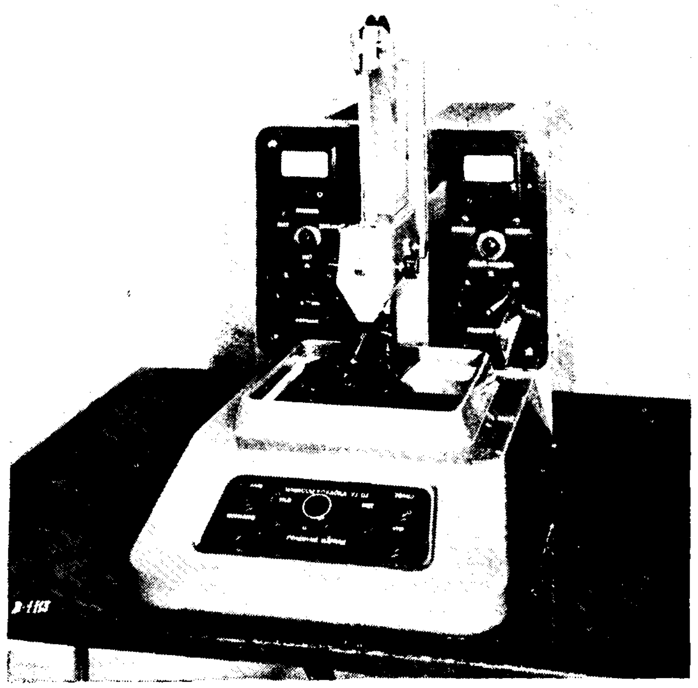


Fig. 2. Electric Spark Erosion Micro-Drill VJ 0.3.

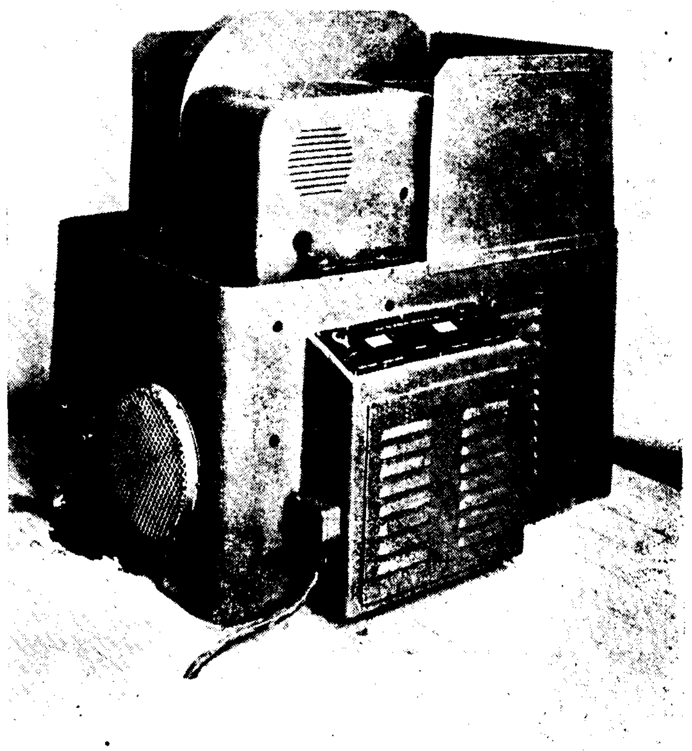


Fig. 3. Anodo-Mechanical Saw PA 150.

component of metal removement. The spark-cut material may be of any strength, hardness and toughness, such as magnetic alloys, nickel alloys, and other alloyed materials, for instance cemented carbides, etc.

Standard toothless saw bands without any further adjustments are used as tools to which the negative pole of the electrical source is connected. The positive pole of the source is connected by means of the clamping device to the material to be sawn. Service fluid (water glass) is led to the point of the spark discharges.

For cutting small sections up to 30 mm. (13/16" dia) the anodo-mechanical saw VUMA PA 30 is used.

This saw cuts very efficiently hard-metal plates and other similar material which up to now could not be cut by any other method. The movement of the saw is fully automatic and maintains automatically the selected electrical paramaters.

The anodo-mechanical saw WUMA PA 150 (Fig. 3) serves for larger sections up to 150 mm. (6") dia.

This saw is used primarily for cutting tool, aircraft, stainless, and other materials. Also manganese, silicon, and other alloyed materials can be successfully cut by means of this machine.

The Czechoslovak industry prepares numerous other electric spark erosion machines solving the most complicated problems in machine manufacture, especially intended for mechanising tool production and machining of metals which can be machined only with very great difficulties when using present production methods. These materials, however, are used at an increasing rate in modern machine production thus adding steadily to the difficulties in their machining. By means of the electric spark erosion machine supplied by Czechoslovak manufacturers all difficulties of the production technology encountered in machining high-strength materials can be easily overcome.

Sole exporters of Czechoslovak electric spark erosion machines for metal machining: Strojexport, Praha, Czechoslovakia.

Are You using Your Milling Machine

By R. Jenks, A. M. I. P. E.

Chief Planning Engineer, Automobile Products of India Ltd., Bombay.

I think readers can be quite bored with very technical articles where usually a lot of technical data is given based on certain conditions which can never be produced in everybodys factory. Therefore, I feel that readers should take a technical article in a broad sense, and only endeavour to apply the data given i. e. looking at it in their own light with regard to their particular production and their particular machines. Certainly, I believe that many people who have the responsibility of a production shop should investigate what their Milling Machines do. For this, I have given a few notes on what a Milling Machine is expected to do based on data received on a new Machine. This phrase ' New Machine' should not upset anybody because if you can get from your Machines about 75% of the production figures given in this article you should be very happy. Bearing in mind that many of your Milling Machines have taken a lot of wear and would not by any means be looked upon as examples, I can only say that if the Milling Cutter is the right one with the right number of teeth and ground properly, fitted properly, it will go a long way towards your Machine giving its proper amount of work.

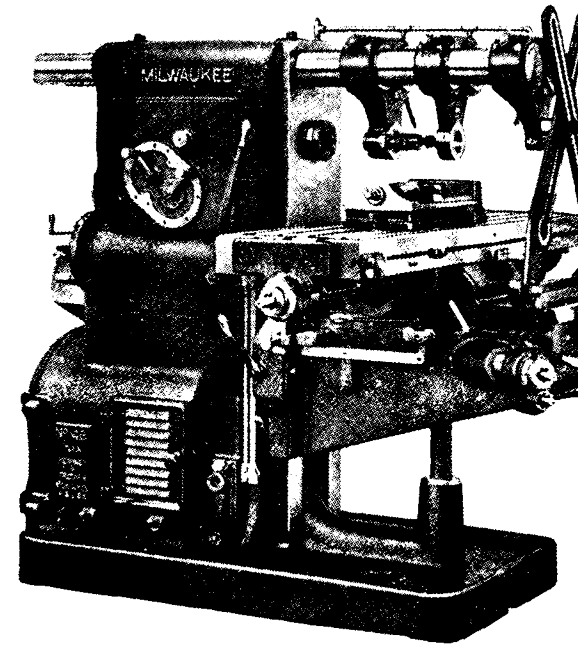


Fig. 1

Milling Machines have progressed in design due to the direct result of cutter manufacturers, and milling machine manufacturers working together. The question of Horse Power in a milling machine is not the first consideration. In the early part of the century, milling machines were working with 15 H. P. but the milling machine today with 15 H. P. does more work, due to the following factors.

1. Better design, i. e. rigidity and better materials
2. Utilisation of Horse Power, i. e. giving the speed its own motor and feeds its own motor.
3. Better milling cutter design including the use of tungsten carbide.

To give an idea of the above remarks, here is shown Fig. 1 the photograph of a milling machine designed nearly 50 years ago, and a similar machine designed today. It will be noticed that the difference in characteristics at a glance is very little, but the performance of the modern machine is vastly different, the modern machine having trebled the spindle speeds of the milling cutters and more than doubled the range of feeds. Yet the Horse Power is practically the same.

No doubt some of you have in your factories modern machines and very old machines and it may be surprising to investigate and find out that your old machine is doing just as well as your new machine. If this is so, then something is wrong. There are many reasons why a modern milling machine is not doing its job, and a number of machine tool factors must be understood which only actual practice can provide.

Firstly is ' Vibration '. The milling machine is probably the only machine tool which can put up more causes for Vibration.

Secondly, milling cutters must be designed to give consideration to this factor in order to obtain rigidity. Also, the milling machine itself must be well designed and well built, tolerances and manufactured parts are kept in close limits so that no unbalance will occur at high speeds or heavy loads. A milling machine spindle will, no doubt, operate with less vibration in speed with cutters having close tooth spacing. However, this is not so in practice due to the fact that in modern high speed milling the teeth of the cutter must be more widely spaced to provide sufficient chip room. Therefore, other causes must be gone into, and they can

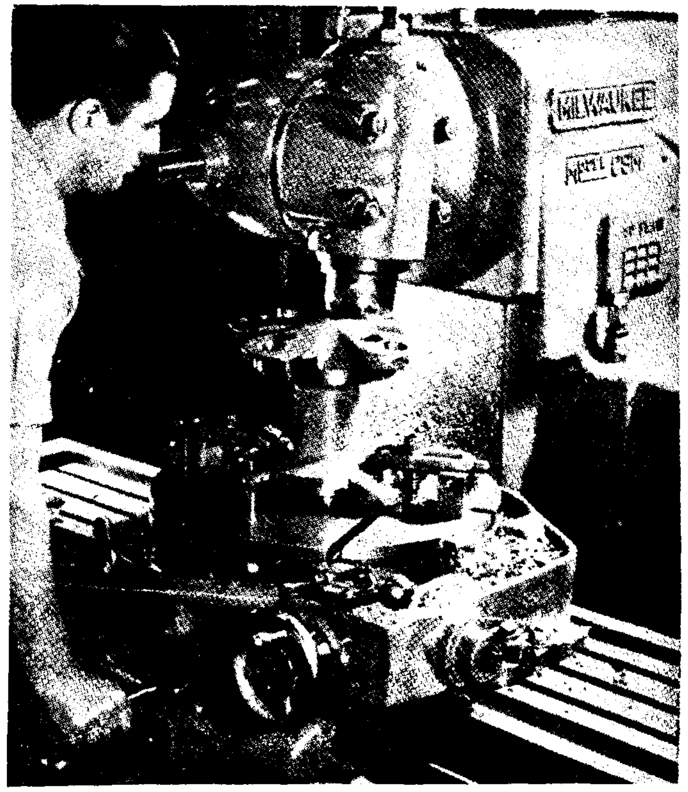


Fig. 2. Special carbide milling set up on horizontal milling machine. Use of vertical head and rotary table detracts from rigidity.

be quite a formidable range. The following examples will serve.

1. Poor milling cutter grinding, and this is the cause more often than not.

2. Cutter running out of true (run out should not exceed 001 to 002 when mounted on milling machine.)

3. Dirt between spacing bushes.

4. Arbors with damaged or dirty taper shanks.

5. Improper foundation settings.

6. All ways should be checked for looseness of gibs.

7. Jigs and fixtures—these must be designed not only for ease in manipulation but for rigidity and should be designed as close to the table surface as possible for the sake of rigidity.

A typical example of a set up which detracts from rigidity is shown in Fig. 2.

Now probably all these causes are known to you, but do you know what your machine is supposed to give you in the way of production ? Modern machines today can easily remove metal at the following capacities.

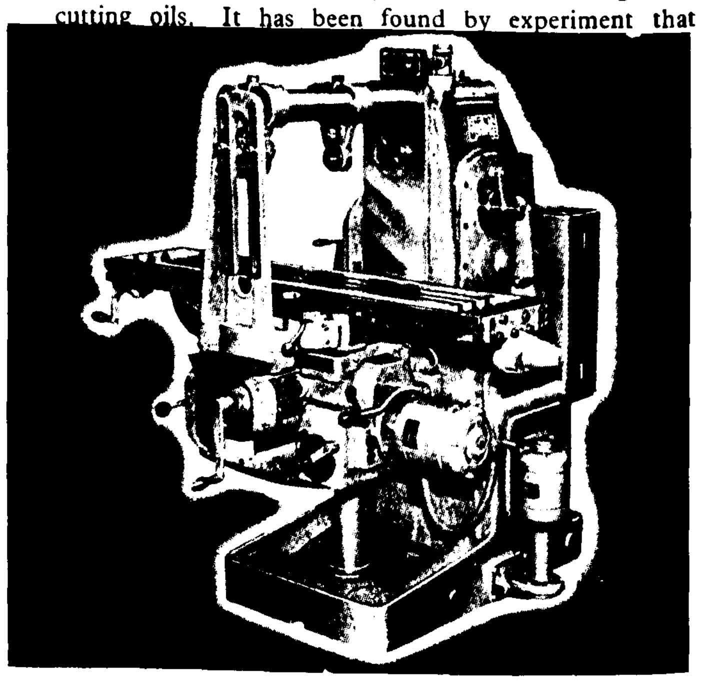
1. Milling machine with 3 H. P. should be able to remove at rated capacity 1.5c. inches per minute ordinary soft cast iron.

2. At a 25% overrated capacity which is not detrimental to a machine, the machine should remove 2.5c. inches per minute. A machine with $7\frac{1}{2}$ H. P. should be able to remove 6 c. inches a minute of ordinary cast iron at the rated capacity and at a 25% overload should remove 9 c. inches per minute and if the milling operations are intermittent, then the metal removal in cubic inches per minute can be up another 30% providing you are using the right milling cutter at the right feeds and speeds. This is the amount of metal removal you should get on production.

No doubt the above would be very surprising to some people if they care to investigate their milling section.

Referring to the question of cubic inches removal, it depends of course upon surface feet per minute and feed which equals the chip load. The great thing in milling beyond doubt is the accurate grinding of milling cutters with regard to concentracity clearance angles and cutting angles to give you the proper use of a milling cutter with regard to its size of job it has to do.

An interesting point may be raised with regard to cutting oils. It has been found by experiment that



Material To Be Milled	Rated Horsepower of Milling Machine — Without Separate Feed Motor: 3		5		7.5		10		15		20		With Feed Motor: 20		30		50	
	Maximum Metal Removal Cubic In. per Min.																	
Aluminum	2.7	4.9	5.5	7.6	8.7	12	12	17	18	26	27	38	30	41	49	65	91	118
	6.0	7.1	11	14	16	21	23	28	35	44	49	60	52	63	81	100	145	173
Brass—Soft	2.4	4.2	4.7	6.6	7.5	10	10	15	16	23	24	33	26	36	42	57	79	103
	5.2	6.1	9.4	12	14	18	20	24	30	39	42	52	45	55	71	87	126	150
Bronze	1.7	3.0	3.3	4.7	5.3	7.3	7.3	11	11	16	17	23	19	25	30	40	56	72
	3.7	4.3	6.7	8.7	10	13	14	17	21	27	30	37	32	39	50	61	89	106
Bronze—Hard	.78	1.4	1.6	2.2	2.5	3.4	3.4	5.0	5.3	7.5	7.8	11	8.7	12	14	19	26	34
	1.7	2.0	3.1	4.0	4.7	5.9	6.5	8.1	10	13	14	17	15	18	23	29	42	50
Cast Iron—Soft	1.6	2.9	3.2	4.5	5.2	7.1	7.1	10	11	15	16	23	18	25	29	39	55	71
	3.6	4.2	6.5	8.4	9.7	12	14	17	21	26	29	36	31	38	49	60	87	103
Cast Iron—Hard	1.0	1.9	2.1	2.9	3.5	4.6	4.6	6.7	7.0	10	10	15	12	16	19	25	35	45
	2.3	2.7	4.2	5.4	6.2	7.9	8.7	11	13	17	19	23	20	24	31	38	56	66
Cast Iron—Chilled	.78	1.4	1.6	2.2	2.5	3.4	3.4	5.0	5.3	7.5	7.8	11	8.7	12	14	19	26	34
	1.7	2.0	3.1	4.0	4.7	5.9	6.5	8.1	10	13	14	17	15	18	23	29	42	50
Malleable Iron	1.0	1.9	2.1	3.0	3.4	4.7	4.7	6.8	7.3	10	11	15	12	16	19	25	36	46
	2.3	2.7	4.2	5.3	6.4	8.1	9.0	11	13	17	19	23	20	25	32	39	57	68
Steel—Soft	1.0	1.9	2.1	2.9	3.3	4.6	4.6	6.7	7.0	10	10	15	12	16	19	25	35	45
	2.3	2.7	4.2	5.4	6.2	7.9	8.7	11	13	17	19	23	20	24	31	38	55	66
Steel—Medium	.78	1.4	1.6	2.2	2.5	3.4	3.4	5.0	5.5	7.5	7.8	11	8.7	12	14	19	26	34
	1.7	2.0	3.1	4.0	4.7	5.9	6.5	8.1	10	13	14	17	15	18	23	29	42	50
Steel—Hard	.56	1.0	1.1	1.6	1.8	2.5	2.5	3.6	3.9	5.4	5.7	8.4	6.3	8.6	10	13	19	25
	1.2	1.4	2.2	2.9	3.4	4.3	4.7	5.9	7.3	9.2	10	12	11	13	17	21	30	36

7.0	10
13	17

RATED CAPACITY
Continuous operation

25% OVER THE RATED CAPACITY
Usually not detrimental

75% OVER THE RATED CAPACITY
Intermittent operation, one minute maximum period. Minimum idle time between cuts should equal the cutting time.

50% OVER THE RATED CAPACITY
Intermittent operation, five minute maximum period. Minimum idle time between cuts should equal 1/5 the cutting time.

To select a milling machine having sufficient power to remove 7 cubic inches per minute continuously of SAE 1020, Bhn 170, read down the material column to Steel-Soft; read right to first number equaling or exceeding 7; read up to horsepower rating. To remove soft Steel continuously at the rate of 7 cubic inches per minute a 15 horsepower machine should be used.

Fig. 3.

whilst the use of cutting fluids will improve the cutter life even at high cutting speeds, there is no appreciable reduction of power saving, and with regard to cooling qualities, there is not much in it. They are all practically about the same.

Cutting fluids do not reduce the tool forces in a machining operation. Any coolant will definitely increase tool life. Cutting fluids apart from giving increased tool life in terms of pieces completed between re-grinds of cutter may often also improve the finish.

Fairly reliable data on power required at the cutter to mill a representative group of metals is produced in this article. It must be remembered that in long production runs cutters wear and get dull. This way, even when there is no breakage of the teeth could increase power requirement to as much as 75%. Therefore, it is always advisable to keep a check on the number of hours a milling cutter is used, and it would certainly help lot of people if they for a certain period keep a quality control check on their cutting tools. A good quality control check will not only give them definite facts on tool life but will give them also definite facts on the efficiency of their machine tools. Do not forget that the modern milling machine cuts metal in the same way as it did 50 years ago, and by means of better materials and tools, the same machine has improved enormously.

One must never forget that the majority of the mechanical power supply to machine tool is used in the small region at the cutting edge of any tool. The rest of the power is used to overcome friction in the machine.

Lastly, many factors contribute to a successful mechanical milling operation and one of the main factors is to use the correct tool. There is no magic cutting fluid or cutting tool or secret angles which will do away with the exacting requirements in tools and set up.

It is far better to analyse and find out the exact life of your milling cutters than to let them run to destruction. It is much cheaper to set up a timing schedule for re-sharpening of milling cutters than to be presented with burnt out motors and broken cutters.

Lastly, it is no good reading a technical article and expect your machine to reduce results tabulated. No company in the world will give a definite statement of what a machine tool will do. They will only tell you what a machine can do under certain circumstances and these certain circumstances are never in your shop. The thing to do is to take a realistic view, examine your machines carefully, realise in a practical manner your machines failings and try to improve it by proper tool set ups, proper grinding of cutters and by taking even only for a short time a quality control check will you be able to feel that your machines are giving you a run for your money.

(Continued on page 76)

Preparation of Ion-Exchange Materials from Some Organic Wastes for use in the Treatment of Certain Waters

PART 1. EFFICIENCY OF THE MATERIALS AS CATION EXCHANGERS

By C. Anandeswara Sastry, P. V. R. Subrahmanyam and S. C. Pillai

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THE phenomenon of ion-exchange was observed about a hundred years ago.[1,2] But substantial progress in this field has been possible only after the observation that certain synthetic organic resins are capable of exchanging ions[3]. Synthetic ion exchangers are now being extensively used for a variety of purposes[4], including treatment of water.

Although great strides have been made in the development of synthetic ion exchangers, carbonaceous exchangers are still extensively used. This is due to the fact that they are cheap and they possess sufficiently high exchange capacity. In 1934 Liebknecht[5] observed that if certain coals were granulated and treated with sulphuric acid, they developed ion-exchange properties and, in addition, the product (sulphonated coal) was physically and chemically stable towards acids and to some extent towards alkalis. Much work has been done on the possible utilisation of coal, peat and lignite for the preparation of ion-exchange materials. Cation-exchangers prepared by the sulphonation of carbonaceous materials such as coal, peat and lignite are now available under various trade names, e. g. Catex 27, Catex 55 and Zeokarb.

Earlier studies carried out in this laboratory indicated that ion-exchange materials could be prepared from coffee waste and cotton "dust"[6-8]. Further studies have shown the possibility of preparing ion-exchange carbons from a variety of organic wastes.

THE ORGANIC WASTES EMPLOYED AND THE METHOD OF PREPARATION OF ION-EXCHANGE CARBONS FROM THEM

The following organic wastes were employed: tea waste (obtained from a section in the Institute Hostel), jute waste, ground-nut shell, coir fibre, paddy husk, saw dust, begasse and paper waste.

The ion-exchange carbons were prepared from the above carbonaceous materials by the following general procedure. 1,000 gms. of the waste was taken in a beaker and 1,500 c. c. of concentrated sulphuric acid (commercial sulphuric acid) added to it with constant stirring. This amount of acid was sufficient just to cover the material completely. Carbonisation took place instantaneously. After about 5 minutes, the reaction proceeded more vigorously giving rise to frothing. The beaker was then cooled in water and left overnight. The contents were poured into excess of water, the lumps crumbled with fingers and filtered on a Buchner funnel. The carbon was washed with water till it was free from acid (using methyl red as indicator), dried and sieved so as to pass through 20-mesh and be retained on 40-mesh. The yields of the ion-exchange materials obtained are given in Table I.

(Continued from page 75)

Finally a word with regard to carbide milling cutters and negative rate. This technique is purely and simply removal of metal by brute force. The milling machine will therefore be of a very heavy construction and will have usually 50 H. P. under its belt. The gearbox will also be specially designed for this racket. Also, negative rake cutting can only be applied in very special circumstances.

Trying to be clever an ordinary standard type machine will only result in very expensive noises. Please do not attempt to turn your milling section into a laboratory. It never pays. The negative rake milling is really a means of removing metal fast. The only reason there is a negative rake is to ensure the utmost strength at the cutting edge. The negative rake angle places the cutting tip under compression and a positive rake angle keeps the tip in tension. This is the difference in a nutshell, and quite frankly, the negative rake angle technique is only possible because carbide is so much harder than steel and when used on a very high powered and rigidly constructed machine there is success.

TABLE I

The amounts of the ion-exchange carbons obtained by sulphonation of organic wastes

No.	Material	Yield (in gms. per 1,000 gms. of the material)
1	Tea waste	520
2	Jute waste	440
3	Groundnut shell	480
4	Coir fibre	380
5	Paddy husk	420
6	Saw dust	500
7	Begasse	340
8	Paper waste	340

EFFICIENCY OF THE CARBONS AS CATION EXCHANGERS

For testing the material, 20 gms. of the carbon (20"–40" mesh material) was weighed into a glass tube of 1 inch diameter in which it was supported on a layer of glass wool spread over a one-holed rubber cork. Five per cent sodium chloride was then passed through it till the effluent showed no acidity to methyl red, thus indicating that all replaceable hydrogen ions of the carbon were exchanged for sodium. The bed was then washed free from excess sodium chloride (as tested by silver nitrate solution). At this stage, 0.1% calcium chloride solution was allowed to percolate through the bed at the rate of 25 c. c. per minute, and 100 c. c. lots of the effluents were collected successively and analysed for calcium. The results are presented in Tables 2 to 6.

TABLE 2

Efficiency of the carbon prepared from tea waste in removing calcium from 0.1% calcium chloride solution

Lot No.	Amount of calcium: 1st cycle mg. in 100 c. c.		2nd cycle mg. in 100 c. c.		3rd cycle mg. in 200 c. c.*		4th cycle mg. in 200 c. c. *		5th cycle mg. in 200 c. c. *	
	In the effluent	Taken up by the carbon	In the effluent	Taken up by the carbon	In the effluent	Taken up by the carbon	In the effluent	Taken up by the carbon	In the effluent	Taken up by the carbon
1	1.0	33.2	0.2	34.8	0.4	67.6	1.2	66.0	0.8	68.0
2	2.6	31.6	0.6	34.4	1.0	67.0	2.8	64.4	4.2	64.6
3	7.1	27.1	1.0	34.0	4.0	64.0	6.8	60.4	9.2	59.6
4	10.6	23.6	2.1	32.9	16.8	51.2	9.6	57.6	23.0	45.8
5	21.4	12.8	4.2	30.8	27.2	40.8	24.8	42.4	25.8	43.0
6	23.8	10.4	4.8	30.2	35.4	32.6	28.7	38.5	33.4	35.4
7	27.6	6.6	10.6	24.4	49.2	18.8	46.8	20.4	42.2	26.6
8	33.2	1.0	15.4	19.6	59.8	8.2	52.4	14.8	56.2	12.6
9	—	—	23.2	11.8	64.2	3.8	63.8	3.4	60.0	8.8
10	—	—	28.8	6.2	66.8	1.2	66.8	0.4	67.2	1.6
Blank	34.2	—	35.0	—	68.0	—	67.2	—	68.8	—
Total calcium taken up	—	146.3	—	259.1	—	355.2	—	368.3	—	366.0

* As the amount of calcium taken up by the carbon was considerable, 200 c. c. lots were collected instead of 100 c. c. lots.

TABLE 3

Efficiency of the carbon prepared from jute waste in removing calcium from 0.1% calcium chloride solution

Amount of calcium

Lot No.	1st cycle mg. in 100 c. c.		2nd cycle mg. in 100 c. c.		3rd cycle mg. in 200 c. c. *		4th cycle mg. in 200 c. c. *		5th cycle mg. in 200 c. c. *	
	In the effluent	Taken up by the carbon	In the effluent	Taken up by the carbon	In the effluent	Taken up by the carbon	In the effluent	Taken up by the carbon	In the effluent	Taken up by the carbon
1	0.1	35.7	0.0	36.0	0.3	71.7	0.2	71.0	0.9	72.5
2	2.2	33.6	0.8	35.2	2.8	69.2	1.9	69.3	5.9	67.5
3	8.9	26.9	0.9	35.1	9.9	62.1	12.3	58.9	14.9	58.5
4	15.8	20.0	4.8	31.2	15.9	56.1	19.1	52.1	21.2	52.2
5	28.2	7.6	9.7	26.3	30.8	41.2	29.8	41.4	36.1	37.3
6	32.7	3.1	12.0	24.0	48.8	23.2	37.6	33.5	42.4	31.0
7	34.9	0.9	19.8	16.2	59.6	12.4	61.6	9.6	57.8	15.6
8	—	—	28.9	7.1	66.4	5.6	68.9	2.3	69.4	4.0
9	—	—	29.2	6.8	68.5	3.5	71.0	0.2	71.4	2.0
10	—	—	34.8	1.2	71.2	0.8	—	—	72.9	0.5
Blank	35.8	—	36.0	—	72.0	—	71.2	—	73.4	—
Total calcium — taken up		127.8	—	219.1	—	345.8	—	338.3	—	341.1

*As the amount of calcium taken up by the carbon was considerable, 200 c. c. lots were collected instead of 100 c. c. lots

TABLE 4

Efficiency of the carbon prepared from groundnut shell in removing calcium from 0.1% calcium chloride solution

Amount of calcium

Lot No.	1st cycle mg. in 100 c. c.		2nd cycle mg. in 100 c. c.		3rd cycle mg. in 200 c. c.*		4th cycle mg. in 200 c. c. *		5th cycle mg. in 200 c. c. *	
	In the effluent	Taken up by the carbon	In the effluent	Taken up by the carbon	In the effluent	Taken up by the carbon	In the effluent	Taken up by the carbon	In the effluent	Taken up by the carbon
1	2.6	30.8	0.4	34.4	2.6	68.8	0.3	71.7	0.1	70.9
2	5.8	27.6	0.9	33.9	6.1	65.3	1.2	70.8	2.3	68.7
3	8.4	25.0	1.6	33.2	10.9	60.5	11.7	60.3	6.7	64.3
4	9.8	23.6	3.7	31.1	19.8	51.6	26.9	45.1	18.9	52.1
5	16.5	16.9	5.2	29.6	21.2	50.2	28.8	43.2	31.6	39.4
6	21.4	12.0	10.8	24.0	35.3	36.1	39.4	32.6	38.9	32.1
7	27.8	5.6	17.6	17.2	47.1	24.3	47.5	24.5	47.4	23.6
8	32.4	1.0	25.2	9.6	58.0	13.4	60.4	11.6	52.5	18.5
9			30.8	4.0	69.6	1.8	66.8	5.2	61.2	9.8
10	—	—	34.2	0.6	70.9	0.5	71.0	1.0	70.8	0.2
Blank	33.4	—	34.8	—	71.4	—	72.0	—	71.0	—
Total calcium taken up		142.5	—	217.6	—	372.5	—	366.0	—	379.6

* As the amount of calcium taken up by the carbon was considerable, 200 c. c. lots were collected instead of 100 c. c. lots.

TABLE 5

Efficiency of the carbon prepared from waste coir fibre in removing calcium from 0.1% calcium chloride solution

Amount of calcium

Lot No.	1st cycle mg. in 100 c. c.		2nd cycle mg. in 100 c. c.		3rd cycle mg. in 200 c. c. *		4th cycle mg. in 200 c. c. *		5th cycle mg. in 200 c. c. *	
	In the effluent	Taken up by the carbon	In the effluent	Taken up by the carbon	In the effluent	Taken up by the carbon	In the effluent	Taken up by the carbon	In the effluent	Taken up by the carbon
1	0.8	32.8	1.0	32.0	3.0	65.0	1.5	66.1	1.0	67.0
2	2.4	31.2	1.8	31.2	6.0	62.0	3.0	64.6	2.3	65.7
3	8.6	25.0	2.2	30.8	10.0	58.0	9.5	58.1	2.0	66.0
4	16.2	17.4	4.6	28.4	17.5	50.5	20.2	47.4	13.0	55.0
5	22.6	11.0	8.8	24.2	30.4	37.6	35.4	32.2	31.0	37.0
6	23.8	9.8	12.4	20.6	42.1	25.9	48.7	18.9	52.3	15.7
7	27.2	6.4	13.8	19.2	50.2	17.8	56.4	11.2	58.3	9.7
8	33.2	0.4	20.4	12.6	54.8	13.2	60.8	6.8	60.4	7.6
9	—	—	22.8	10.2	65.2	2.8	62.2	5.4	62.6	5.4
10	—	—	31.0	2.0	67.2	0.8	66.4	1.2	67.2	0.8
Blank	33.6	—	33.0	—	68.0	—	67.6	—	68.0	—
Total calcium — taken up		133.0	—	211.2	—	333.6	—	311.9	—	329.9

*As the amount of calcium taken up by the carbon was considerable, 200 c. c. lots were collected instead of 100 c. c. lots

TABLE 6

Efficiency of the carbons prepared from paddy husk, saw dust, begasse and paper waste in removing calcium from 0.1% calcium chloride solution.

Amounts of calcium (in mg.) removed from 0.1% calcium chloride solution

Materials	1st cycle	2nd cycle	3rd cycle	4th cycle	5th cycle
Carbons from:					
Paddy husk	138.4	298.2	384.2	368.9	380.1
Saw dust	144.4	276.8	370.0	388.2	369.9
Begasse	129.2	227.2	336.4	324.7	329.7
Paper waste	116.8	214.1	308.2	316.4	315.0

Attempts are also being made to improve the ion-exchange capacity of the carbons. It has been found that further sulphonation of the ion-exchange carbons with 10% fuming sulphuric acid (50 c. c. for 100 gms. of the carbon) at 90°C. improved their ion-exchange capacity, e. g. tea waste carbon (20 gms.) after treatment with fuming sulphuric acid removed 520 gms. calcium from 0.1% calcium chloride solution.

SUMMARY AND CONCLUSIONS

The method of utilisation of organic wastes outlined above may perhaps be a new approach in regard to the disposal of certain organic wastes which are abundantly available in many parts of India. Some of the wastes are available throughout the year, and the others are obtainable during certain seasons of the year. At present these materials are used as fuel or for manurial purposes. In some places they are dumped on the waste land.

By the method indicated above a granular carbon possessing ion-exchange properties may be prepared from the waste materials by suitable treatment with sulphuric acid and sodium chloride. The efficiency of the sulphonated carbon in removing calcium from 0.1% calcium chloride solution was studied to some extent in the laboratory. The studies indicate the possibility of preparing ion-exchange materials from certain organic wastes and using them in the treatment of hard waters.

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New Science of Industrial Productivity

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IN the industrial sphere as scientific methods became more and more in vogue, the industry became more and more conscious of the defective methods of production and all began to appreciate the advantages that accrue from the use of science. This way increasing progress was achieved in the kind of machinery, methods of manufacture and types of raw materials. In the wake of this progress, scientists developed newer and newer sciences and amongst them Statistics and Industrial Engineering for Productivity are the latest.

The term 'Productivity' can perhaps be best defined by apparently simple connotation of the ratio of 'Out put' to in put. The units of 'Out put' are as a rule easy to understand, compute and represent. But that is not the case with 'In put'. In the use of that factor, all constituents (e. g. labour time, machine time, power consumption and so forth) that go to make total 'In put' ought to be considered to get the proper value. However, there are technical difficulties of measuring and putting on par the various factor of 'In put' in different expressions of Productivity and, therefore, to avoid confusion and disparity between one expression and the other, it is customary and probably the only practical way, to compute productivity based on labour factor alone, of-course with its own limitations of accuracy. In other terms, optimum productivity of a factory aims at fullest utilisation of its existing resources (viz. Men, Machines and Materials) with little or no additional capital investment.

Men thus have no small share of contribution and responsibility in the Productivity Index of a factory. Of men, there are various categories, Industrial Engineers being one of them. Managerial staff and routine machine operatives are other categories under the same class. We shall examine role that Industrial Engineers can play for the common goal of high productivity.

Industrial Engineers have a primary function to perform—and that function is to effect 'Methods Improvement' programmes constantly in their daily work—and thereby increase the chance of high productivity of the organisation.

DEVELOPING AN IMPROVED METHOD

One should first get a complete and accurate picture of the present job—so as to answer the six key questions: What, Why, When, Where and How, and should also consider the possibilities of improvement by elimination, combination, simplification and change of sequence of various operations. This is done by using any one or several of the tools. The improvement should aim at: (a) Economy in Human Effort, (b) Reduction in unnecessary fatigue (c) Improvement of workplace lay-out (d) Improvement of factory lay-out (e) Improvement of tools and equipment. These are achieved by applying principles of Motion Economy and Operation Analysis, which are listed hereunder:—

PRINCIPLES OF MOTION ECONOMY

Related to the use of the Human Body.

(1) The two hands should begin as well as complete their motions at the same time.

(2) The two hands should not be idle at the same time except during the rest periods.

(3) Motions of the arms should be made in opposite and symmetrical directions and should be made simultaneously.

(Continued from page 79)

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(To be Continued)

(4) Hand motions should be confined to the lowest classifications with which it is possible to perform the work satisfactorily.

(5) Momentum should be employed to assist the worker wherever possible and it should be reduced to a minimum if it must be overcome by muscular effort.

(6) Smooth continuous motions of the hands are preferable to zigzag motions or straight line motions involving sudden and sharp changes of direction.

(7) Ballistic movements are faster, easier and more accurate than restricted (fixation) or "Controlled" movements.

(8) Rhythm is essential to the smooth and automatic performance of an operation and the work should be arranged to permit an easy and natural rhythm wherever possible.

Related to the Arrangement of the Work Place.

(9) There should be a definite and fixed place for all tools and materials.

(10) Tools, materials and controls should be located close in and directly in front of the operator.

(11) Gravity feed bins and containers should be used to deliver materials close to the point of use.

(12) "Drop Deliveries" should be used wherever possible.

(13) Materials and tools should be located to permit the best sequence of motions.

(14) Provisions should be made for adequate conditions of seeing. Good illumination is the first requirement for satisfactory visual perception.

(15) The height of the work place and the chair should preferably be arranged so that alternate sitting and standing at work are easily possible.

(16) A chair of the type and height to permit good posture should be provided for every worker.

Related to the Design of Tools and Equipment.

(17) The hand should be relieved of all work that can be done more advantageously by a jig, or a foot-operated device.

(18) Two or more tools should be combined wherever possible.

(19) Tools and materials should be prepositioned wherever possible.

(20) Where each finger performs some specific movement, such as in typewriting, the load should be distributed in accordance with the inherent capacities of the finger.

(21) Handles such as those used on cranks and large screw-drivers should be designed to permit as much of the surface of the hand to come in contact with the handle as possible. This is particularly true when considerable force is exerted in using the handle. For light assembly work the screw-driver handle should be so shaped that it is smaller at the bottom than at the top.

(22) Levers, crossbars and hand-wheels should be located in such positions that the operator can manipulate them with the least change in body position and with the greatest mechanical advantage.

OPERATION ANALYSIS

The questions listed below, although by no means complete, show some of the elements that enter into a through consideration of the problems of finding the best way of doing work. This list is typical of a check sheet that can be prepared for use in a specific plant.

I Materials.

(1) Can cheaper materials be substituted?

(2) Is the material uniform and in proper condition when brought to the operator?

(3) Is the materials of proper size, weight and finish for most economical use?

(4) Is the material utilized to the fullest extent?

(5) Can some use be found for scrap and rejected parts?

(6) Can the number of storages of material and of parts in process be reduced?

II Materials Handling.

(1) Can the number of times the material is handled be reduced?

(2) Can the distance moved be shortened?

(3) Is the materials received, moved and stored in suitable containers? Are the containers kept clean?

(4) Are there delays in the delivery of material to the operator?

(5) Can the operator be relieved of handling materials by the use of conveyors ?

(6) Can backtracking be reduced or eliminated ?

(7) Will a rearrangement of the lay-out or combining of operations make it unnecessary to movet he material ?

III Tools, Jigs and Fixtures.

(1) Are the tools the best kind for this work ?

(2) Are the tools in good condition ?

(3) If metal-cutting tools, are the cutting angles of the tools correct and are they ground in a centralized tool grinding department ?

(4) Can tools or fixtures be changed so that less skill is required to perform the operation ?

(5) Are both hands occupied by productive work in using the tools or fixtures ?

(6) Can "slide feeds" "ejector" "holding devices" etc., be used ?

(7) Can an "engineering change" be made to simplify the design ?

IV Machine

A. Set up :

(1) Should the operator set up his own machine ?

(2) Can the number of set ups be reduced by proper lot sizes ?

(3) Are drawings, tools and gauges obtained without delay ?

(4) Are there delays in making inspection of first pieces produced ?

B. Operation :

(1) Can the operation be eliminated ?

(2) Can the work be done in multiple ?

(3) Can the machine speed or feed be increased ?

(4) Can an automatic feed be used ?

(5) Can the operation be divided into two or more short operations ?

(6) Can two or more operations be combined into one ?

(7) Can the sequence of the operation be changed ?

(8) Can the amount of scrap and spoiled work be reduced ?

(9) Can the part be prepositioned for the next operation ?

(10) Can interruptions be reduced or eliminated ?

(11) Can an inspection be combined with an operation ?

(12) Is the machine in good condition ?

V Operator.

(1) Is the operator qualified mentally and physically to perform this operation ?

(2) Can unnecessary fatigue be eliminated by a change in tools, fixtures, lay-out or working conditions ?

(3) Is supervision satisfactory ?

(4) Can the operator's performance be improved by further instruction ?

VI Working Conditions.

(1) Are the light, temperature and ventilation satisfactory on the job ?

(2) Are washrooms adequate ?

(3) Are there any unnecessary hazards involved in the operation ?

(4) Is provision made for the operator to work in either a sitting or a standing position ?

(5) Are the length of the working day and the rest periods set for maximum economy ?

(6) Is good house-keeping maintained through the plant ?

VII Inspection Requirements.

(1) By whom were the inspection requirements established ?

(2) What are the inspection requirements of the preceding operation ?

(3) What are the requirements of the following operation ?

(4) Will changing the requirements of a previous operation make this operation easier to perform ?

(5) Will changing the requirements of this operation make a subsequent operation easier to perform ?

(6) Are tolerance, allowance, finish and other requirements necessary ?

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ALL ABOUT STANDARDS

SUPPLEMENT TO FIREGUARDS STANDARD

SINCE October 1953 Statutory Regulations issued under the Heating Appliances (Fireguards) Act of 1952 have made it compulsory for all electric, gas, and oil-burning heaters to be fitted with safety guards which satisfy the requirements of British Standard 1945. The requirements specified in the Regulations, which are based on those in the British Standard, deal with the construction, fitting and testing for effectiveness of such guards.

Difficulties in interpreting some sections of the standard and thence in observing the Regulations have been experience both by manufacturers of heating appliances and by local government inspectors, whose responsibility it is to see that the Fireguards Act is properly complied with.

To help in avoiding such difficulties in the future the Committee which prepared B. S. 1945 has, with the help and approval of the Home Office, now produced a supplement to the standard. The supplement consists of a series of notes and three appendices which have to be read in conjunction with the original B. S. 1945.

Among other things, the notes explain what is meant by the phrase "maximum rate of burning" of the heating appliance for each of the three fuels concerned (electricity, gas and kerosene), and details are given regarding the conditioning of the strip of flannelette prior to the test for the effectiveness of the guard. A statement is also made which should help towards a clearer understanding of the term "smoulder".

The clause in B. S. 1945 dealing with the application to fireguards of the B. S. I. approvals mark (the "Kite") has been deleted, as marking requirements are included in the individual standards covering the complete heating appliance, namely, B. S. 1250 — 'Domestic gas appliances', B. S. 1670 — 'Safety requirements for electric fires', and B. S. 2049 — 'Kerosene appliances for Domestic use'.

* * *

BRITISH STANDARD FOR W. C. FLUSHING CISTERNS (INCLUDING FLUSH PIPES)

The present revision of this British Standard has been published after a review of the working of the standard

(Continued from page 82)

(7) Are they suitable for the purpose the part has to play in the finished product ?

(8) Will lowering the requirements materially reduce costs ?

Conclusions :

In order to improve, it must be approached with the idea that it can be improved. In other words, an open mind and a questioning attitude are essential. If improvement was possible in the past, it must be possible in future also. If sufficient thought is given, it would be found that any method can be improved, and therefore, a systematic method of questioning in an orderly and logical sequence is necessary because there are too many factors affecting production. If more than one operator is doing the same work, the difference in methods they use is the most important clue to Methods Improvement. We may summarise by stating that the following are sequential steps in Methods Improvement :—

SELECT	The Right job
RECORD	all details.
EXAMINE	Critically
DEVELOP	A new method and reduce it to writing as new standard practice.
INSTAL	The new standard practice
MAINTAIN	the new method to ensure that it is actually followed.

and of developments that have taken place since the last revision in 1945.

For the convenience of the user and to give greater clarity the specification has been devided into four sections: general requirements; requirements for low level cisterns; for high level cisterns; and for flush-pipes.

A minimum inside width is now given for the cistern shell, and external dimensions are now controlled only by the minimum thickness of the material. The external shape is no longer specified as it is thought unnecessary to control this feature.

The standard recognizes the tendency, particularly in low level suites, to place the ballvalves above the level of the warning pipe, whilst still allowing for the reversible types of cistern. A further help to manufacturers is given by allowing them to choose the diameter of the inlet and warning pipe holes to suit their purpose, provided that the hole takes a half-inch ball-valve and three-quarter inch warning pipe.

The requirements covering resistance to corrosion have been amplified and the possible materials divided into three groups: non-corrodible; corrodible but effectively protected, and products which corrode so slowly as to be virtually unaffected.

Provision has been made for the first time for bottom entry cisterns. Simple methods of test for capacity of discharge and time of discharge of the flush are given in appendices.

* * *

TUNGSTEN FILAMENT GENERAL SERVICE ELECTRIC LAMPS

The Indian Standard Institution has prepared and circulated for comments a draft Revision of the Indian Standard Specification for Tungsten Filament General Service Electric Lamps (IS: 418-1953). This standard which was originally published in 1953 has been in use for the last three years, having been followed by most of the manufacturers in India and adopted by almost all big purchasing organisations in the country. The present revision is based on experience gained during the currency of the standard and takes advantage of latest developments in the field. The scope of the standard which was originally confined to lamps up to 500 watts is now being extended to 1000 watts. Another important change introduced is the alteration of the methods of measurement of lamp performance. The average efficiency figures have been dispensed with and replaced by individual lamp lumens. This is in line with the latest international trend as reflected in the proposals under consideration by the International Electrotechnical Commission. A number of changes consequent on the above mentioned two modifications have been introduced in the different clauses of the draft standard.

* * *

The Indian Standards Institution has circulated for comments, a draft Indian Standard Code of Practice for Safety and Health requirements in Electric and Gas Welding and Cutting operations. In recent years considerable development has taken place in the field of welding. Electric and gas welding and cutting are becoming increasingly popular in the field of fabrication in both structural and non-structural parts. Associated with these are certain hazards which have to be taken note of and certain rules observed from the safety and health points of view. This draft Indian Standard Code is expected to guide those engaged in electric and gas welding and cutting operations in the observance of safety rules.

* * *

ELECTRONIC COMPONENTS

The Indian Standards Institution has published two more standards (IS: 824 & 825-1956) relating to electronic component. One of these, namely IS: 824-1956, covers a standard series of preferred values for capacitors and resistors used in electronic and communication equipment. Three series of preferred values with their associated tolerances have been given for wire-wound as well as fixed composition resistors and for capacitors up to the value of 1,00,000 picofarads. The other standard, IS: 825-1956, lays down the colour code for identification of values and tolerances on values of fixed resistors used in radio and electronic equipment. Only the band system has been recognized for the standard colour code and the colours of the different bands are required to comply with the relevant shades given in IS: 5-1955 Colours for Ready Mixed Paints. Both the standards are in conformity with the international practice as recognized in the published recommendations of the International Electrotechnical Commission (IEC).

* * *

RECOMMENDATIONS FOR SELECTION OF GRINDING WHEELS

The Indian Standards Institution has prepared and circulated for eliciting comments draft Indian Standard

Recommendations for Selection of Grinding Wheels. The draft attempts to provide information, in very general terms, on the major considerations that should influence the selection of wheel suitable for a given class of work.

The ISI will entertain comments on the draft upto 31st January 1957.

* * *

SPECIFICATIONS FOR PESTICIDES

The Indian Standards Institution has recently circulated the third series of six Draft Indian Standard Specifications for Pest Control Formulations with a view to receiving critical review, comments and suggestions from all interests concerned in this country and abroad. These draft standard specifications prepared by the Pest Control Products Sectional Committee of the Indian Standards Institution, inter alia cover the following subjects:

(i) Lime Sulphur Solution
(ii) Pyrethrum Extracts

Lime Sulphur Solution is largely used as a fungicide and also as in insecticide against pests of animal husbandry and agriculture. The fungicidal and insecticidal properties of this material are essentially due to its polysulphide sulphur content. In the draft standard for lime sulphur solution minimum requirements of polysulphide sulphur content which will make the material effective as a fungicide have been specified. Maximum permissible limits for thiosulphate sulphur and sulphate sulphur content have also been laid down in this draft standard.

The second draft concerns pyrethrum extracts. Pyrethrum extracts containing varying percentages of pyrethrins, are largely used in the control of insect pests of medical, agricultural and veterinary importance. Different percentages of pyrethrins are required for different purposes. This draft standard, therefore, stipulates the variations that are permitted in the nominal percentage, which has been left to be decided between the purchaser and the vendor according to the purpose for which the material will be utilized. The solvents used in extracting pyrethrum being of inflammable nature, the lowest permissible flash point has been specified in this draft standard to reduce the risk of fire during handling and transport of the material. Since pyrethrum extract is also used as an ærosol, a maximum limit for matter insoluble in dichloro-difluoromethane has also been prescribed for the material used as a ærosol.

* * *

MAGNESIUM OXYCHLORIDE FLOORING COMPOSITIONS

The Indian Standards Institution has issued an Indian Standard Specification (IS: 657—1956) for Materials for Use in the Manufacture of Magnesium Oxychloride Flooring Compositions (Tentative).

The specification forms a supplement to the Code of Practice for Magnesium Oxychloride flooring Compositions (IS: 658—1956) issued by the ISI sometime ago and lays down the requirements for materials which are to be used in the preparation and laying of magnesium oxychloride flooring compositions, such as calcined magnesite, fillers and aggregates, pigments and magnesium chloride also known as gauging solution.

The practice in regard to the laying of magnesium oxychloride composition floors varies from purchaser to purchaser. While on a small scale the manufacturers of magnesium oxychloride flooring compositions undertake laying of the floors, large users such as railways purchase the dry mix and the gauging solutions separately and use them when required according to the recommendations of the manufacturers. In the latter case it is important that the dry mix and the gauging solutions should conform to certain essential requirements in regard to quality as well as storage. This specification helps in testing the dry mix and the gauging solution to check whether they conform to the requirements.

* * *

FREE LIME IN PORTLAND CEMENT

The Indian Standards Institution has prepared a draft Indian Standard Method of Test for Determination of Free Lime in Portland Cement and has circulated it widely inviting comments.

The presence of free lime in cement is one of the factors that causes unsoundness in cement or concrete and also leads to leaching of cement defacing the exposed surface of good masonry work or cement concrete work. Knowledge of the free lime content in cement will help the engineer to take note of possible unsoundness or leaching that may occur after construction. The draft Standard has been prepared with a view to providing a guide to determine free lime content in cement. It outlines three methods, of which the first method, though tedious, is accurate and will have to be used as referee method. Two alternative methods have been included which are rapid and are useful in determining free lime as part of testing routine in a manufacturing works.

PROCEEDINGS OF THE AMERICAN POWER CONFERENCE: Illinois Institute of Technology, Technology Centre, 3300 Federal Street, Chicago, Illinois, U.S.A., 750 pages, $ 6.00.

The American Power Conference is sponsored by the Illinois Inst. of Technology, with the co-operation of the various universities and technical societies such as the universities of Wisconsin, Michigan, Minnesota and others, and aims in providing a national forum for discussion of problems on all matters of interest to the power industry and associated lines of endeavour.

The first few pages are devoted to a general sessions, followed by papers on Nuclear Energy; Mechanical Engineering; Water Technology; and Electrical Engineering. The first sessions covered topics of general interest to industry and each paper presented by a leading figure in the industrial world. The role of electrical industry is portrayed by the President of Commonwealth Eddison Co., followed by speakers from Edison Electric Inst; and General Electric Company. Dr. Daniels of the University of Wisconsin, an authority on Solar energy, and one of the participants of the recent Solar Energy conference held in India, contributes an enlightening discourse on the shortage of world's normal fuels, and the need to concentrate on solar energy. The last in the general sessions is a lengthy paper on the industrial developments of atomic energy contributed by six persons. The main nuclear energy sessions started of with papers on the Dual-cycle reactor plant as a part of the future power system; general nuclear power industry development; sodium graphite reactor power plants; followed by papers on steam generators and the problems associated with research and industry; steam turbines, research in fuels with reference to petroleum and coal industries; central station powerplants; gas turbines; and automatic generating equipment for utilities. Interesting papers are also contributed on the subject of cooling towers, now coming into prominence in this country.

The section on water technology is subdivided into four parts, and a general introduction. The latter containing four papers cover the description of St. Lawrence Seaway; method of conversion of saline water; effects of precipitation on ground water in Wisconsin; and use of water for irrigation, navigation and power. The first part of the next section deals with demineral isation of water and boiler feed make up; the second part covers topics on centralised control of boiler and feedwater and use of water for heat pump systems; the third covers use of water in high pressure steam valves and the operating characteristics; followed by the last part on filming amines.

The electrical sessions covers topics on planning, distribution and application of electricity in industry. Electronic application and network analysers also receive their due share of merit. Most of the papers are followed by panel discussions. Although a bit disjointed in their contents, nevertheless the proceedings forms a veritable handbook of current information of the fast developing power industry of the United States.

S. K. G.

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THE COLD ROLLED SECTIONS ASSOCIATION MANUAL OF TECHNICAL REFERENCE: Frank Impey and Co., Lombard House, 114 Gt. Charles Street, Birmingham, 3, England. 78 pages, 21 double folding plates, and 32 photographs, £ 2-2-0d.

Cold rolled metal sections are a new industrial material manufactured from any metal with sufficient ductility to bend. The process of forming makes it possible to distribute the metal evenly so as to give a better strength/weight ratio than any other forming process of comparable cost. The rolling process uses strip metal in the required width and thickness and forms it into a section of uniform profile and of any desired length.

The applications of cold rolled sections are numerous and depend on the ingenuity of the designer. Among these may me mentioned industrial buildings, storage

sheds, schools, garages, and housing, for the structure; and lattice girders, stanchions, beams, purlins and bracings, window frames, door tracks, roller shutters, for components. In other fields they have proved of great utility in the automobile and rolling stock industry, as well as in metal furniture.

The text under review concentrates on the structural side of the applications, although in the first few pages general descriptions of sheet strip operations are also given. The availability of a wide variety of sections by cold rolling are discussed and the limitations of tolerance and dimensions evaluated. This is followed by sections on machine operations, such as cutting, curving, punching, notching and dimpling, joggling, welding, and general fabrication. Topics on simple and compound profile sections are given, together with a digress on protective treatments and storage and packing arrangements. The main reference tables on structural characteristics are preceded by a short review on the structural strength of cold rolled sections. The main aspect of thin walled sections is that a greater economy in weight per unit of load carried is achieved, while the designer has at his disposal a large range of sections from which he can choose the best profile.

The load tables drawn up are for mild steel cold rolled sections to B. S. 1449: 1948, having an Yield stress of 14 tons/sq. inch, and an Ultimate Stress of 24 tons/sq. inch. The tables cover plain channel struts, lipped channel struts, plain channels back to back; beams—lipped channels back to back, plain channels back to back, with and without lateral support, geometric properties of elements, areas of webs and flanges, corners, and moments of inertia, general properties of different materials, such as metals, glass, timber, and asbestos, strip steel weights, and gauges. A good bibliography is also appended. These are followed by fold out drawings giving working details of storage sheds, portal frames, prefabricated hutting, decking, rail car sections etc. and excellent photographs of the structures built in cold rolled sections in the United Kingdom. An impressive Foreword is contributed by Sir Charles Mole, Director General of Works, of British Ministry of Works.

An excellent work of reference on the structural applications of cold rolled sections in steel.

S. K. G.

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THE CHEMICAL BACKGROUND OF THE ALUMINIUM INDUSTRY: by T.G.Pearson, Ph. D., D. Sc., F. I. M., F. R. I. C., The Royal Institute of Chemistry, 30 Russell Square, London, W. C. 1., 104 pages.

This impressive monograph, written by the Director of Research, The British Aluminium Co., Ltd., actually coincides with the year of the 100th anniversary of the launching of the aluminium industry by Henry St. Claire Deville, as a result of some research work begun about 1845.

The monograph provides a detailed outline of the commercial processes now used in extracting and refining aluminium and also gives an account of its chemistry. It also reviews the massive accumulation of discoveries, inventions and basic researches, that have so far failed, except in very special circumstances, to reach large-scale commercial development.

The aluminium industry was founded in 1854 by Deville on the basis of the reduction of aluminium chloride with sodium to yield substantially pure aluminium and sodium aluminium chloride, the latter being removed by distillation. Deville appears to have manufactured nearly 60 lbs. of aluminium during 1855—56. The price of the metal fell from about £ 50 per pound in 1855 to 5 sh. per pound in 1859. The modern industry founded on the methods of Hall, and Heroult, and Bayer is still in the process of growth. In 1900 the world production of virgin metal was nearly 7000 long tons, while in 1954 it had reached 2,750,000 tons. On an average the production has increased at the rate of 8½% per year. The valuable characteristics of the metal have contributed to this expansion and a real reduction in the price of the metal. The author has divided the work into six sections and a general introduction and an exhaustive bibliography.

Beginning with the raw material Bauxite which is the principal source of extraction of aluminium, the author passes on to the Bayer process of manufacture. With rare exceptions, all of the pure aluminia used by industry amounting to well over 5,000,000 tons a year is manufactured by the Bayer process, the essentials of which were patented by Karl Josef Bayer of Austria in 1888. The reduction of alumina to aluminium is carried out by the smelting process which consists of a furnace having a carbon anode, a molten aluminium cathode, and an electrolyte of molten cryolite in which alumina is dissolved. This process is described in detail with many practical observations from the author's rich experience. This is followed by the refining process, which on a commercial scale has been successfully carried out only with the aid of molten salt electrolysis. The last two sections cover the work of several investigators who have tried to evolve new methods of manufacture to replace the Bayer process and the Hall Heroult processes. It actually forms a critical survey of their work with an outline of the merits of the methods.

The work is well documented, and contains a number of tables and illustrations, and will form a very illuminating source of reference on the background of the aluminium industry with reference to its chemical structure.

S. K. G

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THE ORGANISATION OF APPLIED RESEARCH IN EUROPE, THE UNITED STATES AND CANADA: Vols. I, II, and III. The Organisation for European Economic Co-operation, 2 Rue Andre-Pascal, Paris 16e, France. Vol. I, 78 pages, Fr. Fr. 300.—Vol. II, 184 pages, Fr.Fr. 600.— Vol. III, 128 pages, Fr.Fr. 400.—

The three volumes jointly issued by O.E.E.C., form the Report of Technical Assistance Missions Nos. 81, 82, and 83 whose membership included the leading distinguished personalities from various European countries, namely, Italy, the Netherlands, Belgium, France, Germany, as well as from the United States, United Kingdom and Ireland.

The first volume is a comparative study between United States and Canada on one hand and Europe on the other. Points of difference are noted and evaluated and an attempt is made to show where European organisations engaged on research can learn from their American counterparts in both methods and attitudes. Europe has a vast store of fundamental research capacity, and it is recommended that it should enlarge its function in the field of applied research to utilise its resources. If applied research programmes are to be effective they must be well administered. More attention should be given, as in the United States, to the training of research directors combining the high qualities of the scientist and the manager. The report is sub-divided into four chapters, covering the above under National Research Policy; The Internal Structure of Applied Science; Particular Aspects of Administration within Research Organisations; and The Research Climate in Europe and America. General recommendations are appended.

The second volume forms a review of applied research in Western Europe and reveals the wide divergencies both in facilities for research and the importance attached to it in the various countries. It also contains a summary of views expressed during a symposium held in London in 1952, by some of the leading figures in European research among the countries taken up for detail studies are Austria, Belgium, Denmark, France, Germany, Ireland, Italy, the Netherlands, Norway, Sweden, Switzerland, and the United Kingdom. The third volume discusses the position of research organisations in the United States and Canada. This report is written by authors appointed by the U. S. National Academy of Sciences and the National Research Council of Canada, and detail the parts played in those countries by the Central and local Governments, the Universities, Scientific Foundations, and the industry itself.

The United States is large in area, rich in natural resources has an average population density of 50.7 persons per square mile. Ever since Europeans migrated into this land to live on the edge of wilderness, a pioneering spirit has pervaded the settlers, now clearly visible in the dominant attitude of industrial development that has marked and singled out that country. This development is mainly due to its spirit of applied research, a field of study which has not so far been pursued in any other country with the same zeal as in the United States.

The three volumes put together give a very critical cross section of the nature of applied research in various countries of the world and should be read with profit by all interested in the field.

S. K. G.

RUSSIAN AID FOR STEEL INDUSTRIES

It is reported that the Government of the U. S. S. R. have offered to supply industrial equipments for steel projects as may be agreed upon, upto a total value of about Rs. 55-60 crores, over a period of three years from 1959-61 on a long term credit basis. The offer has been accepted by the Government of India. The credit terms offered are (including the period of repayment, rate of interest etc.) similar to those for the Bhilai steel plant. According to the terms, the credit raised shall be repaid by 12 equal annual instalments payable on or before the 15th of March of each year following the year in which each such credit is raised. Interest will accrue at $2\frac{1}{2}$ per cent per annum from the date on which each particular credit is raised and will be similarly paid on or before the 15th of March of the following year. Projects which should be financed from this source are under consideration of the Government.

COMPANY NEWS

RADIO LAMPS WORKS—SPEECH OF THE CHAIRMAN SHRI KAMALNAYAN BAJAJ

ADDRESSING the Annual General Meeting of the Company, Shri Kamalnayan Bajaj, Chairman said that there had been considerable mprovement in the working of the firm and that they were able to close the year with a net profit of Rs. 3,77,490—11—5 after writing off certain amounts as detailed in the Directors' Report. With the increasing tempo of industrialisation and electrification during the second five year plan, he added, the demand for electric goods including electric lamps, transformers, instruments and other items in which your Company is dealing will increase rapidly. We are making all possible efforts to see that your Company is able to obtain a fair share of this increased demand and I am confident that the Company can look forward to increasing sales and a bright future.

Continuing Shri Bajaj said "You will remember that some years ago we entered into an arrangement of technical collaboration with Messrs. N. V. Philips Gloeilampenfabriken of Holland and four British Companies, viz., The British Thomson-Houston Co., Ltd., Crompton Parkinson Ltd., The General Electric Co., Ltd., and Siemens Electric Lamps & Supplies Ltd., whereby our factory at Shikohabad and the Company's lamp manufacturing business were transferred to a new jointly owned enterprise known as Hind Lamps Private Ltd. We own 50 per cent interest in this Company and the five-above-named European Companies own the other 50%.

"The production of the factory is distributed amongst the different Companies in their respective brands in proportion to their share-holding in Hind Lamps. The technical management of the factory is entrusted to Messrs. N. V. Philips. This collaboration arrangement has now been in operation for nearly five years and you will be glad to learn that this arrangement is working to the satisfaction of all concerned and Hind Lamps have made considerable progress during this period.

"Besides Electric Lamps, Hind Lamps Private Ltd., now make the two most important components required for electric lamps, viz., Glass Shells and Brass Caps. In addition to meeting their own requirements Hind Lamps are supplying these components to other lamp factories in the country. A Plant for the manufacture of Glass Tubings and Rods is expected to go into operation shortly. Schemes are now on hand to considerably expand the production of General Lighting Service Lamps and to manufacture Fluorescent Tubes and Miniature Lamps at Skhokhabad. All this expansion will result in additional quantities of lamps and tubes being available to your Company for sale."

In a reference to the growth of sales of transformers, Mr. Bajaj said that the production of transformers, instruments, and allied goods was considerably on the increase and that in the coming years they can confidently look forward for a further improvement in this respect.

* * *

INDIAN COPPER CORPORATION LTD. SPEECH OF THE CHAIRMAN MR. J. F. E. d' A. WILLIS

Addressing the 32nd Annual General Meeting of the Company, the Chairman, Mr. J. F. E. d' A. Willis, announced the unexpectedly satisfactory results in business of the Company for the year and which had far exceeded the those of the previous year which had constituted a record in the annals of the Corporation and attributed them to a phenomenal rise in the demand for copper and also the world increase in prices. The maintenance of a high production standard and satisfactory despatches also played an important part in achieving these results. Although these high world prices for copper continued early 1956, there has since been a rapid decline to approximately two-thirds of the peak reached.

The production of refined copper he said stood at 7281 long tons and this was a record in the Corporation's history. Despatches were good and operating costs satisfactory although slightly higher than the previous year.

Lateral development, the Chairman continued, was again restricted but development in depth continued satisfactorily. Speaking about Ore Reserves he said that the estimate reserves now stood at 3,330,090 short tons as compared with 3,369,286 short tons at the end of the previous year, and this was considered satisfactory in the circumstances of restricted lateral development. Good progress was being made in the development of depth which should eventually provide with lateral development resulting in a substantial increase in ore reserves.

Speaking about the future development plans of the Corporation he said "In conformity with the underlying principles of the Second Five-Year-Plan, an extensive programme of prospecting and development has been prepared and is already well advanced. This expansion programme is aimed at increasing considerably the present output of the mines and whilst no immediate results can be anticipated, it is hoped, provided the results of the present exploration are satisfactory, that by the end of the present Plan your Company will have substantially contributed towards making India less dependent on imports of this important metal.

"During the year under review considerably development in depth has been effected in the existing Mosaboni Mine, utilising the newly constructed Circular Shaft to which my predecessor referred in his address last year. Development in depth on the scale at present envisaged will permit of extension lateral development, but only to the extent as will counteract the diminution of ore reserves at the adjoining Badia Mine whose life is limited. Any expansion in output, therefore must be derived from other areas and it is with this in mind that prospecting on an extensive scale is in progress to the north of the present working area.

"With the Government of India's recent industrial policy announcement, it is satisfactory to note that existing industries in Schedule A, which includes copper, will be permitted to remain in the Private Sector and that this does not preclude their expansion."

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THE SINGARENI COLLIERIES COMPANY LTD.—SPEECH OF THE CHAIRMAN—HON'BLE DR. G. S. MELKOTE

Addressing the 35th General Meeting of the Shareholders of the Singareni Collieries Co., Ltd., Hon'ble Dr. G. S. Melkote, Chairman, said that the results achieved this year had been more appreciable even than last year's when substantial progress was recorded. Speaking about the future plans Dr. Melkote said:

"We have undertaken as our contribution towards industrialisation programme under the Second Five-Year-Plan to raise the output of coal from our coalfields from 1.5 million tons to 3.0 million tons per year. This, in conjunction with production of lignite from Neivelli will just suffice to meet the requirements of the South. This programme of self-sufficiency will also relieve the strain on Rail transport system as it will minimise long haulage of coal from the Northern coalfields except for coal of a special quality required for special industrial needs. The Government of India have agreed to help finance it. The task, however, is not easy considering that we will have to put in six to seven new mines and that it takes 12 months or so of boring operations to prospect the country and locate the site of a mine and three years more to develop it. We will be pouring in money for all that time without seeing any return therefrom. This will be a period of test for all of us when we will have to brace ourselves up with hard work with strict adherence to time-table and tighten our belts for severe economies to be achieved. I have, however, no doubt that with a keen desire noticeable in everyone to serve the country to the best of his ability and play one's part in the mighty venture on which the country has launched the task will not be found insurmountable.

Speaking about the price structure, Dr. Melkote said:

"The Company has always maintained that their task is to reconcile and balance judiciously the three separate interests, i. e., of workers, the investors and customers. I have explained above how the interests of investors and the workers have been served and there remains the interest of consumers. In my last year's speech I said that your Company had reduced prices of certain grades of coal giving consumers a recurring annual benefit of Rs. 2.67 lacs. During the year the price of slack coal was reduced by Re. 1/- a ton giving the consumers a further annual recurring benefit of Rs. 2.14 lacs. This is something of which we can be proud of as you will no doubt recollect that in all other coal fields the price of coal was increased by 3 annas a ton with effect from 18—7—55 to meet the additional cost of the liberalised Provident Fund Rules introduced by the Government. We have not only met this additional liability from our own resources but actually passed on a reduction in the price of slack coal.

Dr. Melkote in conclusion congratulated the management, team of Officers and the Workers for the cordial industrial relations maintained throughout the year under review.

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THE JAY ENGINEERING WORKS LTD.—SPEECH OF THE CHAIRMAN, SIR SHRI RAM

Addressing the annual general meeting of the Shareholders, the Chairman of the Company, Sir Shri Ram, announced the increased output of Sewing Machines and Electric Fans and the discontinuance of the manufacture of Hurricane Lanterns. The machinery, building etc., pertaining to Hurricane Lanterns unit were being utilised for other purposes he added.

Continuing Sir Shri Ram said "Last year I had informed you that we intend to produce a Table Fan and sell it for about Rs. 60/- and I am glad that these Fans have been put on the market. We hope within the next few months to put a 36" Ceiling Fan on the market for about Rs. 100/-. I am glad to say that we have acquired about 75 bighas of land at a distance about 3 miles from our present site at a cost of roughly about Rs. 4 lacs. We have already built the necessary roads, boundry wall, and a bridge and covered an area of about $1\frac{3}{4}$ lac sq.ft. The machinery is being shifted there, and it is hoped that by the end of December we will be making there about 6,000 Fans per month, in addition to about 8,000 Fans in the existing factory. The Fan section will be completely shifted to the new site by next year, when we hope to be making about 25,000 Fans a month.

"During the year the Government of India have been good enough to give us licence for expansion of the fan capacity from 10,000 to 26,500 Fans per month and of the Sewing Machine factory from 10,000 a month to 25,000 a month.

"For the expansion of these factories more finance was required and the Industrial Finance Corporation of India have kindly sanctioned another loan of Rs. 30 lacs.

"Orders have already been placed for machinery for the expansion of the Fan Factory and the balancing of the existing Sewing Machine Factory.

"The Needle Plant has been shipped from Europe and we hope that before the end of this financial year it will be in full swing. A four storeyed building has been put up "for housing the Tool Room Design Office, Development and Research Department and Training School."

Speaking about Export prospects of Engineering goods, Sir Shri Ram said: "We, Industrialists, owe a duty to our country in helping it to secure as much foreign exchange as can be possible. I feel that there is room for considerable increase in the export of general engineering goods. The markets should be explored for proper assessment and every effort made to increase the exports. Like other various countries, it would be a good thing if the Government of India called a Conference of Railways, Industry, Trade, Labour, etc., to seriously consider as to how exports could be encouraged and helped. I do hope that the authorities will give the suggestion of mine due thought.

"I am conscious of the small contribution at present of the general engineering industry to our export trade, but I am sure that in our national drive to conserve and augment our foreign exchange resources we cannot afford to neglect even a small contribution and I am equally certain that there is very great scope for proper encouragement and for the export of engineering goods."

Speaking about the raw materials' position, Sir Shri Ram said "The Government of India recently announced its policy about uniformity in the prices of Steel Pig Iron of both Indian and imported; while this has helped the industries which are away from port towns and is welcome, but so far as the exports are concerned, I would suggest that on the engineering goods exported, the prices of raw-materials, whether Pig-Iron or Steel should be charged on the basis of the indigenous prices. While the difference in cost to the Pool will be negligible it will be a great help towards export of these goods.

DURGAPUR STEEL PROJECT

The United Kingdom's contribution to the establishment of the vast Steel Project at Durgapur, India, was mentioned by Earl of Munster at a meeting of the consultative committee of Ministers representing the Colombo Plan Members. The new steel works are being supplied and erected for the Government of India by Consortium of leading British Steel manufacturers. The Earl of Munster reported that the external costs amounting to more than fifty million pounds would be almost entirely covered by credit arrangements provided by the United Kingdom including a Government loan of fifteen million pounds to the Government of India.

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STEEL EQUALISATION FUND

It is reported that about Rs. 68.8 crores had accrued to the Iron & Steel Equalisation Fund up to the end of Oct. '56. Out of this Rs. 37.44 crores had been used for equalising the prices of Iron & Steel and Rs. 15.16 crores had been given as repayable advances to the Tata Iron & Steel Co. Ltd. and the Indian Iron & Steel Co. Ltd.

ENGINEERING NOTES & NEWS

HARISH KAPOOR

Harish Kapoor of Bombay, left, is pictured ramming up a mold at Austin Gray Iron Foundry. The young student is in the United States doing graduate work in

metallurgy engineering and is spending the summer in Sheboygan learning about foundry operations. Paul Kalk, Superintendent at the foundry, is shovelling the moulding stand.

BRITISH HEAVY MACHINERY FOR INDIAN FACTORIES

An 11-man mission from the United Kingdom, under the chairmanship of Sir Eric Coates, was in India

Sir Eric Coates, Chairman of the British Heavy Engineering Mission to India.

recently to advice on further extension of heavy machinery manufacturing capacity during the period of the second-five-year Plan. Considerable amount of British-buiit heavy machinery and machine tools has already

been installed in Indian industrial plants and factories under the first Five-Year-Plan, and under the new programme, machinery from Britain will continue to contribute to India's advance as an industrial nation.

Sir Eric coates last year led the British Mission which advised India on the setting up of the new steel works at Durgapur, West Bengal. A former Finance Member of the Governor-General's Executive Council, Sir Eric is well known in India. Having joined the I. C. S. in 1921, he served in the sub-continent for 25 years. In Britain, he was chairman of the Overseas Food Corporation (1950—51) and a Deputy Chairman of the National Coal Board from 1951.

OTHER MEMBERS OF THE BRITISH HEAVY ENGINEERING MISSION TO INDIA

MR. ROBERT ARBUTHNOTT

At present Managing Director of the North British Locomotive Co., Ltd., he has been associated with the Locomotive and heavy-engineering industries for over 30 years. He has had a long personal and family ties with India, and has visited the country many times in recent years in connection with railway development and the technical association which his Company has with the Chittaranjan Locomotive Works.

MR. J.W.L. ANDERSON

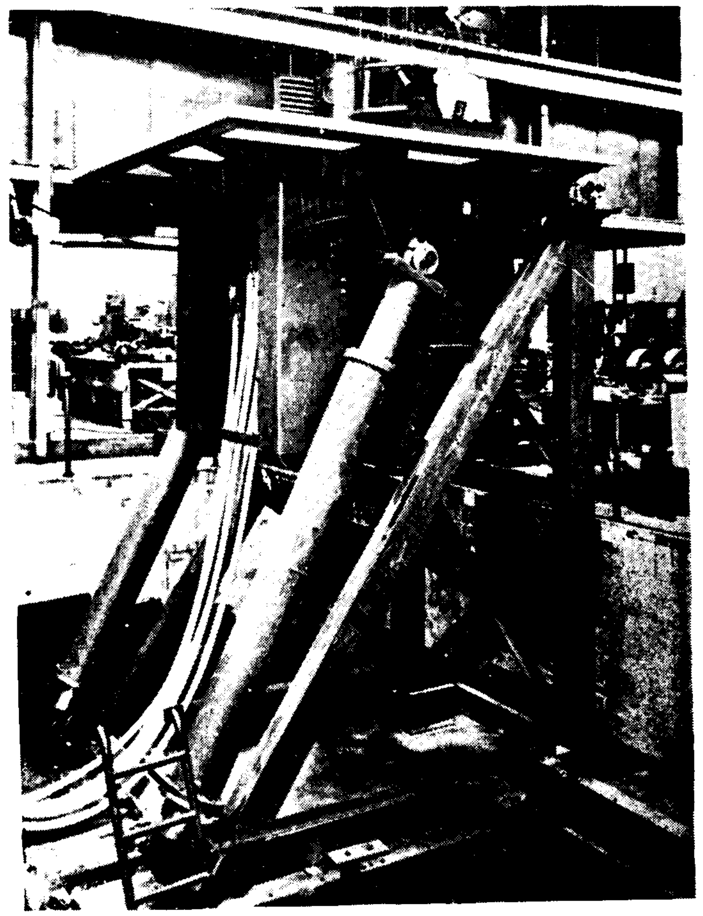
Since 1946, he has been a Director of British Jeffrey Diamond Ltd., of Wakefield, Yorkshire, makers of underground mining machinery and crushing, pulverizing, and grinding equipment. He joined the firm in 1933, served in different areas as District Manager, and in 1944 was recalled to head office and appointed Field Manager to the Company. In addition to his present activities in that capacity, he has the additional responsibility of directing the work of product research.

MR. WILLIAM GEORGE CARTER

He has served with W. S. Atkins & Partners, of London, consulting and industrial engineers, since 1946, and was accepted into the partnership in 1950. Previously, he was with A. & J. Main & Co., Ltd., in Calcutta (1936—39), and served with the Royal Engineers, attached to the Royal Bombay Sappers & Miners, from 1940 to 1945.

MR. L. G. EARLE

He is a partner in Campbell, Gifford & Morton Ltd., Consulting Metallurgical Engineers, of Weybridge,



Testing the hydraulic mechanism on a 5 ton. Birlec Mains Frequency Coreless Induction holding furnace at the company's works in Birmingham—rear angle view showing general construction and water-cooled cables.

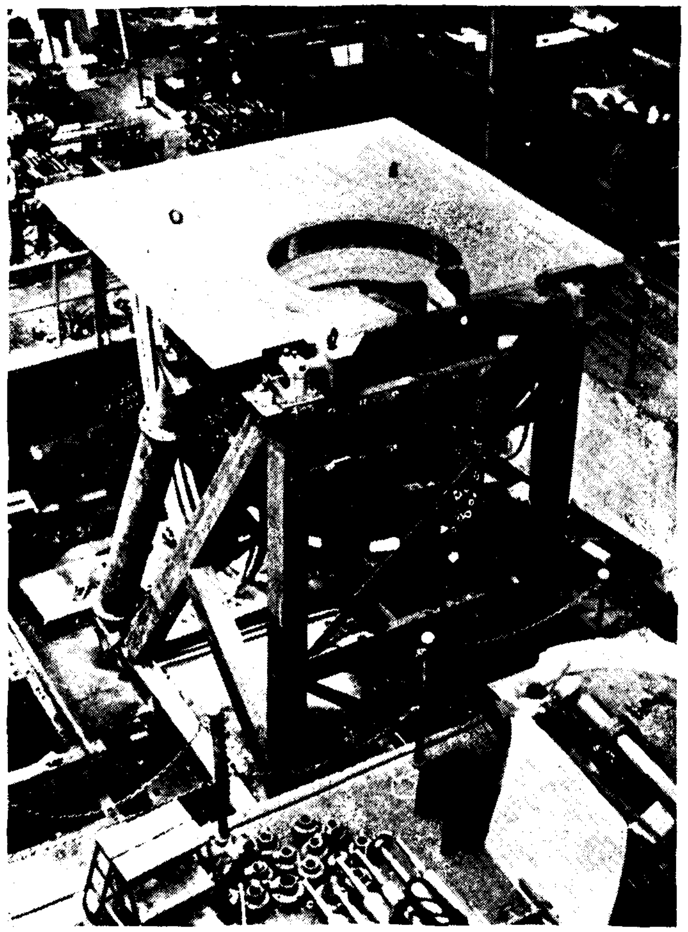
Surrey. The firm has designed, and been responsible for, iron and steel works for the British Government and other leading engineering projects in the United Kingdom.

MR. T. W. HAYES

He is a director of A. C. Wickman Ltd., of Coventry, manufacturers of multi-spindle automatics, grinding-machines and tungsten carbide tools. The firm is a member of the John Brown (Clydebank) group of companies.

MR. WILLIAM G. HUNT

He is a special director of the Asquith Machine Tool Corporation Ltd., of Halifax, Yorkshire, and joint managing director of Drummond-Asquith Ltd., London. He is also a director of the Associated Machine Tool Corp., of Pittsburgh, U. S. A. He joined the Asquith group in 1945, after holding a number of executive posts with A. C. Wickman Ltd., of Coventry.



Overhead view before lining showing furnace body, frame, and hydraulic tilting cylinders.

MR. L. W. NEEDHAM

He is a joint managing director of Head, Wrightson Colliery Engineering Ltd., of Sheffield.

MR. DOUGLAS JAMES STITT

He has had his own business as Engineering Consultant since 1950. He became Technical Director of the Steel Works Plant Association (SWPA) and the Hydraulic Association in 1946, in which capacity he continues to act. On behalf of SWPA, he has served on technical missions to Bangkok, Washington, and Mexico. On the present mission he is representing SWPA and acting as delegate for the Federated Association of Colliery Equipment Manufacturers.

MR. FREDERICK EDWARD WARNER

He is a partner in Cremer & Brearley, of London, Consulting Chemical Engineers. From 1948 to 1956 he was Chief Engineer to Carless, Capel & Leonard Ltd., London. During the war he served at a number of Royal Ordnance factories.

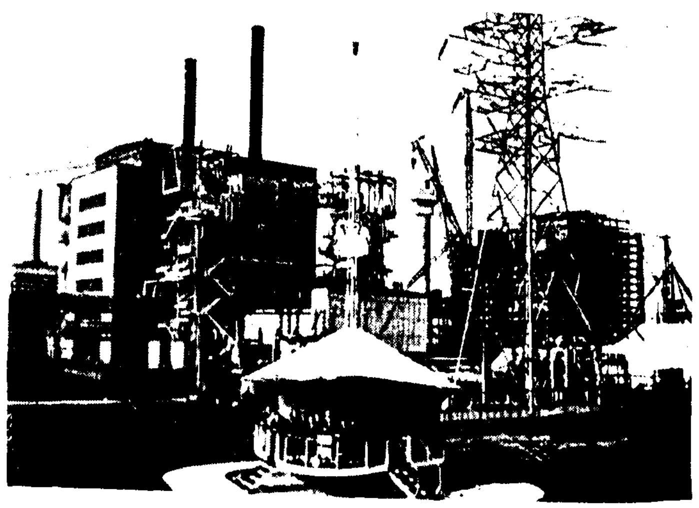
MR. M. D. J. BRISBY—SECRETARY TO THE MISSION

He was Technical Assistant and Secretary to last year's Coates Steel Mission to India. Assistant Chief Development Officer of the U. K. Iron & Steel Board, he has served with the British Iron & Steel Research Association and the London & North-Eastern Railway.

A recent example of the type of equipment being supplied by British manufacturers is a newly designed electric-arc furnace for installation in a large, mechanized alloy-iron foundry at the Tata Engineering & Locomotive Works at Jamshedpur. This furnace, which is now at the testing stage in a Birmingham factory, represents the completion of a large order, including two three-ton and two seven-ton Birlec electromelt arc furnaces, together with two laboratory-size furnaces. Of a newly developed design, this furnace is the first of the kind to be exported from Great Britain in India. It represents the completion of a large order including two three-ton and two seven-ton Birlec Lectromelt arc furnaces together with two laboratory size furnaces.

THE QUEEN OPENS CALDER HALL

H. M. Queen Elizabeth II is seen here making her speech from a dais before she pulled the control lever to open the world's first full-scale nuclear power station at Calder Hall, Cumberland, on October 17. The Queen and other speakers at the ceremony, described it as the opening of a new age which would have its effects throughout the world. "Above all", said the Queen, "we have something new to offer to the peoples of underdeveloped and less fortunate areas. It may well prove to have been among the greatest of our contributions to human welfare that we led the way in demonstrating the peaceful uses of this new source of power."



PORTABLE ATOMIC-ELECTRIC PLANT PLACED ON SALE IN UNITED STATES

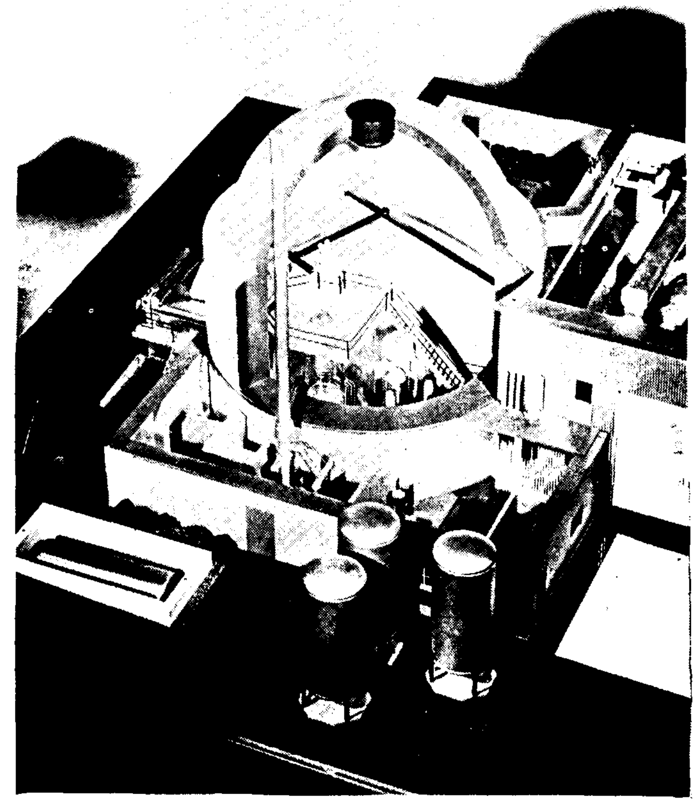
A nuclear power plant, which is completely portable, suitable to any climate in the world, and capable of producing enough electricity to supply a city of 10,000 people for 18 months without refuelling, has been developed by a United States Company and can be delivered to customers "within a reasonable time". The manufacturer of the newly portable, or "package type", atomic electric plant is the Glenn L. Martin Company of Baltimore.

A full size plant, which is fully operative and lacks only the nuclear fuel needed to run it, is being demonstrated now at the Martin factory here. The chief of Martin's nuclear division, which developed the new nuclear plant, is Tibor Nagey who at 34 has had more than 10 years experience as a nuclear engineer. Mr. Nagey believes that the inaccessible, underdeveloped areas of the world, such as the jungles of South America and Africa, the deserts of the Middle East or the frozen tundra of the Arctic and Antarctic, may be the regions in which the new plant would prove to be most valuable in the immediate future. These would be, however, by no means the only areas in which the plant would be useful.

Such a power plant, Mr. Nagey believes, would be of primary importance in many Latin American countries where present power costs are high. Nuclear power, he says, is already on a competitive basis, costwise, with conventional fuels in such countries.

The Martin nuclear power plant can be delivered, complete, in eight packages, or aluminium "pods", the largest of which would measure 9-by-9-30 feet. Eight railroad flat cars, an equal number of large trucks, or seven big transport planes could deliver the packages to the place where the power plant was to be used. Once there, it would take three to four days to set up the plant and put it into operation.

Once in place, the plant would run for 18 months on the nuclear fuel unit placed in it at the time of installation. When that unit is exhausted, a replacement is put in. Should the need for the power plant ever cease at its original location, it could be packed up and moved to another site. What does one of these packaged atomic power plants cost? A total figure has not yet been placed on the entire assembly, because the Martin Company cannot speak for the companies which will make the electric generators. These are separate from

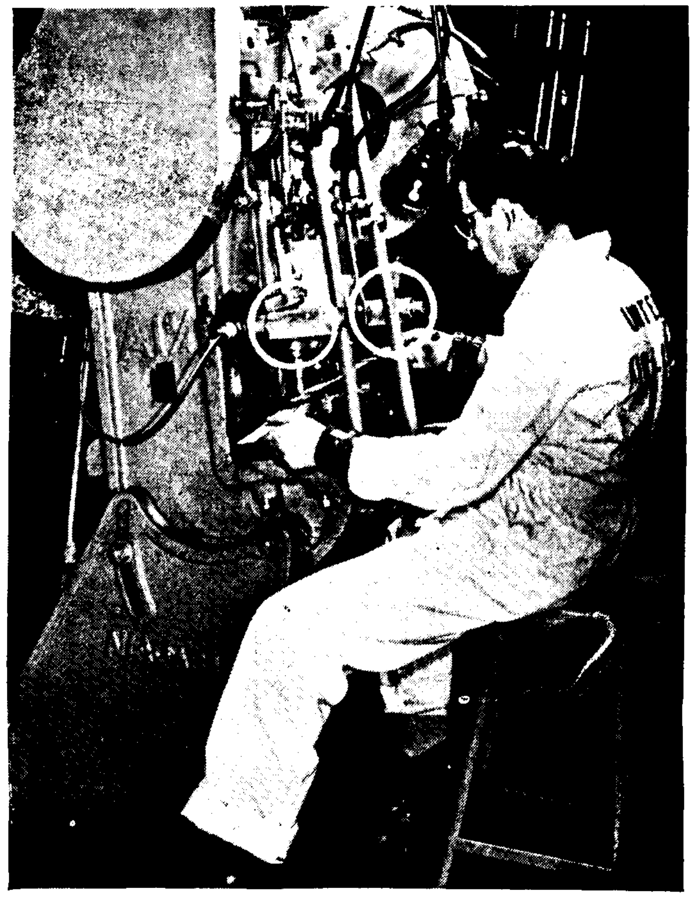


FIRST "PACKAGE" TYPE ATOMIC REACTOR SHOWN TO U. S. PUBLIC

Model of the small 2,000-kilowatt "package" type nuclear reactor electric power plant now nearing completion at Fort Belvoir, Verginia. The name "package" is applied to the unit because its parts can be disassembled, packaged and shipped or flown to any part of the world. Small atomic power plants of this kind can bring electricity to many parts of the world where at present there is no source of electric power.

the nuclear reactor, which provides heat and steam to run the generators.

Dr. Jerome C. Hunsaker, Head of the U. S. National Advisory Committee for Aeronautics, says that the atomic-powered airplane now looks like "a future probability—more than a possibility". For this reason Dr. Hunsaker recently asked a U. S. Congress appropriations committee for funds to build an atomic reactor with which the Advisory Committee for Aeronautics could carry on its own research. He said that the reactor would be used for tests in the effort to develop an air plane engine. He also said that the U. S. Atomic Energy Commission approved the project because, while it had made "substantial progress" toward developing an atomic-powered airplane engine, much still remains to be done.



U. S. Industry and the U. S. Atomic Energy Commission have been co-operating for some time in studying the technical problems, that must be solved before a practical atomic engine for airplanes can be manufactured. Research and development work is being done by the General Electric Company and the United Aircraft Corporation. Officials of these companies say that several years will be required before it will be possible to develop the first experimental engines. One of the main problems is to construct an atomic reactor small enough and light enough in weight for practical use in airplane. But atom-powered planes will be flying within 10 years according to Hall L. Hibbard of the Lockheed Aircraft Corporation, a United States Plane manufacturing concern. Supersonic airliners powered by the atom will be able to cross the Atlantic Ocean in less than 2 hours, Hibbard said. Eventually such planes will fly up to three times the speed of sound, and they will have "almost unlimited endurance, regardless of speed," the Lockheed engineer predicted. The atomic heat source used in such planes will be essentially a simple device in which a proper arrangement of uranium, moderator, reflector and controls permits sustenance of a controlled, continuous fission process.

NEW BRITISH DEVICE—EASY INSPECTION WITH NEW COMPARATOR—COVENTRY GAUGE & TOOL COMPANY'S CONTRIBUTION TO INDUSTRY

A new comparator for checking internally threaded components is in full production at the Coventry Gauge and Tool Company Ltd., Coventry. The construction is simple and is similar in principle to an expanding screw plug gauge, consisting of two master threaded gauging segments, the expansion or contraction of which actuates a sensitive dial indicator graduated in 0.0001 in. divisions. This dial indicator shows the relationships of the part being measured to a master setting ring.

The gauging segments are mounted on two members which pivot on two hardened steel balls housed in conical settings and held in place by tension springs. Movements of the segments are directly recorded on the dial indicator. The comparator is operated by pressing together the two members, which in turn bring the gauging segments sufficiently close to each other to be inserted into the component.

The spring-loaded members are then gently released and the segments engage with the thread, at the same time actuating the indicator. Constancy of pressure against the threads is thereby ensured and makes experience unnecessary in judging an acceptable fit when conventional gauging methods are employed. An eccentric contact pin actuates the dial indicator and

enables the zero to be adjusted to the most convenient reading position. The normal range of the comparator is from 3/8 in. to 1 in. diameter, but special segments can be supplied for fine threads down to 1/4 in. diameter.

SHUTTLELESS WEAVING—CZECHOSLOVAK INDUSTRIAL EXHIBITION AT CALCUTTA

An unusual item at the Czechoslovak Industrial Exhibition at Calcutta is the "JET LOOM" which is claimed to give a very much larger number of picks per minute than the conventional shuttle looms.

Two types of Jet Looms—the hydraulic and the pneumatic—have gone into production in Czechoslovakia. The machines weave in one direction only and use water or air as the weft propellant.

The elimination of the shuttle enables direct use of cheeses as weft packages. The thread is drawn from the cheese through a magnetic tensioner on to a rotating measuring drum with a tapered helical profile. In the case of the hydraulic loom a plunger type pump ejects a minute quantity of water to shoot the coiled thread through the shed at a speed of 130 ft. per second. As the shed reverses, the weft is cut off beyond the nozzle and the drum winds up another length.

Cut edges of the fabric are automatically bound together by three rows of leno selvedge weave. The woven fabric passes between two rollers to express the moisture before being rolled on to the cloth beam.

A speed of 400 picks per minute is claimed for the hydraulic jet loom. It is capable of producing cloth of 150 cms. width. It is far quieter than the conventional looms and cheaper to build. It requires only 3/4 H. P. to drive it.

* * *

LABORATORY GLASSWARE

Capable of producing a very wide range of laboratory glass ware a laboratory glass working machine has been perfected in Britain. The laboratory glassblower usually employes simple hand tools and relies upon a high degree of manual skill to form glass into the complex forms needed in the laboratory. The problem of speeding up such work and making it more economical was studied by the British Coal Utilisation Research Association. Tests have shown that a prototype machine, designed and built at the association's laboratories, is more versatile than the conventional glass working lathe, and can deal with all but the larger and heavier work in either soft or hard glasses. It is so designed that a semiskilled operator can handle specialised work which would otherwise take the time of a more skilled glassblower.

AUTOMATIC SCREW FEEDING—AIR OPERATED TOOL

New equipment for automatically feeding screws to the head of a portable driving tool is being produced under the trade name Pneuma-Serve. It is operated from the normal factory compressed air supply at a pressure between 70 to 90 lb. per sq. in. The device consists of a hopper holding a supply of screws (enough for 5 hrs. to 8 hrs. operating), with an elevator and magazine where they are selected individually and delivered to a cut off plate or shuttle.

Compressed air feeds the screws from the shuttle to the portable driving-head through a tough plastic tube. The driving-head may be attached to any standard power driver. If an air driver is used an armoured plastic tube is coupled alongside the feed tube, or flexible cable if an electric driver is preferred.

DIESEL CRANES

A scheme of a West Bengal firm for taking up the manufacture of jib cranes, steam or diesel cranes for Railways, at the rate of 67 per year to be raised to 194 later, has been approved subject to the terms of foreign collaboration being settled to the satisfaction of the Government. The firm will also have to obtain components from indigenous sources, if available, at any time during the period of implementation of its manufacturing programme. Approval has been accorded to the scheme of a Bombay firm for the manufacture of panel pin-making machines at the rate of 5 per year.

A factory in Punjab is to be allowed to expand its capacity for the manufacture of rivets, bolts and nuts to 60 tons per month. A new undertaking is being set up, in Punjab, for the manufacture of 300 tons of steel bolts, nuts and rivets per month on double-shift basis.

RICH LUSTRE, TOUGHNESS OF FIFTEENTH CENTURY MING LACQUERS

The Chinese Lacquer workman's skill goes back a thousand years. But it was five hundred years later, in the time of the Ming Emperors, that the hardest-wearing and most gem-like of all lacquers were produced.

Over the years, the precious secrets were carefully and jealously guarded, and handed down from father to son.

These lacquers were so tough and durable—so rich in their lustrous beauty that continuous and persistent efforts have been made to match them.

It was only comparatively recently that London Varnish research chemists finally perfected a lacquer of comparable beauty, richness and toughness. Even then, before the name Ming was applied to this new lacquer, it was given long and rigid tests to prove beyond doubt its worthiness and qualifications.

If you want a rich lustrous finish that will stand up to hard wear, you can safely specify and insist on Ming Chinese Lacquer.

Remember too, Ming Lacquer goes on any surface; and it's easy to apply. Simply brush it on and it will flow freely and smoothly, without leaving brushmarks. About four hours afterwards you'll have a beautiful finish of deep lustre that will delight you.

You can use Ming Chinese Lacquer on all wood and metal surfaces both inside and out, including doors, baseboards, bedroom furniture, kitchen cabinets, etc. It is particularly good for toys, garden tools, garden furniture, bicycle and tricycles, because of the hard-wearing qualities.

* * *

313 SHADES OF LOVARINE PLASTIC EMULSION PAINT PROVIDE COLOUR CO-ORDINATES FOR EVERY DECORATIVE SCHEME

No matter what your colour requirements are, for any part of your home, office, or any institution or public building, Lovarine Plastic Emulsion Paint will meet them, to a shade. In no other plastic emulsion paint can you get a wider choice of shades. You work from fourteen base colour and white, any two of which can be mixed in simple fixed proportions, to give in all 313 shades; ample choice for any scheme of decoration!

This new vinyl finish has been outstandingly successful. It dries to a beautiful suede-like finish in only one hour. It can be applied immediately to freshly plastered walls—and it needs no primer; thus you can make substantial savings in both labour and materials.

You can put it on with a brush or paint roller or spray, and it flows out smooth and even. Start doing an average room in the morning and you can re-occupy it *the same day*.

Best of all, Lovarine Plastic Emulsion paint is washable with soap and water, and if necessary can be scrubbed really hard without damage to the beautiful surface.

* * *

MR. H. F. AKEHURST OF BICC

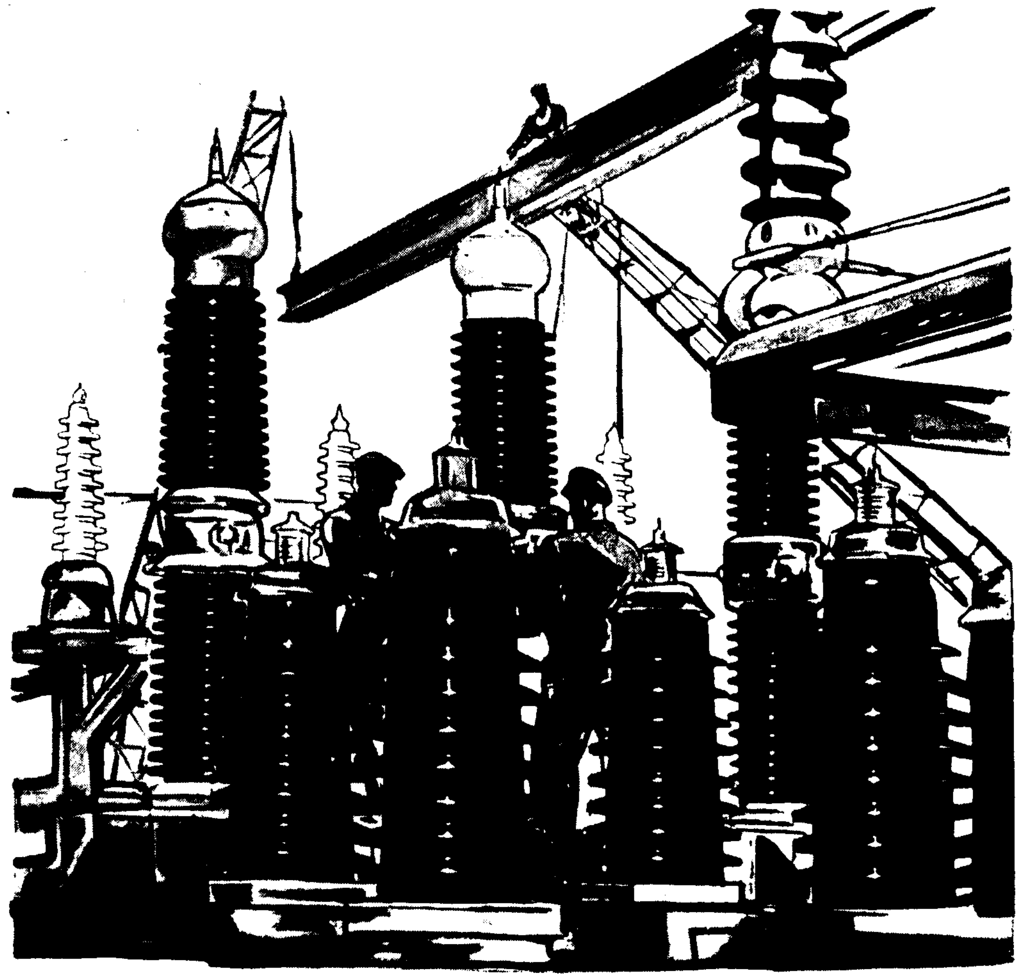
Mr. H. F. Akehurst, B. Sc., A. M. I. E. E., who has been appointed to the Board of British Insulated Callender's Cables Limited to hold the executive position of Director (Overseas Operations) was educated at Oundle School and Leeds University.

He joined the former Callender's Cable and Construction Company Limited in 1930, and proceeded immediately to India where he served for 17 years. During this period he was engaged on both Sales and Contracts work, and was employed for a considerable period on the Uhl River Hydro-Electric contract. In 1947 he became Joint Manager for India, and in the following year returned to London on his appointment as Joint Export Manager.

A new appointment in 1953 made him responsible for the BICC Overseas Factories Organization and in January 1955 he became an Overseas Manager of the Company. He is also Deputy Chairman of BIC (Export) Limited.

Mr. Akehurst's appointment to the BICC Board which takes effect from the 1st January, 1957, is an indication of the great growth in recent years of the Company's activities overseas as a result of which it was considered essential to concentrate responsibility for all overseas operations in one Executive Director. In addition, he will be responsible for the co-ordination of all BICC interests in subsidiary and associated companies located overseas.

Besides his long period of Indian service Mr. Akehurst has travelled widely in all parts of the World, and in recent years has made frequent business tours to Canada, U. S. A., South Africa, the Rhodesias, Australia and New Zealand, as well as Portugal and Spain.



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