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MECHANICAL HANDLING IN INDUSTRY

THROUGHOUT the Indian Engineering industry considerable changes are being made to cope with the increased productivity as called for in the Second Five Year Plan. All of us are aware that it is through increased productivity that we can achieve our avowed aim of economic security and a higher standard of living

New machine tools are flowing and new factories are growing. To ensure that they can contribute most to the Nation's drive for production it is high time that mechanical handling, which is in fact a labour-saving device and indeed an essential part of production technology is given the due consideration it deserves. For many years, however, and regrettably even to-day in many cases, this aspect of technology remains to be the weakest feature of Indian Industry.

Some people may argue that since there is so much of unemployment problem in the country, it would not be proper to advocate the adoption of labour-saving appliances which can only have the effect of scrapping more workers and of further worsening their economic condition.

The reply to that argument is that the mechanical handling is an instrument for relieving man of the necessity for drudgery and exhausting toil. It increases the leisure of mankind and give men to make a better use of it. The advancement of the human race requires a distribution of work as well as of leisure and a distribution of responsibilities as well as of privileges.

There is great dignity in happy, inspiring labour, but there is no dignity in soul destroying toil. There was no dignity in men dragging stones across a sandy desert, under the lash of the slave driver, to build a pyramid. There is no dignity in men carrying basket after basket of coal up a plank to feed a ship's boiler, when such work can be better performed mechanically.

Modern technology is based on the substitution of muscle power by mechanical power; it has caused an extremely potent revolution in the methods of production. In the introduction of the mechanical handling in the various stages of production lies the salvation of not only the enterpreneours but also of the workers as it enables the former to offer healthier conditions of service to the latter.

The field of mechanical handling is vast. The cost of handling is a major item in the total cost of production. What proportion it bears to the whole varies from one industry to another and, indeed from one factory to another.

Mechanical handling applies to materials handling and materials processing when performed with the help of the machanical equipment. While materials handling embraces the movement and storage of everything in or about an industrial establishment, materials processing covers those operations through which material passes during the course of manufacture. The two are closely linked and should always be considered together because the type of processing often determines the method of handling and vice-versa. The blending of the processing and handling leads to uniform flow and influences the working tempo and overall turnover by simplifying instrumentation and control of both the handling and the processing.

Although it is more profitable for the large plant making a standard product in great numbers to install suitable mechanical handling equipment to keep the production lines running smoothly than it is for the small plant, but it should not be forgotten that no matter how small the plant may be, the object should always be to move the work at the lowest possible cost. Improved handling methods are available for all engineering works, from the smallest with a dozen employees to the largest where employees are counted in their thousands.

Among the many advantages secured through mechanical handling are: reduced overhead charges, better utilisation of existing buildings and structures, increased productivity, reduced volume of work in progress, greater industrial safety, reduction in the damage to finished products and a consistent level of production throughout the organisation.

Probably the simplest equipment is the pallet and truck system which can be used for handling an article from its collection from stores as raw material during its passage through various processing departments and to its eventual carriage to the packing and despatch department. Another simple and cheap method is the use of roller conveyors. The great advantage of roller conveyor is that no source of power is needed—gravity does the work and does it at no cost. Roller conveyor is obtainable in standard lengths and widths and of various weights to suit heavy and light loads. When loading or unloading a lorry a short length of conveyor can often save much lifting and carrying.

A short length of roller conveyor can often be used to transfer work from machine to machine for operations to be performed in sequence. Often simple chutes can be used in this way. This avoids lifting up and laying down of work, and it tends to keep the job flowing.

Transfer machine tools are one of the latest developments in this field. In essence these machines embody means for handling and transferring components from one machining station to the next.

The various forms of power truck can be an asset in many works particularly those fitted with platforms with adjustable heights. Their use is particularly advantageous when material has to be moved between a number of points which are not generally fixed, in storage areas, and when the flow is intermittent.

Where lifting and or intermittent transport is required, overhead runways prove very useful. The overhead runway consists of a steel girder on which runs a trolley which may be hand-operated or electrically driven.

The use of overhead cranes should be considered where loads have to be picked up, transported and put down anywhere in a fixed area. These cranes may also be used for loading bays and for feeding processes. For the latter purpose, jib cranes can equally be used with advantage.

There are many instances where a small mobile shop crane can be very useful. Lifting heavy castings or forgings on to the machines, moving heavy jigs and press sets, unloading and loading in works having no loading bay, are typical examples. It can, in fact, provide a simple answer to many of the awkward lifting problems encountered in every shop in daily work.

Screw conveyor which consists of a power-driven helical core rotating in a trough can handle all finely powdered, granular and lumpy materials and semi-liquid and fibrous matter. Materials may be conveyed and mixed, dried or heated at the same time, and charging and discharging points may be positioned anywhere along the trough.

Belt conveyors to-day have many uses and vary much in length from a foot or two (feeding a machine) to many hundred yards. Valuable for servicing processes as they are, their uses extend to assembly work, inspection, filling, wrapping and bag and package handling.

When a continuous flow of articles has to be transported between a number of fixed points as in case of spray booth, stoving ovens, dipping tanks, the use of overhead chain conveyors is usually resorted to.

A further way of increasing output is to decrease rejects. Thousands of rejects are caused every day by throwing perfectly machined parts haphazardly into a box or bin, The remedy is not expensive. The use of such devices as nesting and stacking boxes. mobile rack systems on which are fitted trays or pegs depending on the parts being handled, can be of considerable assistance in these cases.

Handling problem at the actual work point is another very important factor requiring consideration in this connection as it provides the means for obtaining far-reaching economics. As a first step it is essential that a careful method study should be made of the details of operation involved and the movement of the part in question. The most suitable handling equipment is then to be thought of and provided.

The use of air-operated fixtures is becoming widespread and numerous applications are possible in most factories, not only for machine and press shop operations but also at the assembly benches.

By relatively simple and inexpensive means it is possible for the industrialists to reduce their handling costs and increase the output of the plant by using suitable mechanical handling method. Engineers in other countries have realised this fact and are devoting more of their time to planning and integrating methods of handling. While majority of our engineers here concentrate on direct production operations and are primarily concerned with "floor to floor" time, their counterparts on the other side are more concerned with "door to door" or throughput time.

For effecting improvements in productivity in Indian industry, the following factors are essential :—(1) a proper appreciation of mechanical handling by all concerned, (2) attaching more importance to planning, organisation and designing for production, (3) making machine tool designers of the country aware of handling problems so that they can provide concessions to them in design, (4) Employment of more qualified engineers on the production side, (5) Inclusion of mechanical handling as a subject of study in management training and (6) Training of the operators in the use of mechanical handling equipments.

When these are arranged, the slope on the production graph in our industries will automatically increase steadily in the right direction.

EDITORIAL NOTICE

Technical Contributions

Technical contributions are invited from Works Managers, Production Engineers, Technical & Industrial Consultants on all subjects of interest to Industrialists & Manufacturing Organisations.

Articles should be elaborate supported by illustrations, wherever available, and should be of a high order. Only original photograph prints should be sent and drawings should be on drawing paper or cloth in India Ink. Ferroprints are not accepted.

Summary of technical papers read before professional Institutions or at meetings of Engineers are also accepted if they are of sufficient interest to the Industrial Engineers.

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Manufacturers of plants and equipments can send in writeups from their Technical Staff or Chief Engineer about any new technical features, developments, research notes and news having a bearing on their manufactures and which would be of sufficient interest to the Industries.

The Managing Editor reserves the right to delete, amend, or add any paragraph, paragraphs to the contributions.

ACCEPTED ORIGINAL CONTRIBUTIONS WOULD BE PAID FOR AT OUR RATES, IF DESIRED

The Engineering Industry in Czechoslovakia

By A Plant Engineer

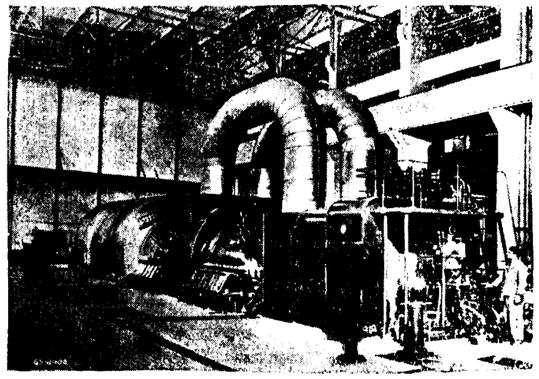
THE Czechoslovak Engineering Industry of today represents a tremendous production trust, which in its basic composition can solve technical problems independently and deliver complete products without outside help. Its structural and systematically directed growth according to actual needs keeps its technical level on a world standard.

The Czechoslovak Engineering Industry can therefore boast of its positive achievements because it travelled a long tedious road of evolution. We find its beginnings already in the middle of the 18th century when the first foundations of industrial plants have been laid and have started to supply new markets not only on the territory of the former Austro Hungarian Monarchy but also beyond its frontiers. Its proper development on an industrial scale coincides practically with the period when the largest industrial concerns of the world were established. It was then when the foundations for the large Czech industrial export were laid. Industrialization of the Balkans and of Eastern Europe, the building of railways and factories (sugar factories and breweries among others) have opened wide fields for activities of the growing Czech industry, above all for engineering works, bridge building plants, steel mills, building concerns, etc.

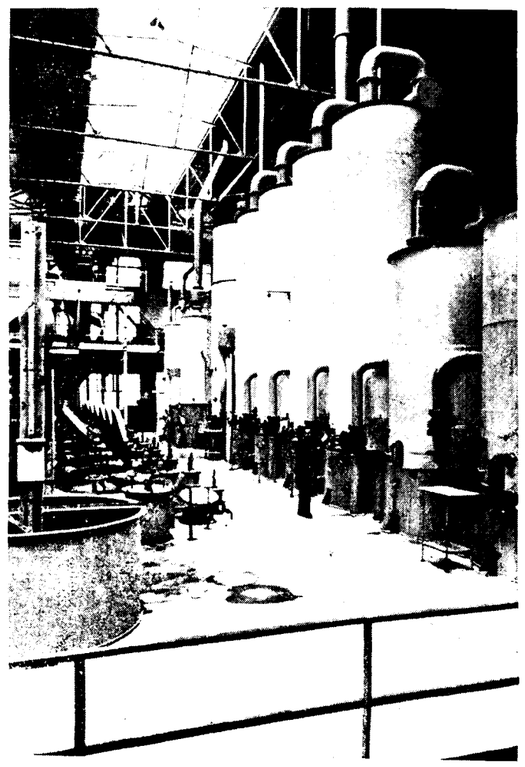
After the first World War the Czechoslovak export encompassed gradually the whole world. It is the quality of the products that blazes the trail for the name of Czechoslovakia, the representatives are the well known firms of Skoda, CKD, First Brno Engineering Works, Vitkovice Steel Works, etc. Equipment for sugar factories, breweries, alcohol distilleries, steam and water power plants, mines, bridges, highways, these are only a few and at a random chosen examples of export transactions. Deliveries of large castings and forgings (especially for big ocean liners) were a speciality of the Skoda Works in Plzen.

Equipment for chemical industry were supplied to North European states, sugar factories and distilleries to Ireland, power plants (especially turbogenerators) to Denmark, etc. Sugar factories, mine equipment, railway material, various constructions and parts for the Suez Canal were supplied to Africa.

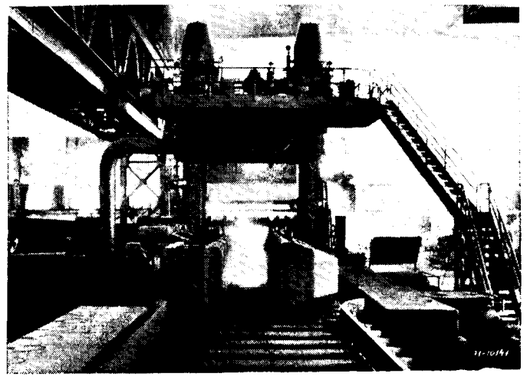
In Asia the Czechoslovak industry always found a great market. Extensive were the deliveries to Iran-



Steam Turbine 50 MW.



View of the Sugar Factory.



Rolling Mill.

power plants, sugar factories, public buildings, a tobacco factory, a foundry, rolling mill, etc. In Afganistan an abattoir was built as well as other plants, sugarcane factories, cement works, an aluminium plant, equipment for rolling mills, Diesel engines, locomotives, automobiles, etc. were delivered to India. The Czechoslovak industry exports on a large scale also to Burma, Siam, Malay and other countries.

Shipments to China consisted mainly of power plants, sugar factories, breweries, locomotives, harbour installations, etc. Even Australia is not missing among the countries buying in Czechoslovakia. To enumerate deliveries to South America-mainly to Brazil a and the Argentine would mean a repetition of all the examples given above. The distillery in San Nicolas, however, is worth mentioning: It is the largest alcohol distillery in the world producing 2400 hectolitres (about 52.800 Imp. gal.) per day waterfree alcohol from corn. The United States were especially interested in special machine tools. Of course, this is only a very rough enumeration which cannot give a real picture of the actual capacity and possibilities of the Czechoslovak industry.

The second World War brought great changes in the structure of the Czechoslovak industry. The endeavours which are characterizing this period are influenced by the general policy to build up the heavy industry and to meet all demand of the home industries and of the national economy; the results of these endeavours manifest themselves in engineering products necessary not only for home consumption but also for export deliveries. For general information we are quoting only a few examples: A hydraulic forging press of 12.000 tons which can forge pieces up to the weight of 200 tons, mine hoisting machines of 12 ton load for one hoist and input of 3400 kW., hydrogen cooled turbogenerator of 62,5 MV, electric locomotive of 2400 kW. output for travelling speed of 120 km/h, giant excavators which can transport and load 1000 cu.m/h, giant loading machines, mine combines, milling machines, washeries, coal sorting plants, steam boilers and turbogenerators for steam power plants of 130 Atm. and 500°C. machine tools, vertical lathes, max. swing 12.000 mm. and horizontal lathes, max. swing 3.150 mm. and 25.000 mm. turning length, suction excavator which while under test operation surpassed the required output of 250 cu.m/h and many others.

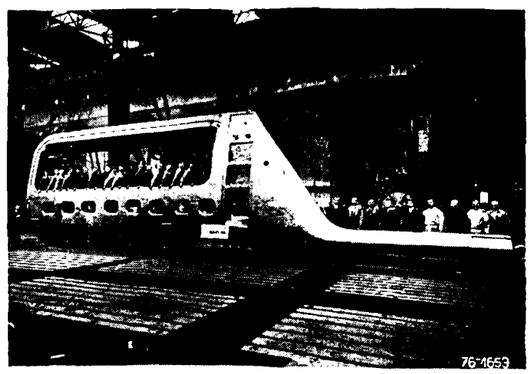
At the present state the Czechoslovak engineering plants represent an industrial unit which has the possibility to realize its endeavours to grant technical co-operation when carrying out deliveries for the building up of many industrial branches abroad.

CERAMIC WORKS

The production of porcelain and ceramic goods has reached within a comparatively short time, a considerable degree of perfectness which is essential not only in a number of important branches of industry, e. g. electrotechnical industry but also in the production of goods for everyday use.

The Czechoslovak ceramic industry has an over 200 year tradition in both the manufacture of the ceramic goods and in the production of the appertaining production machinery.

Czechoslovakia is fortunate enough to possess on her territory rich natural sources of raw materials of all kinds used in the ceramic industry, from the current type of brick-maker's clays and the refractory materials



Rudder for Normandy.

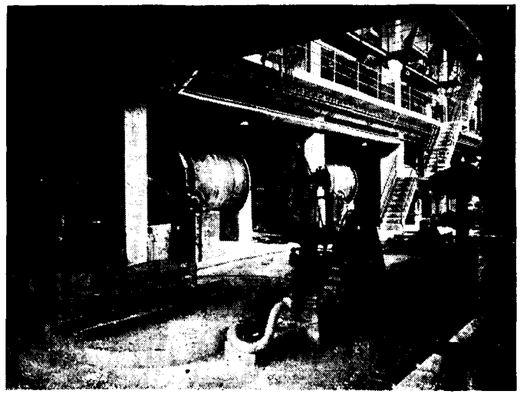


Fig. 1. Preparation of the mass.

to the highest grade kaolins and, it was this factor, which played an all-important part in the development of the ceramic industry in Czechoslovakia.

The production methods used in the manufacture of ceramics are quite complex. When compared with other branches of the industry, the ceramic industry differs from them in as far as here ready goods, are produced directly from raw materials, without the intermediate stage of semi-products, as is the case with other industries.

Raw materials used in the ceramic industry are of two or more kinds and they have to be processed in different ways and mixed in the most suitable proportions in order to obtain a perfect product. On completion of these processes the ceramic raw material is subjected to a number of complex thermal processes, e. g. drying, firing, and sometimes they have to be fired as much as three times.

Thus the whole production programme may be divided into the following operations :

Preparation of Raw Materials e. g. crushing, grinding, treatment of the raw materials in washmills, mixing, de-hydration etc.

In the course of this preparation process the raw materials are processed into a suitable working mass of the required qualities and composition.

Shaping e. g. casting, turning and pressing.

At this stage of the production semi-finished articles are produced, i. e. the required shape is given to the mass.

Drying and Glazing

Here the shaped goods are cleaned, ground and sometimes also glazed.

Firing

In the course of this firing operations, the ceramic mass is deprived of the remnants of the water which is still mechanically bound in it and, with the rising heat, the mass is also deprived of the chemically bound water which it contained. This is followed by the decomposition of the carbonates and other chemical compounds, i. e. a number of complex pyro-chemical reactions takes place here and, as a result of all these processes the mass attains a greater strength and grows denser.

Final Treatment of the Products

In this final phase of the manufacture the goods are cleaned, sorted and ornamented with ceramic dyes.

A whole number of machinery and equipment was developed in the course of many years and made it possible to make the production more perfect and economic. They also facilitate a more advanced and more perfect method of production, as outlined above and, are particularly suitable for the special requirements of the ceramic industry.

In ceramic works of up-to-date design, the production is arranged in such a way as to produce a number of ceramic products in the most optimal ratio, e. g.

Fig. 2. Slurry presses.

Fig. 3. Potter's wheel.

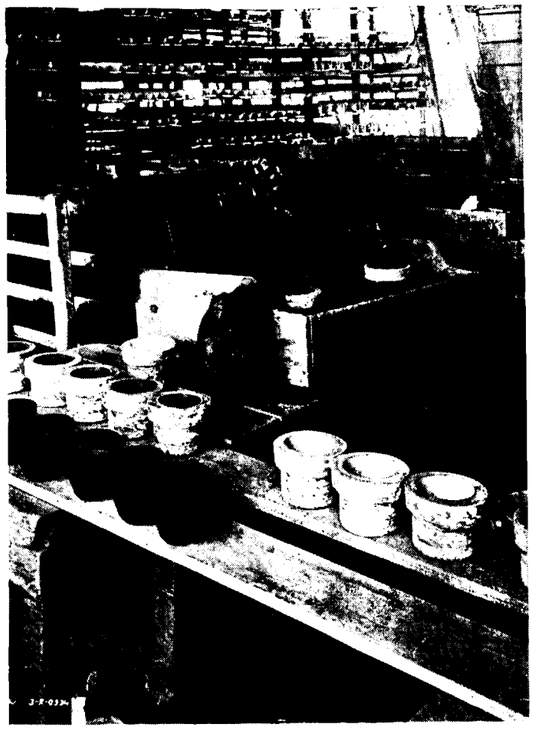


Fig. 4. Semi-automatic machine for manufacture of cups.

(1) Utility ceramics (dinner plates, soup plates, desert plates, cups, saucers, dishes, teapots etc.)

(2) Sanitary ceramics (wash basins) with siphons or without, wash-basins with stands, kitchen sinks, lavatory basins etc.

(3) Tiles of different shape and design

(4) Porcelain articles used in electro-technics—electric insulators of varied shape, electro-technical insulation material—pulleys, fuses etc.

The machinery and ceramic equipment for all kinds of ceramic production are supplied to our customers by well known industrial enterprises, i. e. the SKODA WORKS, the FIRST BRNO ENGINEERING WORKS, the KERAMOSTROJ etc. The design of the above machinery and equipment are well up to the highest requirements of modern technology and technical science because of the long years of the good technical tradition and the extension of the production stock, in particular after the Second World War.

Technoexport, Foreign Trade Enterprise for the export of complete industrial plants, is engaged in the export of complete machinery and electric equipment for ceramic works of different capacity and according to the Buyers requirements. Bucket elevators, complete roapways, belt conveyors, elevators, Diesel mobile steam engines etc. are supplied to Customers to make the gaining of the ceramic raw materials possible.

For the preparation of the mass, the Czechoslovak engineering industry manufactures complete machinery equipment such as crushers of different design, edge runner mills, drum mills, propeller wash-mills and mixers, diaphragm pumps for the liquid ceramic slurry, slurry presses of different size, first rate vacuum presses etc.

Figure 1. shows some of the equipment used in the preparation of the mass. It gives the view of one of the production halls of one of the Czechoslovak ceramic works, an up-to-date factory, completed 5 years ago. In the upper storey of the hall there are the discharge openings of the storage tanks of the raw materials and

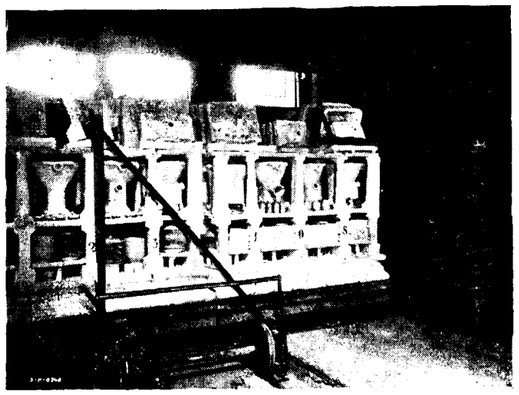


Fig. 5. Kiln truck (laden with sanitary ceramics).

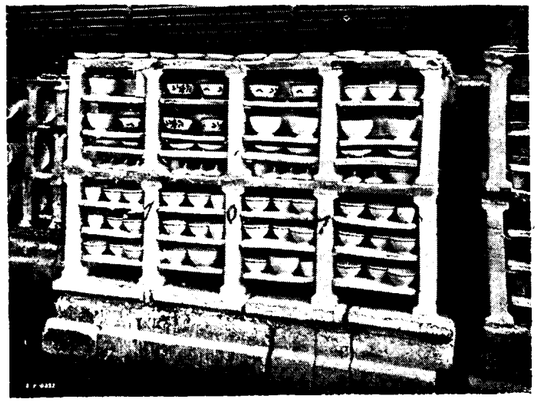


Fig. 6. Kiln truck (laden with utility ceramics)

lower down, we can see the mobile mechanical weighing machine. With the aid of this equipment the raw material is dosed, together with the required additions, into the individual drum mills which are lined up in a row. In the mills the raw material is milled to fine consistency and is then passed into the propeller wash-mills and agitators and here, together with the clays and kaolin, a fine slurry suspension is achieved. From the washmills the ceramic slurry is pumped by diaphragm pumps (shown in the background of the picture) into the slurry presses, where the water is removed from the mass and then into the vacuum presses, for further processing in the shaping department (Figures 2, 3, 4 and 5.)

From the shaping department the various kinds of the products are taken to be fired. In modern ceramic works the firing is done in tunnel kilns which are heated either with liquid fuel (oil, crude oil) with gas or electricity.

The tunnel kiln, in which the goods are shifted in the course of the firing, is, today, a typical modern kiln of ceramic industry and its development within the past 20 years has been very extensive. The chief aim in the improvement of the kiln had been the achievement of a maximum thermal economy and mechanization and automatization of the production process involved. The operation of the kiln is continuous and it is designed in such a way that the products which are about to be fired, are put onto kiln trucks and travel on these back and foreward for a period of approximately 60 hours inside the kiln (See figures 6 and 7).

On completion of the firing operation the products are sorted and cleaned by grinding. The utility ceramic is

Fig. 7. Tunnel kiln—firing zone.

also ornamented when required—this being mostly done by hand. The ornamenting is done either by hand-painting or by means of transfer pictures. In case of ornamented goods it is necessary to re-fire them at a temperature around 750 degrees Cent. (Firing of the ornaments) The firing may also be done with the aid of so called sub-glaze dyes which are applied prior to the final firing of the goods and this makes the additional firing of the ornament unnecessary.

The design and rationalization of the ceramic works of different capacity, requires wide-range experiences in the technical sciences, economics, organization etc., if optimal results are to be achieved.

The Czechoslovak Export industry, is through the aid of the Export Company of Technoexport, ready and

(Continued on page 12)

National Metallurgical Laboratory

By A Staff Officer

NATIONAL Metallurgical Laboratory in its six years of active life has established its place and have conducted a number of research projects which have paved the way of valuable improvement and additions to India's metallurgical industries. The research work of the laboratory is carried out in the following seven divisions.

1. General Metallurgy
2. Chemical
3. Ore-dressing and Mineral Beneficiation
4. Refractories
5. Physical Metallurgy
6. Mechanical Metallurgy & Testing
7. Extractive Metallurgy.

Pioneering work has been done in this laboratory on Indian moulding sands and a large variety of indigenous foundry sands from various localities have been investigated and their suitability for use in non-ferrous, cast iron and steel foundries have been determined. A side-line attention has been given to the 'bonding clays' such as bentonite, used in preparing synthetic sands.

Cast iron can be made ductile by a process known as nodularising and this nodular cast iron—as it is called—can be substituted for a number of steel products. Extensive work has been done on the production of nodular cast iron and determining the suitability of Indian pig iron for its manufacture. The theoretical aspect of the problem has also been dealt with and an explanation has been offered on the mechanism of formation of graphite spherulite which has been highly appreciated in U. K. & U. S. A.

Alloys of aluminium and silicon are widely used in engineering and automobile industries. The existing methods of preparing aluminium-silicon alloys are expensive under Indian conditions. A new method of production of aluminium-silicon alloy by alumino-thermic reduction of quartz has been successfully developed which will be particularly advantageous under the existing Indian raw material conditions.

A process has been developed whereby steel materials can be coated with a layer of aluminium which can be used in place of galvanized steel. Utilisation of this process would enable to cut down the import of zinc and is advantageous from the view point that resources of aluminium are plenty in this country.

With the object of promoting the growth of alloy-steel industry and utilizing the available raw materials of the country, a research project has been undertaken to find out the possibility of developing chromium-manganese-nickel stainless steels similar in properties to the well known 18/8 variety. The main aim is to conserve nickel (which has to be imported due to the absence of suitable economic deposits) and to utilise manganese for which abundant resources are available. Investigations on the possibilities of production of ferro-alloys which are also vitally important towards the establishment of alloy steel industries in the country, have been undertaken.

Experiments have been conducted on the cottage industry production of steel by direct reduction of iron ore with charcoal. The process is particularly suitable for utilising iron ore fine, huge dumps of which have already accumulated in our country. This method will yield blooms weighing a few pounds that can be worked down by blacksmiths. Much progress has been made towards the preparation of self-lubricating bronze bearings by powder metallurgy techniques. Successful conclusion of the project would be of great assistance to the Indian electric fan manufacturers.

India is placed in a fortunate position in regard to the deposits of ilmenite—an ore of titanium. Till recently ilmenite was mainly used in the titanium paint industry.

(Continued from page 11)

willing to grant its full assistance in the projection and building up of the ceramic industry, to supply the necessary complete equipment for these ceramic works and to put these works into operation with the aid of Czechoslovak ceramic experts, thus guaranteeing and passing on their expert knowledge to the Buyers.

Recent developments, however, have given great importance to the metallurgy of titanium and the use of metallic titanium as an engineering and structural material. Titanium metal has already been prepared in this laboratory on a small scale and alternative cheaper methods of preparation are under investigation.

The problem of preventing the national waste of low-grade manganese ores is having its due considerations in this laboratory. Electrolytic manganese metal over 99.75% purity has been produced on a laboratory scale from low as well as high grade manganese ores, production of which on semi-pilot plant scale has given equally encouraging results. This electrolytic manganese can be used as a substitute for high grade ferro-manganese as well as for making some non-ferrous alloys. Production of high-purity manganese dioxide suitable for use in batteries has been investigated and a process to this extent has been developed.

The problems of plating industry found extensive scopes at the National Metallurgical Laboratory. Several plating problems relating to plating industry have been completed. The substitution of cyanide baths which are dangerous to work with, by those of non-cyanide solutions for the electro-plating of brass, has been successfully developed. Commercial application of this method is understudy. Technique of plating metals on non-metals like glass, wood, porcelain, has been evolved. Experiments on a laboratory scale for plating nickel and chromium on aluminium have proved extremely successful. This problem should be of special interest to automotive industry, as it combines the advantages of light weight of aluminium with the wear and corrosion resistant surface of chromium.

Under the scheme 'Protection of Metals' research work is being carried out on various corrosion problems and methods of preventing corrosion. Protection by plating, inorganic surface coating, painting and metal spraying are being tried.

Utilisation of the country's low-grade ore-deposits is receiving constant attention of the laboratory. A large varieties of low-grade manganese ore-deposits from all over the country have been beneficiated and their suitability for the manufacture of standard grade of ferro-manganese have been determined. A large number low-grade chromites have also been investigated and their suitabilities for use in metallurgical, refractory and chemical industries have been investigated.

Successful investigations have been conducted on a number of pyrite ores from which sulphur or sulphur bearing minerals were economically concentrated to a marketable grade which can be subsequently used for the manufacture of sulphuric acid.

For the development of atomic energy, beneficiation work has been undertaken on a large number of low-grade radio active ores so as to produce a suitable concentrate for the extraction of uranium.

In connection with the establishment of steel plant at Bhilai, experiments on sintering of iron ore fines were carried out in this laboratory and successful sinter has been produced for the first time in this country.

Development of quality refractory materials from indigenous resources is actively pursued in this laboratory. In accordance with it high temperature refractory with mullite as the main constituent has been produced from Travancore beach sand sillimanite. Hot face insulating bricks have also been successfully made from bladed kyanite.

The use of carbon refractories is well established in the field of electro-metallurgical industries. It has been found possible of produce carbon blocks of suitable quality for the cathode linings for aluminium cells as well as for lining blast furnaces. Full size bricks which were prepared were found to be in no way inferior to foreign brands.

Forsterite refractories are finding extensive uses in metallurgical industries and may be substituted for magnesite refractories on certain cases. Forsterite refractories having high spalling resistance have been developed in the laboratory using indigenous raw materials.

A carbon bonded graphite crucible with satisfactory physical properties and good resistance to oxidation has been arrived at in the course of investigation on the possibility of graphite crucible manufacture from indigenous graphite and clays.

A comprehensive study of Indian fireclays has shown that some of them could be used for the manufacture of firebricks having a refractoriness under load value of 1500 C or above. This quality of firebricks which would be required according to Russian specification for the Bhilai Steel Plant, is not being made in this country at present. Commercial exploitation of these clays on scientific lines should meet the entire requirement of the Bhilai Steel Plant.

Encouraging results have been obtained on development of a new heat resistant alloy based on iron,

manganese and aluminium. Investigation on controlled friction material and determination of fatigue resistance of structural steels have made considerable progress. Study of wear resistance of railway wheels, tyres and rails has produced encouraging results. Production of iron using non-coking coal is under active consideration of the laboratory.

Apart from the above applied researches a number of fundamental problems on different aspects of metallurgical science have been undertaken, work on some of which have brought commendable remarks from foreign countries. Holding of symposia on important metallurgical subjects form a regular feature of the laboratory. Such symposia bring together the scientists and industrialists on a common platform where the various technical aspects of the subject matter are discussed. The following five symposia have been held so far which were highly successful from all angles.

1. Electroplating and metal finishing.
2. Industrial Failures of Engineering Metals & Alloys.
3. Non-ferrous metal industry in India.
4. Recent trends in the field of production, practice and research on refractories used in metal industry.
5. Production, properties and applications of alloy and special steels.

In addition to the research work, one of the important activities of National Metallurgical Laboratory relates to the education and development of the country's metallurgical industries by supplying them proper technical information and guidance and undertaking problems on their behalf. Already a large number of private industries and government bodies have been benefited by the technical information service operated by the Liaison & Information section of the Laboratory.

Catering to the demand of Indian metallurgical industries and the public forms an essential function of the National Metallurgical Laboratory. Contact with industries and public bodies is maintained by the Liaison and Information Section with a view to ascertain the type of work required of laboratory so as to plan its activities and to clarify and popularise the aims and results of the research, thereby, rendering as much aid to industrial development of the country. The open door policy of National Metallurgical Laboratory to guests and visitors is another way in which the Laboratory keeps in touch with the public. The results of the research work carried out are mostly published in Journal of Scientific & Industrial Research, New Delhi, "Research & Industry," publications Division C.S.I.R., Old Mill Road, New Delhi, and in the proceedings and transactions of learned societies and institutes.

The work of National Metallurgical Laboratory is continuing and expanding. A number of pilot plants have been set up and more are coming up to facilitate experimental trials of research projects on a semi-commercial scale. Research results thus nourished in the laboratory are translated into industrial production. In the industrialisation programme of our country under the impetus of Second Five year Plan the National Metallurgical Laboratory is playing and will continue to play a vital role towards the development and establishment of metallurgical industries.

SUPPLIES FOR BHILLAI PLANT

It is reported that structural steel for the openhearth shop of Bhillai Steel Plant have been shipped from Soviet Russia. The main structures of two big capacity all welded blast furnaces have already been manufactured and are now being equipped with up-to-date automatic devices and mechanisms for smelting under increased gas pressure. Assembly work has already been completed on basic structures for two 250-ton openhearth furnaces, a foundry shop and a bunkering trestle. It may be mentioned that so far about fifteen hundred trainloads of plants and machinery have been shipped since the beginning of 1956 for the Steel plant at Bhillai.

India's Decimal Coinage & the Facit Automatic Calculator

By Kai Myring, Stockholm.

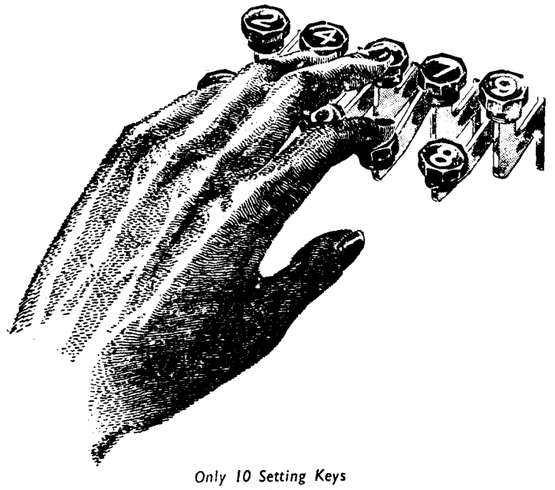
WHEN from the beginning of next official year the young Indian nation adopts the decimal system, it breaks away from a series of obsolete weight and measure system which for centuries have complicated the world's commerce, engineering, industry, science as well as the elementary education of the masses.

When the metric system was first mooted at the end of the 18th century, it was proposed in the National Assembly of France that a committee consisting of an equal number of members from l' Academie des Sciences in Paris and the Royal Society in London to determine a natural unit of weights and measures. The English government ignored this appeal and the subject was referred to a commission of the French academy, whose recommendation of the metre (one ten-millionth part of the distance from the pole to the equator) was adopted.

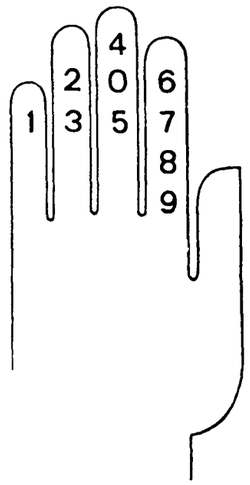
The fact that the English ignored the French appeal has since had serious consequences for the entire English-speaking world. The systems of weights, measures and in some countries even currency, suffer from obvious drawbacks as soon one tries to do anything but the simplest calculations. These systems cause many difficulties and waste much time and labour in the world of business.

Breaking out of this tangle means great opportunities for India. One is that it makes it possible for Indian businessmen, engineers, scientists and others to make full use of the small, compact and fully automatic calculator, the Facit. Although it is versatile enough to cope with sterling, weights, lengths, dozens and gross, the calculations are greatly complicated. They will be carried out with both price and quantity and expressed in decimals. The resulting figures will have to be reconverted back into sterling which, even if it can be done quickly takes some time and encreases the possibility of errors. The decimal system eliminates all.

Twenty years ago it was quite a business to calculate by machine. Why shouldn't be as easy, said the Facit engineers, to calculate as to use a typewriter? They set to work, found a solution and created an entirely new

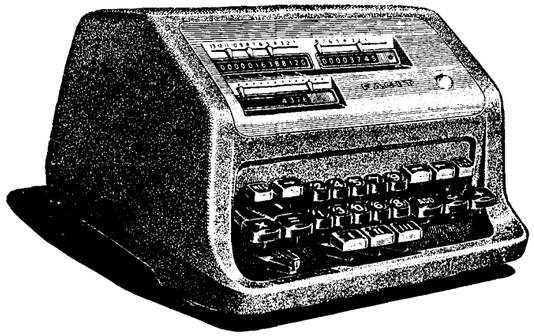


Only 10 Setting Keys
. . . .but they are sufficient for all calculations.



type of calculating machine: the nifty little hand operated Facit model with only 10 keys, a machine so simple that even a beginner quickly became an expert on it.

The little Facit was a roaring success. It was the first in a long series and started a new epoch in machine



calculation. In model after model new improvements were introduced, increasing convenience and capacity, ease of operation and performance. The latest, all-automatic model, the CA 1—13, with the ingenious central electric zeroing, is new proof of the progressive outlook of the makers, and has brought added renown to the already world famous Swedish firm of Atvidaberg-Facit.

This fully automatic calculator commands all four rules of arithmetics, and, thanks to the ingenious two-row ten-key keyboard and central zeroing, makes all known shortcuts to the final result quite automatically. With the zero placed in the middle, no wheel has to turn more than 180 degrees. What this means in reduced wear on a machine with 2,417 moving parts can only be conjectured.

The keyboard, small and simple, makes fast touch calculating possible. And the Facit machines are beautiful to look at. The latest models are signed by one of Sweden's top industrial designers, none less than Count Sigvard Bernadotte, second son of the present king of Sweden.

The firm of Atvidaberg is not a new one. Its history reaches hundreds of years back. In the beginning its chief industry was copper mining—the oldest royal charter in existence dates from 1413. That is a long time for a firm to exist in a country whose entire history hardly exceeds a thousand years.

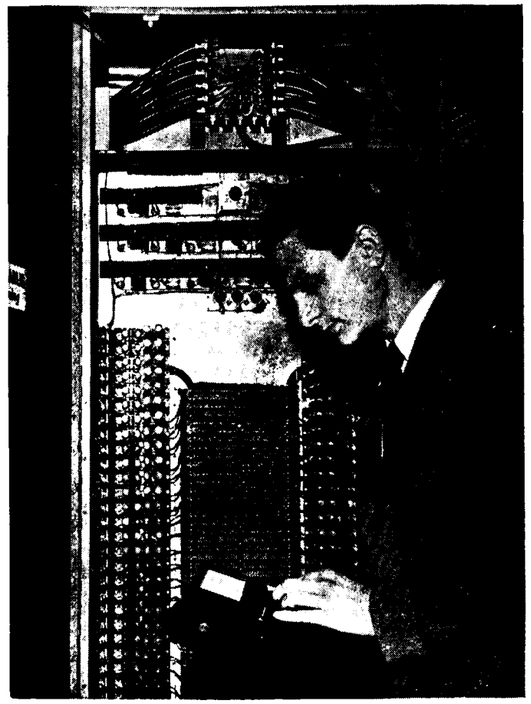
FEUDAL INDUSTRY

Until 1922 the industry of Atvidaberg was what the Swedes call a "bruk" (in English it would be pronounced as "brewk"). It is well nigh impossible to translate this term—the word "industry" does not cover the conception. The Swedish "bruks" came into being many centuries ago and were founded on the natural resources and water-power in their localities. In accordance with the prevailing feudal system they passed from father to son, generation after generation, and this applied to the workers as well as the owners. Large Communities grew up around the "bruks" and developed a tradition and industrial culture that have survived to this day. Atvidaberg was one such "bruk". Towards the end of the 19th century the copper mines were no longer profitable. It had become increasingly expensive to extract the metal from the lower-grade ore. Atvidaberg was facing stark ruin. Unemployment and poverty reigned and people started emigrating on a large scale.

A GOLD MINE OF WOOD

Baron Theodor Adelsward, owner of the mines and squire of the community, solved the problem for the time being. Around Atvidaberg grew large forests of mighty oaks, a "gold mine" if it could be properly exploited. At the 1897 World Fair in Paris the baron

Count Sigvard Bernadotte, second son of King Gustaf Adolf of Sweden, showing the difference between his new Facit model (left) and the old.



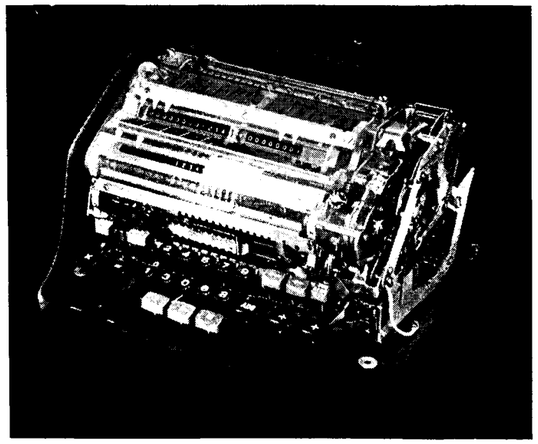
Facit electronics engineer Ivar Bergman testing the ferrite "memory" of the new Facit electronic calculator and data processing machine.

saw for the first time a modern American office desk of the rolltop type and immediately realized that here was the very thing to be made of oak—Atvidaberg oak. The industrial revolution was in full swing with a great resurgence of trade in its wake. All over the country new offices were popping up like mushrooms. The demand for office furniture was fabulous. Atvidaberg supplied them with desks and chairs and bookcases and tables. Prosperity returned to the community. The oak forest had become a gold mine.

REBIRTH

In 1922 the company was reorganized under the leadership of the present Chairman of the Board, Elof Ericsson, and a large scale expansion took place. The new management rationalized the furniture production, carried through the standardization of the products and built up an effective distribution system in Sweden.

Then a new idea was born. Atvidaberg made desks, then why not make office machines that were going to be placed on them? In 1923 the first FACIT calculating machine was launched on the world market and soon the 10-key FACIT followed, the only calculator in the world with only ten keys. The FACIT marked another Atvidaberg victory, a success so outstanding that the management suddenly found themselves in charge of one of the most prospering export enterprises in Sweden.



Another view of "Facit CALCULATOR"

Only a few traces remain of the old copper industry. Modern Atvidaberg has expanded from a factory into a large corporation comprising several industries. Concentrating on the office machine market the management soon included the HALDA typewriter factory in the Atvidaberg programme, and also the Original-Odhner, a lever type calculator with a good reputation throughout the world. In 1939 FACIT was the most exported calculator in the world with Original-Odhner a good second. Now FACIT is sold and serviced in 102 countries. Brochures and other advertising material are distributes from Atvidaberg all over the world in up to 14 languages.

The HALDA typewriter factory has progressed as well, and in 1954 a HALDA factory was opened in Madras, India, under Indian management. Head of this factory is Mr. T. D. G. Raijan, who has spent months at Atvidaberg, studying Swedish production methods.

A FIRM WITH A SOCIAL CONSCIENCE

In the rapid development of modern Atvidaberg the management has not forgotten the human element, the men and women who make the products. Many of the workers and employees have built their own homes with the aid of company loans and subsidies. At the

company cafeteria the personnel can have good meals at low prices. In the modern mess building there are club-rooms and lounges for study circles, a gymnasium and an auditorium with a stage. Here the company can carry out its programme of constructive recreation — lectures, language courses, hobbies, etc., all financially supported by the management. Sports also play an important part in the programme, and the firm provides for medical care, contributes to the workers' vacations and even runs a rest home for the workers' wives.

GETTING READY FOR OFFICE AUTOMATION

Atvidaberg has just entered into a new field — electronics — the goal being large scale production of electronic office equipment. For this purpose the company has signed up a complete 18-man team of electronics experts and the work is now well under way. Astounding results have already been achieved; for instance, the team is now perfecting a code tape perforator with the sensational punching speed of 200 to 300 characters per second. Perforators commonly used to punch 7–10 characters per second. In a few months the group will have a new electronic calculator ready. It will be the first element in the FACIT Data a Processing Centre, which is planned to give continuous service to all firms and institutions that are interested.

The old venerable " bruk " thus stands on the threshold of a new era — an era of " black magic " as the layman sees it. We have indeed come a long way since the old copper mining days.

HEAVY MACHINERY MANUFACTURE

Discussions are progressing between officials of the Ministry of Heavy Industries and representatives of the Soviet Government on the financial and technical aspects of the report on heavy machinery manufacture in India prepared by the Soviet team of experts. The team has been in India since last July. The Russian report, which has been submitted to the Ministry of Heavy Industries will be discussed in the context of Indo-Soviet technical and other collaboration for its implementation. The Soviet Government are understood to have indicated their willingness generally to help in implementing the report. The report envisages a plant with an annual capacity of 80,000 tons of machinery and equipment and is understood to be in two main parts, one dealing with the manufacture of machines and the other with foundry and forge project to make heavy castings and forgings required for the machinery period.

The development of mechanical tests and their value in relation to design

PART—1 THE HISTORICAL DEVELOPMENT OF TESTS

By S. Ramanujam, M.A., A.I.M., A.R.I.C., M. Inst. Metals
Dy. Director, Research, Railway Testing and Research Sub-centre, Chittaranjan.

INTRODUCTION

IN the past, when supplies were abundant, the practice was to substitute quality by quantity. Weight was synonymous with quality and the commercial value of a design was assessed by its weight. However, with the increasing loads to be hauled and the increased speed demanded, the locomotives are reaching their limits of size and weight requiring reduction in the factors of safety.

Under modern conditions of scarcity of raw materials and soaring prices, engineers have realised that provision of excess weight as an arbitrary factor of safety to cover 'unknowns' is an inexcusable economic loss while insistance on the old-time requirement of ductility for all engineering materials in unnecessary in practice. There has, therefore, been an attempt everywhere to save weight by reviewing traditional methods of design in the light of recent developments to ensure that every ton of steel is used to the fullest advantage. In England, the B. S. specification for structural steel in building has been revised to take advantage of the supply by the steel industry of mild steel with a guaranteed yield point at a small extra charge. An attempt has been made to modify structural practice so as to make the best use of metallurgical progress by relating working stresses to the yield stress rather than to the ultimate breaking stress. For mild steel with a guaranteed yield point, this enables a 25% increase in the basic working stress. For instance, this means thinking of mild steel in terms of 10 t. s. i. instead of the conventional practice of 8 t. s. i. It is the purpose of this paper to give an outline of the changing concepts with reference to, and the shift in, emphasis in some of the laboratory tests used for evaluating engineering materials with regard to design.

THE IMPORTANCE OF CHEMICAL COMPOSITION

Till about 75 years ago metallurgy had neither the methods for exact chemical analysis nor the metallurgical microscope nor the X'rays with which to work. Everything connected with the manufacture of steel was empirical being based entirely on the results of experience. Man made fine steel for centuries before he knew or cared anything about its composition. The famous Damascus sword made by Moslems in the middle ages owes its wavy appearance to the use of the composite material made by welding alternate strips of high and low carbon steel. The composition was judged with amazing accuracy by fracture or by forging a small block into a flat disc at an angle and examining the edge for cracks. This state of affairs was followed by the introduction of testing machinery and mechanical properties appeared in specifications. The use of chemical analysis for tracing the influence of composition on physical properties did not become general till a decade after large scale steel making by the basic and open hearth processes had been introduced. The first reaction of the steel maker to chemical methods of control was to refuse admission to the Chemist on the ground that nature had supplied the best metallurgical balance in the trained eye and the best pyrometer in sound judgment. His exclamation was " What ! make steel in a druggist's shop ? Never ! " Time was when Andrew Carnegie that great American steel magnate and philanthropist drew the mockeries of his competitors in the steel industry when they came to know that " Andy had imported a German professor with spectacles to teach him to make better steel ! But who was this German Professor ? He was simply a good chemical analyst who was able to inform his employer which ores were best while his ignorant competitors valued their ores by the prices at which they had to purchase them ". Conditions have changed since then.

The value of Chemical composition in relation to the properties of metals has been well emphasised in the statement of Sir William Roberts-Austen that if the thousands of tons of steel in the Firth bridge had contained two tenths per cent less of carbon the material would have been worthless and that the 80 million sterling of gold coin would have crumbled away if it had contained one tenth per cent of lead. The deleterious effects of sulphur and phosphorus were realised in the early days of steel making. Though Bessemer had established his process by using in the

beginning Swedish iron, low in phosphorus and high in manganese, it failed when applied to English pig iron high in phosphorus and low in manganese, since the acid slag formed did not retain sulphur and phosphorus. Many ingots which crumbled under the hammer were found to contain more sulphur than usual. It is now known that sulphur forms a sulphide with iron (melting point 988°C) which forms a eutectic with gamma iron and oxygen (melting point 930°C). This iron sulphide eutectic which has a much lower melting point than steel tends to envelop grains as thin films which are brittle when cold and are molten at hot working temperatures. This results in splitting and disintegration during cold-working. As these films melt at hot working temperatures, the metal breaks under the hammer during forging splitting along the planes separated by the molten sulphide.

It was also found that steel with over 1% phosphorus broke into two when dropped on the floor. It is now known that phosphorus in solid solution while strengthening and hardening the ferrite makes it also brittle. At 0.5% phosphorus, steel fails at 1/3rd the number of cycles withstood by normal steel having 0.04% phosphorus. At 0.3% phosphorus the ratio of endurance is 3 : 4. According to Dr. Stead, phosphorus over 0.1% induces coarse crystallisation which is a potent cause of notch brittleness. Further, iron phosphide and iron carbide are mutually insoluble. The carbon is therefore expelled from areas rich in phosphorus resulting in segregation during solidification of ingots. Its concentration in certain regions may therefore greatly exceed the average, so that a steel with uniform properties cannot be had. Actually, areas containing as much as 0.1% have been found in steels having an average content of 0.05% phosphorus. The higher the average content, the greater the tendency for segregation with the result that after rolling or forging, it is in the form of alternate elongated bands of pearlite and dangerously weak streaks of ferrite rich in phosphorus (ghost bands). As a result of embrittlement and segregation, such steels are cold short and are unable to withstand sudden shock. This is serious especially in higher carbon or alloy steels.

THE NECESSITY OF MECHANICAL TESTS

Till 30 to 40 years ago the Engineers were assured that so long as the chemical composition of two steels was the same their mechanical properties would be identical. However, not much time passed before steel began to give the lie to this assertion. Steels registering practically the same chemical analysis gave astoundingly different mechanical tests. Then came an addendum to the theory. Steels having a good chemical composition and possessing satisfactory tensile and bend tests were thoroughly reliable. This too is no longer true.

Till 40 years ago, untreated carbon steel, hot rolled or solid drawn was used for at least 97% of steel structures and machines. Even in 1939, about 95% of steel produced in the U. S. A. was carbon steel. About 3% of this carbon steel was poured into castings while the remaining 97% was poured into ingots that were hot worked by rolling or forging. Most finished wrought sections received no further treatment, only about 5% of the steel used being subjected to some form of heat-treatment. The engineer was, therefore, primarily interested in the tensile strength. In the process of evaluating the strength of the metal by finding out the load causing complete failure, other important information of its load-carrying ability was obtained such as the elastic limit, yield strength, elongation and reduction of area. The change in length and in cross section after the test specimen had fractured was a measure of the ductility of the material or its ability to deform. If the metal broke with little or no distortion it was assumed to be brittle. On the other hand, if it underwent much distortion before fracture, it was thought to be tough and ductile.

As long as strength figures were adequate and the values for elongation and reduction of area were high, the engineer never bothered about other tests. It was not realised that these results would be useful only if the steel were required for a service entailing large deformation as in deep drawing. They would be suitable for design involving simple axial loading in tension. Even here, the use of the last few per cent of the elongation and R. A. figures after the application of the maximum load is of little interest in practice as they are not contemplated in normal service. On the other hand, in stiffened plate structures, no part is an axially loaded tensile test piece and other tests would be necessary.

THE EFFECT OF NOTCHES

The mathematical theory of elasticity predicts that a uniform stress distribution will not be attained at any cross section where the form or size is changing. A notch concentrates the stress at its apex so that one tiny spot has to withstand much more stress instead of the cross section merely being reduced with uniform distribution of stress over the section. The theoretical stress at the tip of an infinitely sharp crack is infinite. But the highest stress concentration obtained in practice is about 9. Nearly all articles in use on a railway have a nick or its equivalent in some part of them, such as screw threads, forging marks, corrosion pits, etc. Dust and grit produce heavy scoring of smooth wearing surfaces. In this rough and ready place it is not possible to polish steel components free from notches. In hundreds of welds the metallurgist would discover blow holes due to indifferent welding.

Though design endeavours to avoid notches, yet in practice some concentration of stress is unavoidable. For instance, even a circular hole increases the stress to 3 times the mean in the extremities of the hole. If at these positions, small sharp workmanship notches are introduced, a second multiplication of stress occurs which may prove to be the proverbial last straw. The difficulty in designing and building up structures free from notches requires the use of materials which will not snap when broken in the notched condition, i. e. which are free from notch brittleness.

TOUGHNESS AND BRITTLE FRACTURE

Toughness involves a combination of strength and deformability. If a piece will stand battering without breaking or if it merely splits slowly when it does break, it is tough. But if it readily flies into pieces, it is brittle. In general, a ductile steel (i. e. one having high elongation) is also tougher than one with low elongation. In the case of metal broken in the testing machine, the inherent properties of the materials determine whether the failure will be granular or fibrous of the cup and cone type. Grey cast iron, for instance, contains myriads of tiny flakes of graphitic carbon which interrupt the continuity of the metallic matrix in which they are embedded. They form thousands of points of local weakness at which incipient fractures may begin. Again, their sharp edges act as discontinuities tending to concentrate internal stress and aid propagation of fracture. The rupture starting at these countless centres produces a typical granular break. Owing to the very small amount of work absorbed, brittle fracture can occur with great suddenness. By increasing the rate of loading the tendency to brittle fracture is increased. A ductile material like mild steel bar subjected to a shock wave produced by gun cotton suffers a brittle fracture. A sudden shock results in a high stress which may be twice or more than that produced when the same load is gradually applied. When this is much greater than the elastic limit, fracture will be produced more readily. Much less severe conditions will produce a similar result.

Brittleness is also caused by a prolonged heating at high temperature though this does not affect the chemical composition or tensile strength. A microscopic examination shows that the grains of the metal have become larger. It may be noted that steel consists of the organised material of the crystal and the unorganised boundary surrounding the crystal. The cleavage planes in the crystal are planes of weakness along which fracture can occur with ease. This, incidentally, is one of the anomalies of Nature in which organisation makes for weakness. Consequently, steel with small crystals having increased amount of non-crystalline boundary material and with no continuity of cleavage planes will resist impact better than large crystals with large cleavage planes or lines of weakness. Though steel coarsened by overheating has poor resistance to impact yet the tensile properties (T. S., R. A., y. pt. & elongation) are unimpaired. Thus, the tensile test, though it may detect brittleness resulting from defective chemical composition will not reveal brittleness caused by a coarse structure. It is, however, just as important to know that the steel is not of too coarse a structure as it is to know that it does not contain say too much phosphorus. Brittleness caused by a coarse crystallisation is as objectionable and should be guarded against with as much care as the brittleness produced by high phosphorus.

THE VALUE OF METALLOGRAPHIC EXAMINATION

For giving information on the size of grains, a micro-examination is necessary. This method was introduced in 1864 when Dr. Sorby reported the results of his investigations on the use of the microscope to study the structure of meteoric iron. It shows whether a steel has been burnt or finished in the rolling at too high a temperature. It is capable of giving warning of the dangerous character of a steel chemically and apparently mechanically safe which neither the chemist or the testing machines can indicate with any reliability.

The examination of the internal structure of steel was at first looked upon as something of interest to the Professor, but too refined and delicate for application to the commercial side of engineering. To-day it may determine the acceptance of tons of materials and the payment of thousands of rupees and more important it may prevent the breaking of a rail and the wreck of a crowded express train.

It was the microscope which gave the explanation of brittleness that caused in the U. S. A. the mysterious failures of cast steel kedge anchors having normal chemical composition. A study of the various structures with known thermal conditions showed that steel as cast has coarse crystals which cannot resist shock. By, judicious annealing, however, a fine grain is got though the ultimate composition and the proportion of Ferrite

and Pearlite are the same. It was found that more depends on the proper Mechanical and heat treatment of steel after the ingot has been cast and bloomed than upon either its chemical composition or the process by which it has been made.

The same is the case with mysterious premature failure of railway axles in service, though they have been found to pass specification requirements as regards conventional mechanical tests. A micro-examination of these fractures under high magnification shows the presence of zig zag intercrystalline cracks on the area covered by the axle box. The portion just below the crack shows the presence of copper or its alloys along the grain boundaries sug gesting that these constituents from the bronze axlebox diffuse into steel under optimum conditions of temperature and pressure whenever they come in contact as a result of failure of lubrication. This gives rise to embrittlement, resulting in fine cracks which ultimately develop into fatigue failures unless the portion penetrated by copper is completely removed.

WELDED CONSTRUCTION AND NOTCH EFFECT

It has been found that steel sometimes fails in use through apparent brittleness notwithstanding the fact that the tensile test had revealed considerable ductility as judged by the amount of elongation. The recent introduction of welded construction as a means of weight saving brought to lime light the possibility of structural steel exhibiting unexpected brittleness. Paradoxically enough, increasing the " Factor of Safety " by using heavier plates increased the risks of failure by brittle fracture at low stresses. The unavoidable notch effects were magnified owing to constraint in the vicinity of welded joints as a result of which the steel has no place to flow to and hence the crack advances in brittle fashion. So long as riveting was the accepted means for joining structural members and plates, brittle fracture seldom meant catastrophy since the fracture simply stopped at the next joint and the overloads were more uniformly distributed.

During the war years a number of all-welded oil tankers failed during cold weather. The nature of the fracture was what any engineer would associate with brittle cast iron or glass rather than with mild steel. Tankers broke in two at temperatures near the freezing point even when lying in still water in the dock showing that this was not due to high stresses likely to be caused during storms. The failures occurring in plates meeting usual specifications including tensile ductility disclosed certain 'unknowns' which the usual physical tests do not show. Out of 2,600 'Liberty' ships built for defeating the Nazi submarine blockade, some 1,200 suffered crack. The first major fracture occurred on the 16th of Jany. 1943, when the all-welded tanker Schenectady for no immediately apparent reason broke in two with almost explosive rapidity while lying at her builders' outfitting quay. Such brittle fractures without any notable distortion originated at some kind of notch effect such as a square hatch corner and frequently occurred in cold weather or in the refrigerated cargo spaces when the steel becomes stiffer and less ready to flow. For similar reasons, 2 welded bridges suddenly fractured with violent detonation in Belgium during a drop in temperature to-20°C in 1940. Again, the Duplessis welded bridge built in 1947 over St. Murrays river—one of the largest road bridges in Quebee province-suddenly collapsed in 1951 when the temperature fell to-34°C.

In the tensile test, plastic deformation involves shearing slip along crystal planes within the crystals. But in the presence of tension of equal magnitude in each principal direction, shearing stresses are absent. The plastic deformation by gliding is, therefore, prevented and brittle fracture occurs as soon as cohesive strength is exceeded. Thus brittle fracture can occur in mild steel if the three principal stresses at a given point are all tensile. Equal triaxial tension stresses do not arise frequently in practice but it is common to find a triaxial tension superimposed on an unidirectional tension. Such compound stresses arise in welds in very thick plates and in a tube under internal pressure and an axial tension. A notch produces locally at the root multi-axial stress system from simple external loading. It thereby inhibits yield and invites the initiation of a brittle fracture even in a material ordinarily considered ductile when the increased stress at the notch is close to the cohesive strength. A brittle fracture, in spite of good ductility in the Tensile test is invariably accompanied by a crystalline appearance of the whole or part of the surface of fracture since the fracture occurs along crystallographic cleavage planes of the grains. If the material is brittle, the entire surface of the fracture may be crystalline. But in broken notched bars of ductile materials, that part of the fracture next to the notch is fibrous and not crystalline.

The increased brittleness of metals when notched has been well-known ever since some ancient blacksmith discovered that the easiest way to break a metal bar was to nick and bend it by hammering over in his vice, thereby using such notches as the crack starter.

IMPACT TESTS AND TRANSITION TEMPERATURE

It will be seen from the above that steel may become brittle and fracture without notable distortion not only due to high sulphur and phosphorus, not only due to copper penetration or coarsening of grains by prolonged heating at high temperatures, not only due to suddenness of application of stresses but also due to notches especially at low temperatures. This led to the use of notch impact tests. Since brittle failures are more common at low temperatures, notched bar testing was extended to lower temperatures. As the temperature fell, increasingly large brittle 'crystalline' centres appeared until at a particular temperature the fracture was all brittle. The temperature at which the transition of the fracture from the tough tearing type to the brittle shattering type became evident was termed the 'Transition temperature'. It was hoped that this would be characteristic of the steel or at least serve as a mode of evaluation. This hope was in vain for it depends also on the size of the specimen. Increase in thickness leads to an increase in susceptibility to brittle fracture. This is confirmed by the fact that casualities to welded ships seldom occurred in plates $\frac{1}{2}$" or less in thickness. Further, the tough behaviour of two steels at room temperature is no guarantee that both will continue to do so at lower temperatures. One may behave brittle while the other may be tough. Hence, it is necessary to carry the tests down until the transition has become evident.

Though the notch impact test is a sensitive indicator of structural change and is, therefore, valuable in controlling heat treating methods, determining aging embrittlement and in evaluating the brittle transition temperature, its value is diminished by a number of inherent defects. Complete fracture is impossible in case of tough materials. Considerable part of the fracture work is accomplished only after the crack has formed. The energy absorbed in the fracture of different sized test pieces does not follow the cubic law which should be the case in ductile materials according to principles of geometric similarity. Measurement of energy in terms of fractured area actually shows a square law variation. This is because a crack starts at the root of the notch after a considerable degree of local yielding which destroys chances of geometric similarity in straining actions up to the point at which fracture is initiated. Further, in these tests, the crack has to enter and progress through a zone of compression under the head of the striking pendulum. An attempt was, therefore, made to overcome this defect in the Schnadt-type test piece where the compression zone through which the crack travels from the notch is removed and replaced by a close fitting pin of hard material.

In December 1954, for the first time, a welded British-built ship, the 20, 125 ton Liberian tanker " World-Concord " completed in 1952 broke into two as a result of brittle fracture though this was built with steel meeting the Lloyds Register's construction rules. As a consequence Lloyd's Register introduced new amendments to their construction rules requiring the use of specially approved notch-tough steels, close attention to design details and workmanship in assembly stricter control of welding technique and the extended use of radiography. As results depend on many variables like nature of steel, temperature of service, size effect, etc. the recent trend is to use full sized objects in the exact shape it is to have in service, with the stress raisers they actually carry and to test at below the actual temperature range of service.

The chances of failure in a brittle mode can be reduced by using materials which at service temperatures and in the presence of notches will not support the propagation of a fast moving brittle crack. The difficulty of designing and building a structure free from notches throws the emphasis for safety on the quality of the steel. A new criterion used at first as an addition to normal mechanical tests was a low transition temperature. The material should be notch-ductile at the service temperature. Hence tests were carried out over ranges of temperature which covered the transition from tough to brittle fracture. Though, by this means, plates could be placed in an order of merit, there still remained the vexed question—what is the minimum acceptable test value for a ship plate to which there was no specific answer. In the izod test, when the primary crack has torn its way for a short distance into the strained test piece, a brittle crack is initiated which produces a brittle appearance over a certain area of the fracture. But the brittle part of the fracture has also suffered over-strain. It cannot therefore represent the practical case of a high speed crack propagating through a plate carrying a low value of stress.

THE ROBERTSON TEST

Satisfactory results have, however, been obtained with the help of the Robertson test introduced in December, 1953. Here, a crack is started in the material under conditions of great brittleness such as extreme cold and a known stress is imposed transversely to the direction of propagation of the crack. By varying the temperature along the length of the test piece, the resistance of the material to brittle fracture is assessed from that temperature at which the crack is arrested. The test piece is 12" long and 3" wide. One end is rounded and has a 1" dia. hole drilled in it. A saw cut is made

centrally in the width on the side of the hole remote from the radiused end. A transverse stress of known value is applied through lugs welded on the test piece. The rounded end is cooled to—80°C by liquid nitrogen while the other end is heated by a gas flame to+60°C. The cold end is given a sharp blow by pneumatic hammer while a heavy mass is rested against the warm end. The shock starts a brittle crack at the root of the notch and propagates into the material through zones of gradually increasing temperature till it stops. This arrest temperature is plotted against the transverse stress.

THE FATIGUE TEST

In the past it was considered that if service load in a structural part did not exceed the elastic limit, the material will not fall, no matter how often the stress was applied and released in service. With the advent of high speeds which placed engine parts under rapidly alternating tensile and compression stresses, the sense of security ensured by satisfactory static tests was rudely disturbed by the fact that a ductile steel was liable to fracture at far below its elastic limit, more after the manner of glass than that of a ductile material. Credit for discovering the sudden infidelity of steel under vibration and repeated stresses much lower than that necessary to break it with a single pull or under a slowly applied stress, is due to Wholer whose pioneering investigations were made in Germany nearly hundred years ago.

The failure of metals under repeated stress is called 'fatigue' and their resistance to failure of this kind as 'endurance'. The term 'fatigue failure' is not a happy one as it gives the impression that under repeated stressing the capacity to withstand stress gradually diminishes. Metals do not get tired and do not recover by a period of rest. Hence 'progressive failure' would be a better term. The range of stress within which and indefinitely large number of repetitions of stress will not cause fracture, is called the 'fatigue range'. The 'fatigue limit', or the 'endurance limit' is the limiting stress below which the material will not fail if subjected to an infinitely large number of cycles of stress. To find this, several identical specimens from a single material are subjected to reversals of stress, each at different intensity, till failure occurs or until 10-20 million cycles have been endured.

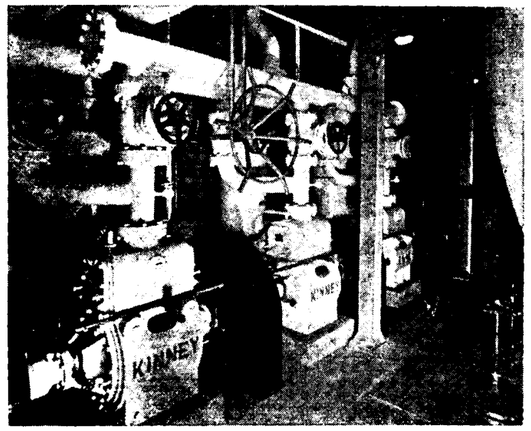
(To be continued)

New Processing Plant and Improved Facilities for Transformer and Rectifier Production

By Plant Engineer

Hackbridge & Hewittic Electric Co., Ltd.

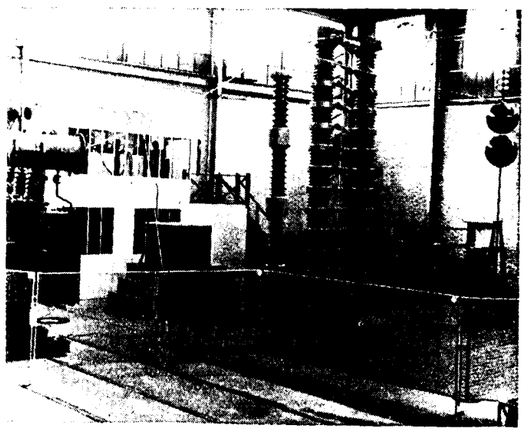
A programme of considerable expansion of premises as well as re-organisation of production methods and the installation of important new plant has been carried out by the Hackbridge and Hewittic Electric Company in its transformer and rectifier works at Walton-on-Thames.



The vacuum pumping equipment.

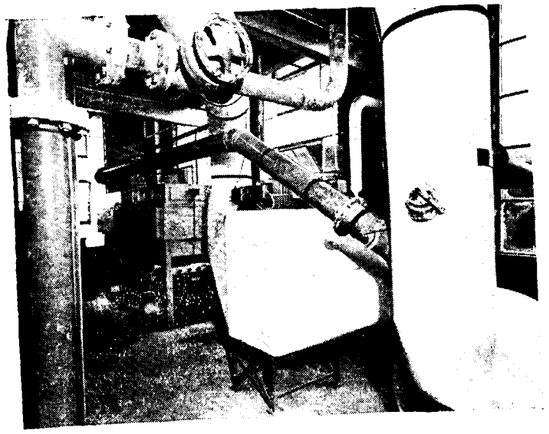
In particular a notable stage has been reached this year, as the Company celebrates 50 years of progress, with the erection of a further extension to the works and installation of a specially designed transformer process oven and associated oil treatment plant. The impulse test laboratory has been increased in capacity and an annealing furnace is being installed for treatment of cold rolled steel, whilst improvements have been made in design and construction of both transformers and rectifiers.

Four major extensions have been made to the works since 1950 with the result that since 1925 the floor area has increased to over four times its original size whilst the number of employees has increased tenfold. Although to a large extent the extensions have been necessary on account of the large size transformers now called for and the treatment and testing plants necessarily involved in their manufacture, they have permitted a measure of expansion in almost every department. The factory roof has been reglazed and the interior completely repainted and re-arranged to allow best possible light, utmost cleanliness and ease of production. The flooring of all factory extensions has been laid with ferrogranolithic material giving the essential features of adequate strength to carry highly concentrated loads and freedom from dust formation. In addition the whole of unglazed portions of the roof and the side walls above the brick line throughout the factory have been lined with thermal insulation to facilitate the uniform heating of the shops in cold weather.



A general view of the impulse test laboratory.

In addition particular importance has been attached to the manufacturing stages of very high voltage units and a portion of the extended bay 3 has been devoted exclusively to this assembly. It has been screened off and the floor specially painted to ensure that the highest level of cleanliness is maintained. Coil winding for these units is carried out in similarly painted and screened coil winding bays, and two 120 MVA 275 kV transformer units are at present in course of production in these departments.



The auxiliary air circulation and dry air plant.

The new extension forming No. 9 bay now in course of construction measures 120 ft. wide by 105 ft. long and a second floor is provided over half of this area giving a total extra floor space of 18,900 square feet. This section will be devoted almost exclusively to winding and erection of rectifier transformers.

The works boilers have been converted to oil firing thereby eliminating the dust associated with coal and ash handling. The plant consists of three boilers operating at 100 to 120 lb./in^2 and is capable of raising 40,000 lbs. of steam per hour.

OVEN AND IMPREGNATION PLANT

The requirement of transformers to pass an impulse test and to withstand such stresses in service has emphasised the importance of process treatment during manufacture. It is essential to remove moisture and air from the transformer unit; similarly the oil has to be dried, de-ærated, and filtered to remove all fibrous and suspended foreign matter, so that the maximum possible dielectric strength of the insulation materials may be achieved.

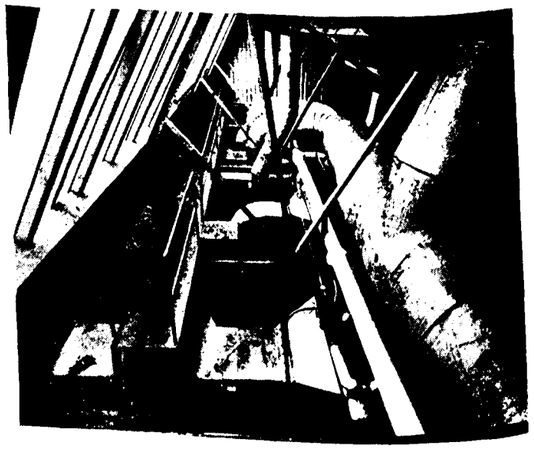
For this purpose the most up to date process plant has been installed recently by the Company in collaboration with the General Engineering Co. (Radcliffe) Ltd. It incorporates a drying oven, believed to be the largest in the country, which is capable of accommodating the largest transformers envisaged complete in their own tanks. The plant includes de-ærating equipment for treatment of the oil prior to transformer impregnation and for subsequent re-circulation, also ancillary gear and controls together with automatic control of temperature for all process equipment.

Important features of this plant are: it allows complete drying out of core and coil assemblies before impregnation; units can be cooled off in a controlled atmosphere to permit transformer assembly personnel to enter and prepare the transformers for assembly in their tanks thereby reducing to a minimum the time of exposure to shop atmosphere: oil in reservoirs is de-ærated and maintained in a heated condition under vacuum in readiness for use; and ease of transportation of units in and out of the oven.

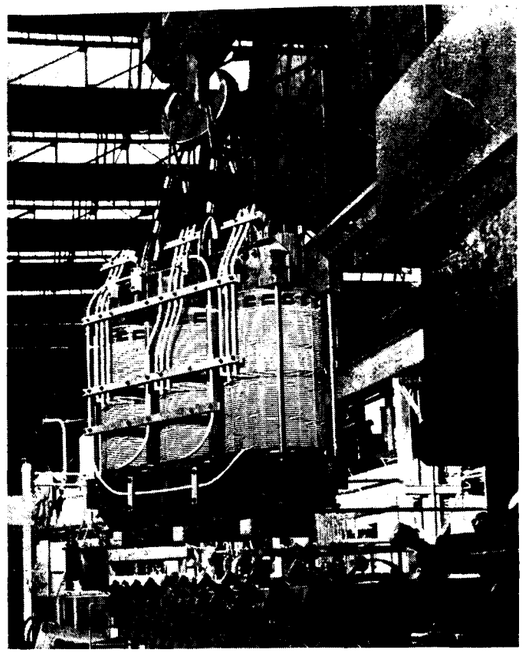
The equipment has been installed as a self-contained unit in a building flanking the extreme end of No. 3 bay so that it is in close proximity to the heavy erection shop, E. H. V. power test department, impulse test laboratory and despatch exit. Conveyance therefore from one section to another has been reduced to a minimum and is ideally arranged by co-ordination between the heavy overhead crane and two hydraulically propelled bogies which run on flush mounted floor rails in a crosswise direction between the oven and impulse test laboratory. By this means transformers for treatment are placed on the bogies and run into the oven, from thence to the impulse test laboratory and back to the crane position for preparation for despatch and loading on to the transport vehicle alongside.

THE OVEN

The oven chamber measures 37'—6" long, 26'—6" wide and 24' high. It is thoroughly insulated with fibre glass on the walls and ceiling, and is lined with sheet aluminium. Ample illumination is provided by a well distributed lighting system. The chamber is closed by means of sliding wall which is sealed in the closed



The closed air circulation equipment above the oven.



The core and coil assembly (H.V. side) of a 20 MVA 33/6.6 kV transformer of modern design.

position, and incorporates sight windows and a wicket door. The main system of air ducts through which the circulating air from the blowers overhead is passed, is arranged on both side walls to give a uniform distribution of temperature. Auxiliary air supplies, vacuum line and oil supply are connected by flexible hose from flanged connections inside the oven. Measuring and control instruments are mounted externally on a central control platform, and recording instruments include electronic devices for oil level indication and protective alarms.

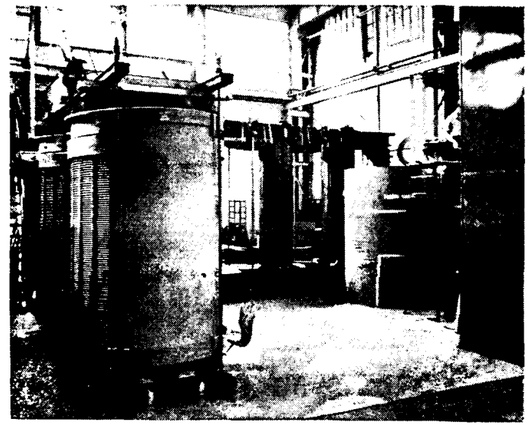
OIL PLANT

The oil is stored in three tanks each of 10,000 gallons capacity, one for raw oil as received from the suppliers and two for storing treated oil. The latter are fed from the former via a Streamline filter and calorifier, and when the required quantity of oil has been transferred it is circulated through the filter press and calorifier, and passed through a heated de-aerator where it is atomised under high vacuum to expose the maximum surface area for extraction of moisture and air until the highest possible dielectric strength has been reached. A sufficient quantity of treated oil is held in readiness for any requirement.

The vacuum plant comprises three high vacuum pumps of the gas ballast type which are connected so as to enable vacuum to be drawn either independently or collectively on the oil reservoirs, de-aerator, or transformer under treatment. A water cooled condenser is incorporated in the vacuum lines for the extraction and measurement of water and collection of gas condensate, and permits the most efficient operation of the pumps and provides an indication as to progress of treatment.

PROCEDURE OF TREATMENT

Having brought the core and coils assembly into the drying oven, air heated by means of external steam/air heat exchangers is circulated through the system of ducts and the temperature in the oven raised to 105°C. The steam heating is automatically supervised to control the speed of evaporation, an important consideration in avoiding deleterious effects on insulation, and the oxidation of metal parts and cores which can occur in uncontrolled drying atmospheres. To prevent a progressive rise of relative humidity a proportion of the moisture laden air is allowed to escape into external atmosphere, and is replaced by an equivalent intake through filters from the factory region. Measurement of temperature, dispersion factor, and insulation resistance, also per cent relative humidity of the atmosphere in the oven and the factory are recorded continuously, and these, after approximately 24 hours, combine to indicate that the



Part of the screened off portion at the end of bay 3 for assembly of very high voltage transformers, and showing erection of a 120 MVA 275 kV unit.

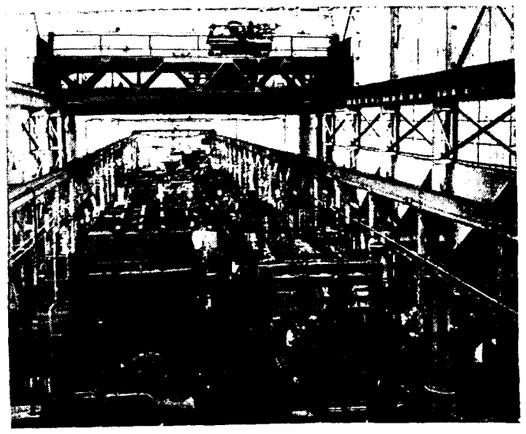
bulk of the moisture content has been dissipated and that the next stage of drying should commence.

During this next stage the relative humidity of the oven is gradually reduced to a very low dew point equivalent to vapour pressure at approximately 0.5 m/m absolute. This is achieved by replacing the existing atmosphere in the oven with dry air as follows.

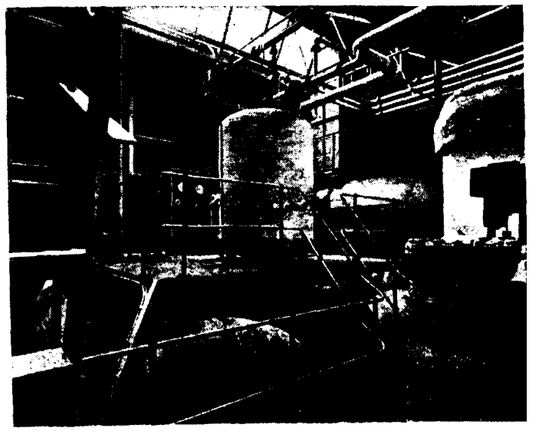
The factory air intake dampers to the oven are closed and the main air circulating system, giving 20,000 cu. ft. per min. is boosted by a secondary air stream at 2,000 cu. ft. per min. which is augmented by a dry air supply, the total air flow being maintained at a temperature of 105°C. While the intake of dry air continues a corresponding amount of air is allowed to escape to atmosphere.

The low dew point of the dry air supply is maintained continuously by means of two absorption towers which, by automatic control, operate from a predetermined cycle whereby whilst one is in service the other is being reactivated. The time needed to complete a preliminary treatment has been reduced to about 72 hours, dependent on the volume of the hygroscopic insulating material used in the transformer windings and the prevailing humidity of the factory atmosphere during manufacture.

The core and coil assembly is now cooled off in a controlled atmosphere to permit operators to prepare the unit for placing in its tank, for which purpose it has



A portion of the main transformer assembly shop (No. 3 bay). In the foreground are two large vacuum and air treatment autoclaves each of which will accommodate the core and coil assemblies of transformers up to 100 MVA.



A general view of the oil storage and treatment plant showing centralised electrical controls, de-ærator, filter presses and condensers.

to be removed from the oven. Thus the time of exposure to shop atmosphere is reduced to a minimum.

On assembly in its tank the transformer is returned to the oven, connected to the external process plant by means flexible hose, and sealed for full vacuum tightness.

It is then processed by a treatment of vacuum applied alternately with a flow of air within an enclosed system. The air circulating within the transformer is heated and this together with heat derived from the closed air circulating within the oven raises the temperature of the transformer to 70°C. To achieve reduction of humidity a dry air stream is injected into the air flow within the tank and a corresponding quantity of air allowed to escape so that the circulating air becomes progressively drier until the required optimum condition of insulation is reached.

This process cycle terminates under a vacuum of 0.1 m/m absolute and at this stage the necessary quantity of de-ærated oil to ensure impregnation of all the insulating materials is transferred from the storage reservoir to the transformer tank where it is allowed to reach a predetermined level beneath the cover.

An important characteristic of de-ærated oil is its avidity for air, and this is particularly advantageous at this stage of treatment since it tends to search out any traces of air which may have remained in the insulating materials before impregnation.

The space above oil level in the tank is now returned to atmospheric pressure from a dry air supply and the

transformer rapidly cooled, using air circulating facilities within the oven. Internal circulation of oil within the tank as a result of cooling accelerates re-absorption of air into the oil at surface level until it has regained its normal quota, but this procedure, performed in this way, ensures that only dry air is re-absorbed. At the conclusion of the cooling period the transformer is withdrawn from the oven for assembly of bushings and other auxiliary fittings.

The last stages of treatment are now performed outside the oven by means of flexible connections to an associated service point. Any moisture which may have been absorbed while bushings etc. were fitted is eliminated by means of dry air flow at 105°C after which the transformer is connected to the treated oil reservoir and the oil raised under vacuum to the correct level. Finally the oil is pumped round a circuit comprising the transformer (now under the pressure of a head of oil) the filtration plant, calorifier, and de-ærator until it has regained its original degassed state, and the mature electrical strength of the insulating materials is obtained. At the same time any fibrous material from the core and windings which may have become suspended in the oil following impregnation will have been removed.

SURGE GENERATOR EQUIPMENT

The surge generator equipment has been transferred to more spacious quarters in the extended No. 5 bay. Its capacity has been increased to over two million volts for impulse tests on transformers upto the 400 kV system voltage class.

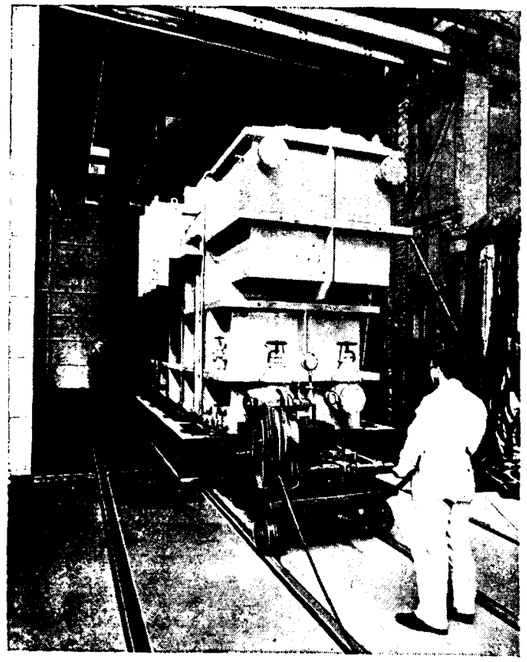
The generator comprises twelve stages each consisting of an oil filled capacitor with the usual front, tail and charging resistors and adjustable gaps. The twelve gaps are adjusted simultaneously by a small geared-down electric motor which is operated from the control desk. The gap spacing control is calibrated direct in Kilovolts, and adjustments can be made while the capacitors are being charged up.

The step up transformer has a peak voltage of 100,000 volts at 50 cycles and a voltage doubling selenium rectifier system gives the 175 kV D.C. for charging the twelve sections of the generator in parallel, this being the maximum permissible working voltage. When the system is triggered, all the gaps spark over and the capacitors become temporarily in series, giving a brief peak of up to 2,100,000 volts when set for the maximum surge. When the capacitors have charged to the requisite voltage, the surge is released by energising a separate small transformer which breaks down the bottom gap; this triggers off instantaneously the complete series of spark gaps. At the same moment an impulse is transmitted to the oscillograph and the "X" sweep is released to make the photographic record.

Facilities are included for the rapid developing and examination of oscillograms while a series of tests is being carried out.

A recurrent surge oscillograph which enables the surge distribution and other data of the windings to be ascertained has been produced by the Company's research laboratories. This apparatus gives a valuable prediction of the impulse distribution and assists in locating any weakness which might be prejudicial to the success of the test.

The equipment comprises a surge generator and an oscillograph mounted as one unit. By means of electronic components, it generates a surge voltage of identical wave form to that used for impulse testing, but whereas the latter is an instantaneous "shot" of the order of 750,000 volts, the recurrent surge is only 150 or 300 volts. The surge is recurrent at a frequency of



A general view of the oven showing a 45 MVA transformer being removed on one of the hydraulic bogies.

fifty times per second so that it can be seen as a steady record on the viewing screen of the cathode ray oscillograph and can be recorded with the comparatively simple photographic apparatus which is attached to the equipment. In addition, the equipment can produce a " chopped wave " to simulate the most stringent part of the full impulse test. The oscillograph is provided with timing waves, a range of sweep speeds between 0.5 and 150 micro seconds, and the generator can easily be adjusted to produce any desired wave form. It is thus not only of immense value for routine testing but has wide applications for research purposes.

ANNEALING FURNACE

A considerable proportion of the Company's output of transformers consists of units in which cold rolled steel is used for the core. Experience has shown that the ideal performance of the steel can be achieved only after " work stresses " produced in its grain structure during fabrication of the laminations have been relieved.

To meet this requirement an EFCO annealing furnace is being installed in bay No. 3. This furnace will permit the stress relieving of 20 tons of steel per week at a maximum temperature of 850°C in a controlled atmosphere of nitrogen.

The plant incorporates two electrically heated hearths each capable of accommodating a charge of 5 tons of the maximum size of sheet supplied by the electrical steel manufacturers, a muffle for holding each charge in the nitrogen atmosphere, an electrically heated bell and a cooling hood.

Continuous operation is afforded by alternate charging of the two hearths by transferring the furnace bell, following completion of the controlled heating and cooling cycle, from the stack loaded in the first hearth to that in the second.

The furnace is provided with fully automatic temperature programme control equipment and, in addition to controllers for the bell and base, provision is made for recording check temperature tests of the actual charge being treated.

The atmosphere plant is of the cracked and burnt ammonia type comprising a burner, a cracker with catalyst, one katharometer with flow meter; also one activated alumina gas drier of the automatic change over type.

TRANSFORMER CONSTRUCTION

Transformer design and construction have been kept in line with modern trends and the latest insulation materials and methods of clamping windings introduced. Much new winding machinery has been installed, many of the larger units being of the Company's own manufacture.

Cores are built from high grade silicon steel laminations cut from either hot rolled sheet or, when specified, from cold reduced an isotropic material. Special cradles are employed in the building of the larger cores to obviate straining of the laminations when lifting the cores into the vertical position. Each winding is rigidly braced radially from the core by core packing strips and the successive strips forming the vertical oil ducts. The pressboard spacers forming the horizontal oil ducts and the end insulation are treated before use to prevent shrinkage and by careful proportioning of the conductor insulation an equal amount of ultimate shrinkage in each winding is obtained. Axial clamping pressure is exerted evenly by means of top core clamping frames pulling down on to a common mild steel end ring, which in turn clamps the windings between the ring and the bottom frames. Thus after final vacuum drying in the factory, no movement of the windings in any direction is possible in service. The entire mechanical support of the windings is designed to withstand the electro-magnetic forces resulting from the peak asymetric short-circuit currents that occur when the only limiting impedance is that inherent in the transformer itself.

The entire dielectric circuit is designed so that an adequate ratio of stress to strength is maintained in all parts for both power frequency and impulse voltage stressing. Stress control, in the form of electrostatic shielding, is employed when necessary and all major insulation to earth includes the requisite amount of solid insulation positioned normal to the electrostatic field, thus obviating the weaknesses and inefficiencies of long unbroken surface paths. Every transformer is designed to meet its appropriate impulse test level, whether or not the customer has called for this test to be applied.

RECTIFIER MANUFACTURE

Concerning rectifiers, the extensions have permitted the opening of a complete new assembly bay for large power rectifiers, and re-arrangement of the medium and low power sections. The rectifiers are constructed on a unit basis and modern production methods have been

(Continued on page 31)

CONTRACTORS PLANT AND EQUIPMENT—PERFORMANCE REPORT

Good Performance by New Muir-Hill Hydraulic Loader

By Plant Engineer

A considerable number of new British-built earthmoving and other contractors' machines were introduced to the public at about the time of the recent Public Works Exhibition. Our contributor has been studying these machines at first hand, their design, construction and performance when on test and when under actual working conditions. In this special report one of these machines is described and its performance discussed. In further reports, which will be published from time to time, the design and performance of other new or recently introduced machines will be discussed.

DURING the past few months a considerable number of Muir-Hill model 2-WL 1 cu. yd. hydraulic loaders have been sold and put to work. There have been a goodly number of demonstrations in different parts of the United Kingdom and a fair amount of information has now come to hand regarding the performance of this new British loader. It has three features which immediately arouse interest (a) the well established double centre pivoting suspension, used on cable operated Muir-Hill loaders, (b) an extremely robust construction and (c) a modern well designed hydraulic system. A typical example of application is at the Brent Works of Constable, Hart and Co., Ltd., where two older machines were replaced by a new 2-WL hydraulic loader. Here road asphalt is produced for use in the London area by Constable Hart's own road gangs.

Mr. Bruce Green, the manager, said that with a run of 30 to 40 yards from the stockpiles to the hoppers the required feeding rate of approximately 30 tons per hour was easily within the capacity of the machine, and in fact it was merely " ticking over." He agreed that a very much greater output was possible. However, output is not the only criterion of satisfactory loader operation on this works site. Railway lines have to be crossed and the ground in parts is not too smooth. With a full bucket of granite chips, slag dust or sand, it is desirable to avoid spillage. During operation it was seen that the bucket remained steady and no material was spilled, although the front wheels articulated considerably when crossing the railway tracks and on uneven ground. This desirable behaviour is due to the design of the suspension system, which is described elsewhere in this report.

The output rate of a loader depends upon (a) the length of run between the load and discharge positions, (b) the material being handled, and (c) site conditions generally, especially the condition of the ground, inclines, etc. The following summary of performance under varying conditions gives a fairer picture of what the Muir-Hill 2-WL hydraulic loader can do, than the above instance of employment well within the capacity of the machine.

When handling builders' sand from a 30 ft. high stockpile directly into an eight-ton Dodge lorry under very wet and muddy conditions, the loading time was 2 min. 30 sec. This corresponded to six bucket loads with a total load of 7 tons 6 cwt. In this case a full width 1½ cu. yd. bucket was fitted to the machine. On this basis the continuous maximum possible output per hour is no less than 175.2 tons. On another occasion when loading the same lorry directly from a 12 ft. to 15 ft. high stockpile on wet washed sand, again under wet

(Continued from page 30)

introduced to speed up assembly and despatch. Simultaneously revolutionary advances have been made in cubicle design which not only assist in production but are of considerable advantage in installation and at the same time afford an exceptionally neat and modern appearance.

All the auxiliary components are housed in a sheeted angle-iron base which forms a compact sub-unit and the rectifier bulbs are grouped in cradles which slide into suitable tracks on the base to form the necessary enclosure for their efficient ventilation and protection. Physically, these cubicles may be banked together in a wide variety of arrangements, in line, back to back, or in double tier, to fit most effectively into the available substation space. By this arrangement a complete rectifier of any capacity can be provided, and installations of up to 30,000 kW capacity are in operation.

and muddy conditions, the vehicle loading time was 2 min. 31 sec., and five bucket loads were required, the total load in this case being 6 tons 7 cwt. 2 qtr. This corresponds to a maximum possible continuous output of 153 tons per hour. When loading loose gravel, graded ¾ in. and under, from a 3 ft. to 4 ft. high stockpile, the lorry was loaded in seven bucket loads, a total of 6 tons 7 cwt., in 2 min. 54 sec., which corresponds to a continuous possible output of 127 to 130 tons per hour.

The influence of travel time between loading and discharge can be seen from the following example. In this case a Muir-Hill 2-WL hydraulic loader is in use at a sand pit near Farnham, Surrey, feeding excavated sand over soft ground to a screening hopper 40 yards away.

Fig. 1. On uneven ground the bucket remains steady even though raised and fully loaded, spillage is thus avoided. Note how front axle articulation acts independently of the engine unit and bucket and side arm mechanism.

The average output is about 60 tons per hour. If the machine really were "pushed," 70 or possibly 80 tons per hour would be possible.

ADVANTAGES OF REAR PIVOTED SUSPENSION

The advantages of the rear pivoted suspension or—to be accurate—the double centre pivoting suspension, employed on all Muir-Hill loaders, are as follows, according to the makers:

(1) Improved loader stability.

(2) Insulation of digging and shock loads from tractor unit.

(3) Improved traction and reduced wheel spin.

(4) Improved stockpile penetration.

(5) Reduced full bucket spillage when traversing uneven ground.

From observation and from the experience of users there appears to be justification for such claims. It is, of course, difficult to compare different machines without putting them through suitably designed trials, but from the following description of the suspension system and other design features, some of the reasons for the good performance can be appreciated.

An extra heavy duty front steering axle is fitted. This is a 4 in. × 2 in. beam and is assembled integral with the main frame. The steering axle is not free to articulate independently of the main frame but is rigidly attached to it. The axle and frame together form a braced framework which is pivoted about the rear or driving axle. This enables the main frame together with the front wheels to articulate in a vertical plane without upsetting the stability of the bucket. The rear axle cases and transmission are braced by a heavy duty cross-member. The rear axle, transmission, gearbox and engine unit can articulate vertically within the main frame. In effect there is a double articulated suspension system.

As against a more or less usual loader stability angle of 16°, the Muir-Hill suspension system increases the stability angle to 30°, i. e., the loader will remain stable with the bucket raised and loaded, when standing on a 30° slope with one side of the machine tipped higher than the other. This is due to the fact that the bucket is supported at two points over the front wheels, i. e., directly under the bucket, and one point at the rear axle, which system may be compared with support at one point at the front axle with other suspension systems, and two point support at the rear axle. The double articulated suspension system considerably limits the bucket movement for a given displacement of the front axle as when traversing uneven ground, and hence makes for good operational stability.

Fig. 2. The new Muir-Hill 2-WL hydraulic loader with ¾ cu. yd. quarry bucket fitted with teeth for use at a quarry face.

Elimination of the A-frame arrangement eliminates the imposition of shock loads directly on to a front axle trunnion pin. Instead, all shock loads are carried by the front axle beam as a whole, which has no pivot holes drilled in its length. Furthermore, shock loads are not transmitted to the engine unit. The engine is pivoted at a cross-member of the main frame behind the front axle beam and the whole design is based upon the need to make the front or digging end of the machine as strong and robust as possible and to link it flexibly with the rear axle in such a manner as to protect the engine, etc., from shock loads, etc., and so as to maintain maximum stability during loading and travelling alike. The rear cross member of the supporting frame is likewise extremely robust, as is the rear pivot. The weight of the load in the bucket is centralised on the two rear wheels under all conditions. These advantages are obtained without any reduction of ground clearance, which at 11¾ in. is quite good. The frame is of box section heavy gauge steel instead of open channel, and this makes for great strength and rigidity. There are buffer stops on the main beams, and these result in good, clean level working. These buffer stops are inclined, their function being to act as rigid stops or supports for the bucket during loading or when fitted with a blade, during dozing, etc. Heavy loads can be transmitted without the front wheels leaving the ground, thus improving the traction characteristics.

GOOD PENETRATION

The loader bucket is well forward of the front wheels. The advantage here is that when the machine is operated with a standard narrow bucket, the width of which is 4 ft. 7 in., very good penetration is obtained when handling heavy and difficult materials. It is possible to completely fill the bucket and to obtain maximum penetration into the material without the front wheels coming into contact with the stockpile.

A second advantage of having the bucket set well forward is the ability to load high sided vehicles and rail trucks. Hoppers in particular can be centrally loaded without the loader coming into contact with the hopper sides. Bucket outreach from the front wheels is 4 ft. 8½ in. with the bucket at ground level and 4 ft. 9 in. with the bucket 2 ft. 10½ in. from the ground. With the lifting beam horizontal the outreach is 6 ft. 2½ in. The maximum tipping clearance is 11 ft. 2 in. under the bucket hinge and 10 ft. under the bucket edge, when tipped for discharge.

HYDRAULICS AND POWER UNIT

The new loader is fully hydraulic, with double acting rams on jib and bucket. The tipping action of the bucket is gentle and under the driver's full control. The hydraulic pump is direct driven from the engine and there is constant flow oil filtering, and a separate air cleaner or breather at the oil tank. The lifting beam circuit is independent from the bucket control circuit and both have their own pressure relief valves. The hydraulic rams have wiper glands to protect the bearings and sealing glands from abrasive dust. All hydraulic linkage pins and bearings are of hardened steel, bronze bushed, and easily replaced. Demonstrations held recently indicated that one advantage of employing double acting hydraulic rams was that of being able to scrape

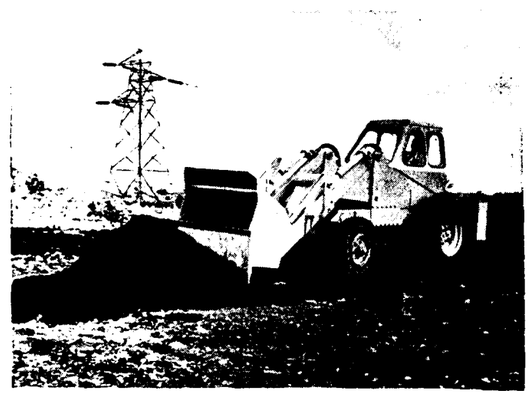


Fig. 3. Levelling refuse in controlled tipping with the bulldozer blade attachment.

accumulated asphalt from a concrete surface. This, it was agreed, makes the new loader suitable for following surface burners and for stripping on road maintenance operations, etc.

When excavating or working in a difficult or heavy material stockpile, full power crowd action is obtainable as follows. By operation of the dual clutch and road wheel brake pedal, a single operation, the engine is disconnected from the road wheels and the wheels are simultaneously braked, thus leaving the machine stationary with the bucket down and penetrating the stockpile. Now, by raising the bucket through a distance of one foot or a little more, and then creeping forward slowly, the bucket is easily filled to capacity. This whole operation is quite simple to carry out and is most effective.

The Muir-Hill 2-WL hydraulic loader is made by E. Boydell and Co., Ltd. It is powered by a Fordson diesel engine which develops 42 b. h. p. at 1750 r. p. m. There are six speeds forward and two reverse speeds. The standard general purposed bucket is 4 ft. 7 in. wide, has a 25 cwt. load capacity and rated struck capacity of 1 cu. yd. A full width bucket is also available. This is for general duties and is of 1 cu. yd. struck capacity, although in practice somewhat greater loads may be carried. Trials in sand with the new full width bucket showed that average load carried is 1 cu. yd. When runs were made into a stockpile of 1 in. downwards, graded gravel, which was particularly free flowing in this instance, full bucket loads were obtained without difficulty. A typical bucket load was weighed and found to be 22 cwt. 3 qr. This standard bucket is 6 ft. wide, which is within an inch or two of the overall width of the machine. The blade metal is of abrasive resisting steel and bucket teeth can be fitted as an extra fitment. During operation the driver can vary the bucket discharge angle and the digging angle of the bucket edge.

Other alternative buckets are available. These include: Full width buckets 6 ft. wide, for light materials, and for light-medium density materials, of struck capacities 2¼ cu. yd. and 1½ cu. yd. respectively; and a heavy duty quarry bucket of ⅞ cu. yd. struck capacity, width 4 ft. 7 in., and with four teeth for rock handling. A dozer blade is also available, simply attached to the bucket. Other equipments are a 25 cwt. crane attachment and a 25 cwt. hook attachment. Electric lighting is available as a standard extra.

MANUFACTURE OF TRUNK CABLES

The Hindustan Cable Factory at Rupnarayanpur (West Bengal) is being expanded to enable the factory to take up the manufacture of co-axial telephone cables required for trunk lines. The first lot of machinery for the project has been ordered. The production of co-axial cables is expected to begin during 1958.

The factory, which went into production in September 1954, is the only unit manufacturing telephone cables in India.

In 1955—56, the factory produced 525 miles of subscriber telephone cables; during the period April-October, 1956, 300 miles of subscriber cables were produced which means an annual production rate of 578 miles of cables against the target of 555 miles for 1956—57.

When in full production, the factory will manufacture 300 miles of co-axial trunk cables which will enable the Posts and Telegraphs Department to link the major cities of India by an underground telephone cable network. At present the trunk-telephone link is provided by overhead wires except between Bombay and Thana and Calcutta and Asansol. Co-axial cables have an advantage over ordinary cables because each co-axial cable can provide 960 channels.

The capacity of the Hindustan Cable Factory for the manufacture of armoured subscriber cables is already being doubled to enable it to meet all the requirements of the P. & T. Department in respect of armoured cables during the Second Five-Year-Plan. The schemes for this expansion, expected to cost about Rs. 7.5 lakhs, will be completed next year.

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DURGAPUR STEEL PLANT

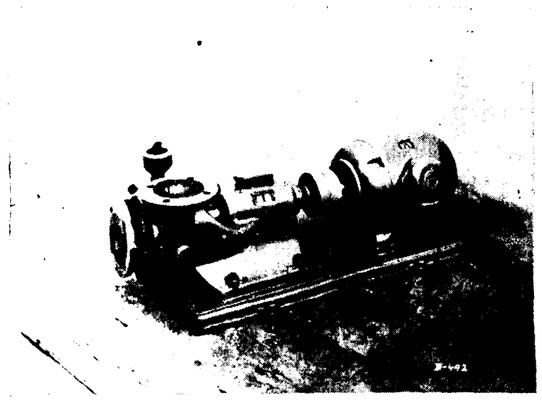
The final contract to build an integrated iron and steel works at Durgapur was signed on 31st October, 1956 between the Government of India and the Indian Steelworks Construction Co., a consortium of leading British firms.

The plant will have three blast furnaces, each having a capacity of 1,250 tons of pig iron per day. The steel melting shop will consist of nine open hearth furnaces with a total capacity of approximately 1.25 million tons of ingot steel per annum. The rolling mills will be able to produce 790,000 tons of finished products, such as forging blooms and billets, billets for re-rolling merchant bar sections, light and medium sections, sleepers and railway wheels and tyres and axles.

Production of Pumps in Czechoslovakia

By Director of Publicity, Strojexport, Praha.

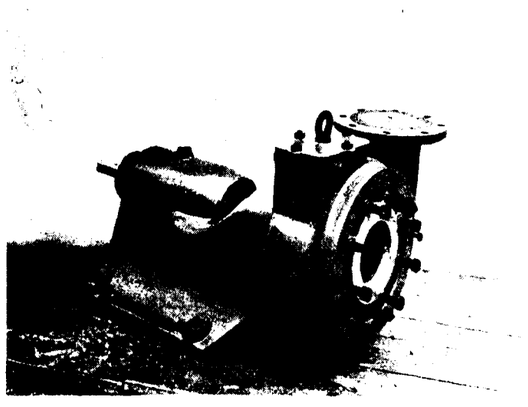
THE Czechoslovak pump industry has a great tradition of more than 80 years standing. After 1945 the production of pumps was concentrated in several factories specialized for their production. Only the best proven types were kept in production, which enabled the pump industry to gain and concentrate existing experience both manufacture and operation of the pumps. The design of the pumps was simplified and improved both as far as higher pressures and delivered quantities and also the choice of materials were concerned. The development and research centres of these factories were not left behind, but hand in hand with technical progress are developing new, modern series of pumps, which meet fully the more and more severe requirement of the industry. Our foreign trade is exploring every road and there are perhaps only few countries in the world where the high quality SIGMA pumps are not known.



Single-stage spiral casing centrifugal pump.

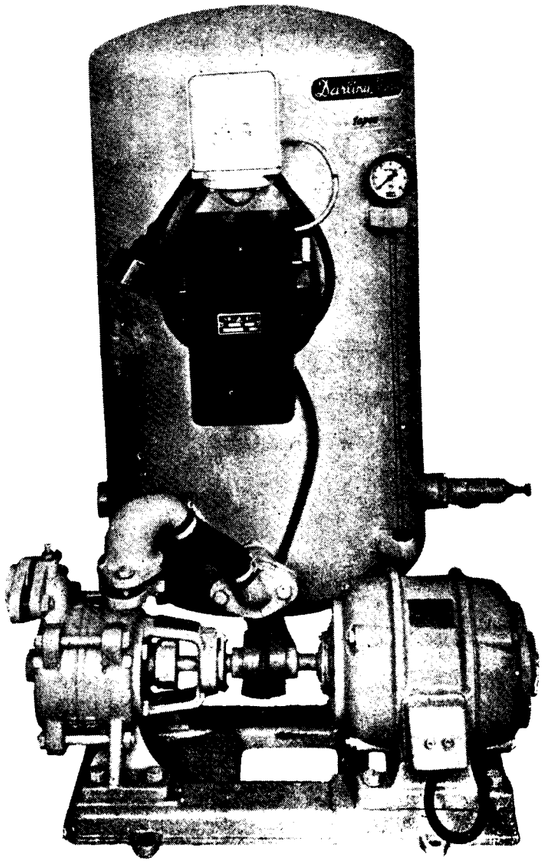
The development and manufacturing programme of the Czechoslovak pump industry contains nearly every type of pump required by various industries, such as mines, foundries, power plants, the chemical and food industries, waterworks, sewage disposal, agriculture, transportation, etc., as well as pumps for different requirements of foreign customers.

For pumping water from mines the type NORA pneumatic pump is used. It is easily transportable and fully automatic in operation in the same way as the type RUBINA pneumatic centrifugal pumps. The main mine pumps for delivery heads up to 800 m. and outputs of up to 10,000 lit. per min. are intended especially for difficult operational conditions in coal mines, where the success and safety of the entire operation depend upon the reliability of the pumps. The modern methods of conveying soil and slurries have required new types of dredging and armoured pumps, as well as pumps for cement slurries. The conveying of sand, manganese ore, fly-ashes, slag, etc., suspended in water is now also inseparately coupled with the application of special pumps, meeting fully all requirements, even under the most difficult conditions. The choice of the appropriate material, such as manganese steel, etc., improves the life of the pumps and to a great extend helps to bring about economy in the operation in metallurgical works and sand pits.



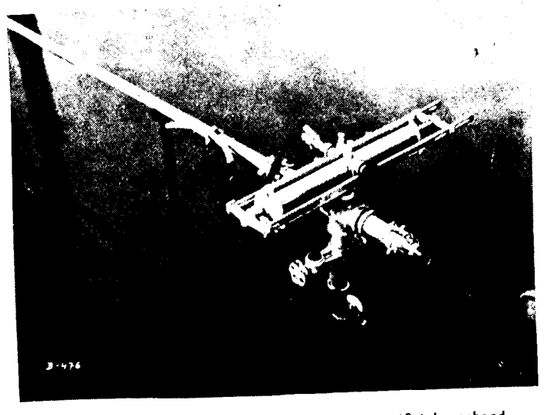
Spiral casing centrifugal pump model NZ.

Boiling water feeding pumps for temperatures of up to 200 C and pressures of over 200 atm. g. operate now in quite a number of power plants. Their robust design is especially suitable for continuous, reliable operation. Accumulation pumps of the largest type, circulation pumps of the La Mont type handling hot water of up to 310 C for boilers, condensate pumps, and the largest turbine driven feeding pumps from a whole group of pump designed for the power generating industry. Many of these pumps have been operated continuously for several years in important power plants in various



Automatic water supply system for households. (another model)

Deep well hand pump.

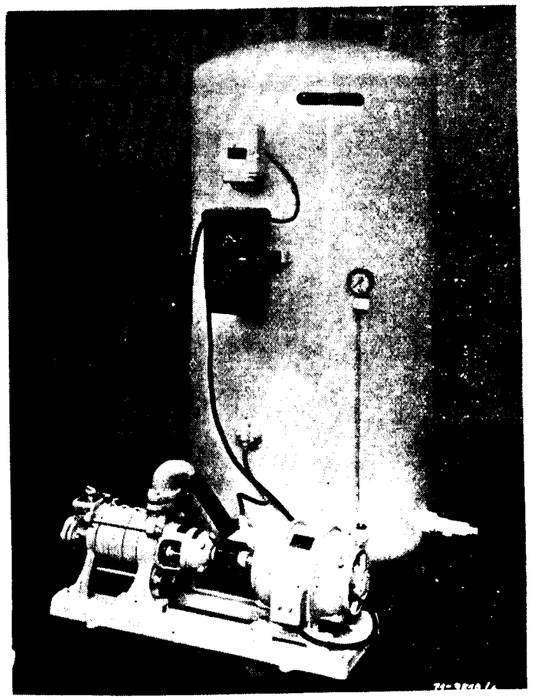


Automatic Oscillator for Spray-line used for artificial overhead Irrigation.

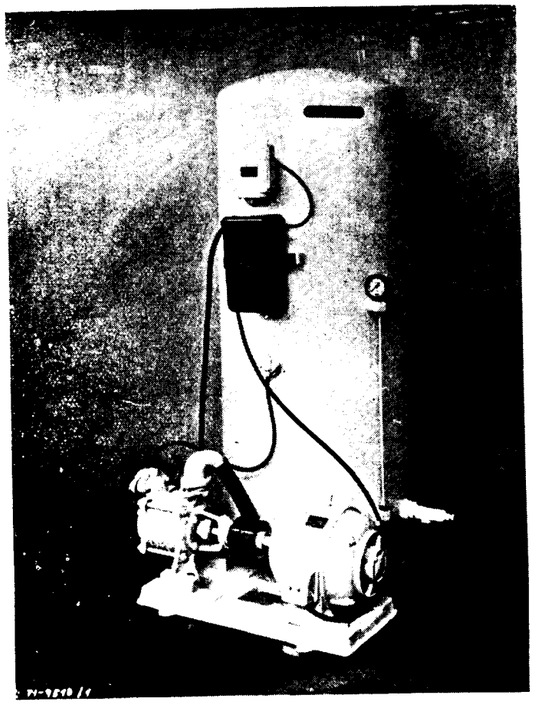
European countries. Feeding pumps are delivered both with electric motors for any voltage and with steam turbines, all of them manufactured by SKODA WORKS, CKD, or other famous establishments.

For the chemical industry several series of pumps have been designed with and without stuffing boxes. Their outputs reach up to 5,000 lit. per min. with pressure of about 7 atm. g. These modern types of pumps have been designed in co-operation with technicians of great chemical works and are characterized by their very robust design, guaranteeing great reliability even in continuous operation. After careful analysis of operational conditions, pumps of various materials are selected, e. g. of cast iron, steel, chromium and nickel steels, chromium cast iron alloy, lead-antimony alloy, aluminium, bronze, ferrosilite, etc. In addition, pumps of non-metallic materials, such as ceramics, plastics or hard rubber are manufactured.

Pumps for the chemical industry without stuffing boxes are of special interest. They have passed with honours their test in the chemical industry, since they

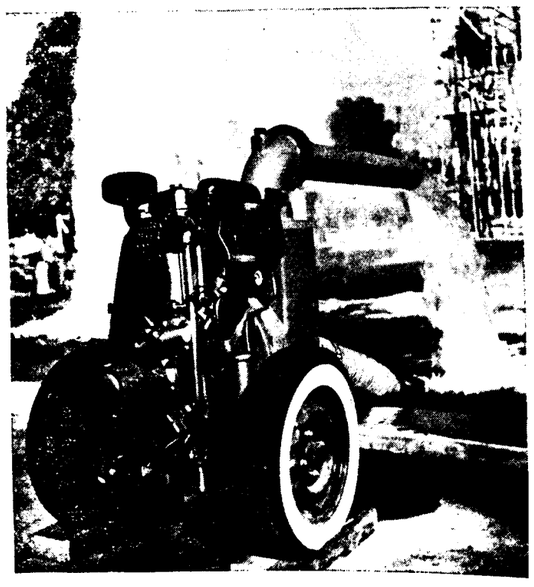


Automatic water supply system for households. Darling Superior



Automatic water supply system for households. Darling Konta Model

Automatic water supply system for households. Darling Nautila Jubila Model



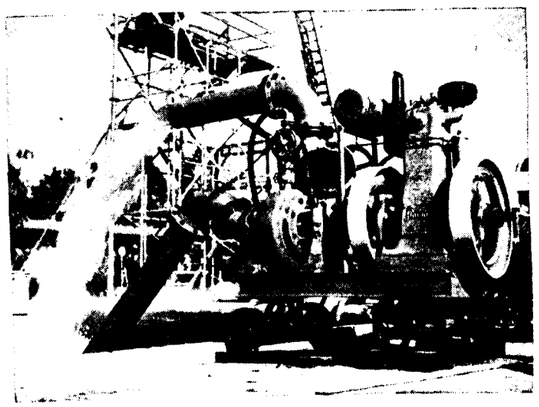
Type 150-UZA Self-suction irrigation set.

have helped to eliminate troubles arising from the intricate properties of the stuffing box packing ropes when pumping various acids. Pumps without stuffing boxes are indispensable primarily in the case of continuous 24-hour operation as they require practically no servicing.

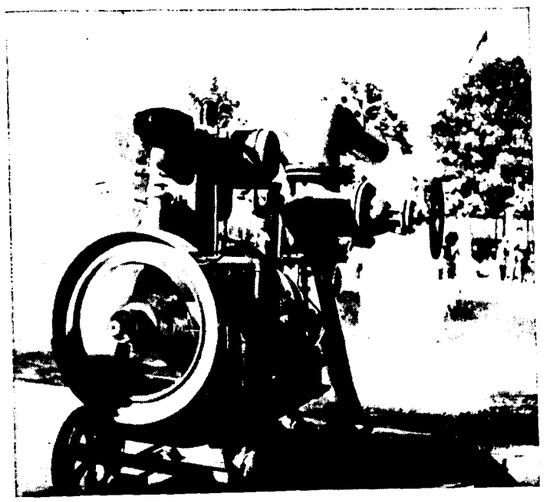
In the food industry spiral pumps operate in dairies, breweries, distilleries, starch and sugar factories.

The SIGMA pumps manufactured for the food industry are both of horizontal and vertical design and handle reliably milk, cream, wine, beer, alcohol, wort, pulp, starch, etc. It is, of course, obvious that each liquid and various operational surroundings require special materials, or possibly a special design of the pump. The remarkable type SIGMA OZO 10 pumps for conveying potatoes handling nearly 1000 q of potatoes floating in water per hour, bear witness that our industry is capable of producing also pumps of the most modern design. The type SIGMA PXO 19 pumps intended for conveying sugar beet in water have also proved their value well in sugar factories and assisted considerably in the mechanization of sugar beet dumps. Their output—up to 50,000 q of sugar beet in 24 hours —undoubtedly marks considerable progress of the pumping technique applied to conveying solids suspended in water.

Also in the paper industry pumps form a very important link in the machinery equipment for paper production, both for mixing of paper pulps and pumping paper pulps with dry contents up to 17% and conveying chlorinised and waste waters. Type SIGMA DK, evacuation pumps are employed to advantage with paper producing machinery and filters type Savalla.



An irrigation unit pump.



A different irrigation unit.

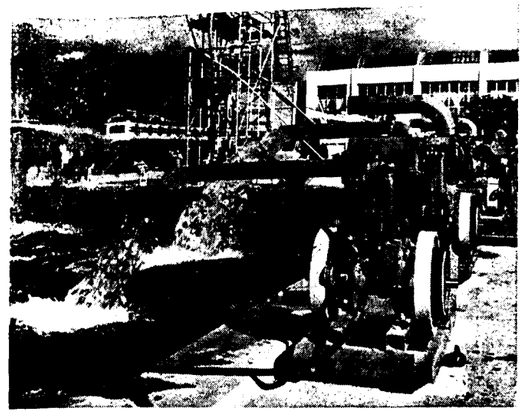
The oil industry also makes considerable requirements of pumps, their materials and design. Boiling oils, with temperature of up to 400°C are conveyed by SIGMA cracking pumps using operational pressures of up to 400 atm. g. A whole series of pumps of various designs for conveying, oil, petrol, centrifugal and piston type pumps, with fluent regulation of the pumped quantities during pump operation, as well as with adjustment of the pumped quantities at rest, render in practical operation good services on long distance crude oil pipelines or as scavenging pumps for drilling deep boreholes.

The spinning pumps for the production of plastic rayon, pumps for dyeing plants for the handling of active and waste waters meet fully every requirement of the textile industry.

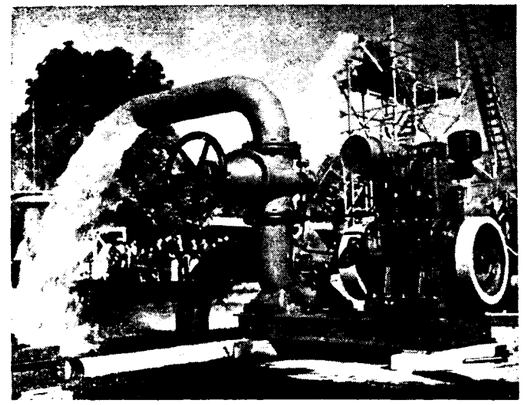
In addition to special pumps for every industrial branch, SIGMA manufactures immersed and vertical pumping sets for wells and bore-holes 200 m. deep.

The propeller type watering and draining pumps delivered abroad in whole units represent successfully the Czechoslovak pump industry.

The vertical spiral pumps with adjustable blades for rehabilitation schemes enable economical pumping under varying delivery heads and the required delivered quantities. Their output are approximately 5000 lit. per sec. per one set and they are a real example of the great technical development of our industry.



Another irrigation unit.



One more type of irrigation unit.

The Czechoslovak pump industry now takes part successfully in the delivery of complete pumping stations for countries with underdeveloped economies in Africa and Asia. At present deliveries for an accumulation station with an input of nearly 50,000 kW for a certain European country are being negotiated.

The technicians of the Czechoslovak pump industry have recently been working on a new design of a reliable, highly efficient, self-priming pump for handling clean and polluted water containing a certain amount of solid admixtures. The operational of this pump is based on the circulation principle, the only operational component part—the impeller, not being very different from the impeller of a common centrifugal pump impeller. The pump is provided with a reliable mechanical stuffing box which requires practically no maintenance.

The pump attains in a very short time a high vacuum, higher than that attained by the normal rotary air ejection pumps and is thus in a position to suck successfully from a depth practically equalling the absolute limit. This pump is delivered as one unit with a type Slavia water cooled Diesel engine.

The long year tradition of the pump industry well equipped designer's offices, employing a great many experienced designers together with large hydraulic testing shops enabling checking tests of the pumps guarantee the good quality and durability of all SIGMA products.

The special research centre attached to the largest factory and dealing exclusively with the pumping technique is working on future pump designs. It studies carefully all possibilities of application of pumps in new industrial branches (such as conveying of ores, pit coal, etc.) and checks theoretically and practically new pump design elements and the possibility of increasing efficiency, correct application of various materials, etc.

Our technicians are undoubtedly able to design means for solving any problems pertaining to the pumping technique without regard to the extend and magnitude of the equipment in question. The existing experience and results give every right to expect that the traditionally well known Czechoslovak pump industry will develop successfully also in the future and continue to maintain one of the first places among the world's manufacturers of pumps. SIGMA pumps have become the symbol of quality and reliability; the technical development of the pump industry, assisted by the government, opens very promising vistas into the future.

Let us conclude with the slogan so well known all over the world:

LET US HELP YOU SOLVE YOUR PUMPING PROBLEMS.

Protection of Industrial Designs in India

By A. K. Sinha, *Examiner of Patents, Govt. of India, Calcutta.*

CONSTANT evolution of new or original designs of industrial products and consumer goods has played a vital role in the development of every industrial country. Every such country has adopted some sort of means for protecting articles with new and original designs so that their proprietors can protect themselves against dishonest competitors making use of such original ideas. The fundamental purpose of registering designs is to encourage new or original designs to industrial products. The purpose is achieved by conferring upon the proprietors copyright in such designs for a limited period. In India protection of new or original "designs" is given by the Registration of Designs under Part II of the Indian Patents & Designs Act, 1911. This article makes an attempt to deal with matters peculiar to designs.

Now the question is "What designs are registrable?" Under the Indian statute the word "design" means "features of shape, configuration, pattern or ornamentation applied to any article by any industrial process or means, whether manual, mechanical or chemical, separate or combined, which in the finished article appeal to and are judged solely by the eye, but does not include any mode or principle of construction or anything which is in substance a mere mechanical device, and does not include any trade mark as defined in Section 478, or Property mark as defined in Section 479 of the Indian Penal Code."

The design of an article is registrable if the feature of shape, configuration, pattern or ornament is 'new or original'. Such originality or novelty of the design must be judged solely by the eye with reference to the external appearance of the finished article to which the design is applied. It is not necessary that a design should possess artistic merit. The novelty or originality will be destroyed by the publication of the design prior to its registration. A design is also liable to be refused for registration if it differs from a design only in immaterial details as features which are variants commonly used in the trade. The expression "immaterial details" includes those differences which although clear, yet do not suffice to give substantial novelty or originality (27 R. P. C., 498 at P. 507.)

In determining the novelty or originality of a design, it is necessary to ascertain the distinction between the two expressions. There is no hard and fast rule by which a sharp line of demarcation can be drawn between them. But it has been decided in the past that "new" refers to cases where the shape or pattern was completely new in itself, whilst "original" refers to cases though, old in itself, it was new in its application to the article in question. The words new or original involve the idea of novelty, either in the shape, pattern or ornament itself, or in the way in which an old pattern, shape or ornament is to be applied to some special subject-matter (27 R. P. C., 498 at p. 503). The existence or not of novelty or originality is a question of fact, to be decided by the eye; the eye must be one which has learnt to appreciate the degree of distinctions (49 R. P. C. 113 at p. 118—9). Lord Moulton said "It is necessary with regard to the question of novelty and originality, that the eye should be that of an instructed person, i. e., that he should know what was common trade knowledge and usage in the class of articles to which the design applies". (37 R. P. C., 233 at p. 240). The test of novelty of a design is the eye of the judge. He must place the two designs not only side by side but also apart and see whether the one for which novelty or originality is claimed is substantial. It is the general impression gathered by the eye that counts and so it is very difficult to formulate any hard and fast rule for guidance.

The principle or the mode of construction of the article, or any mechanism for carrying out any operation cannot be registered as design under the Act. Neither the constructional details of the article, nor the utility of the article would be relevant for deciding the registrability of the design. It is only the actual shape or pattern of an article that can be registered, as distinct from the general characteristics of the article concerned. In other words, a shape dictated solely by the function of an article cannot be regarded as a design.

It is of interest to note that artistic subjects which are capable of registration under the Indian Patents & Designs Act, cannot be protected under the Indian Copyright Act. Designs which are reproduced or intended to be reproduced in more than 50 single articles or which are to be applied to printed paper hangings, carpets, floor cloths. or oil cloths, textile goods or lace not made by hand, are excluded from protection under the Indian Copyright Act.

Under the Emblems and Names (Prevention of Improper Use) Act, 1950, public are warned that no registration is obtainable in respect of a design which is similar to or is a colourable imitation of the official seal and emblem mentioned below:—

1. The name, emblem or official seal of the United Nations Organisation and the World Health Organisation.

2. The Indian National Flag; and

3. The Official Seal or emblem of the Government of India or of any State, or any other insignia or coat of arms used by any such Government or by a Department of any such Government.

For purposes of registration of designs, goods to which the designs are to be applied are classified into 14 classes contained in the Schedule to the I. P. D. Rules, 1933.

PROCEDURE FOR OBTAINING COPYRIGHT IN A DESIGN

An application to register a design should be made by the proprietor of it, that is to say, by the author or by some other person to whom the author has executed the work for good consideration or by any person who has acquired the design or the right to apply the design to any article. The word "acquire" means to obtain a transfer of the proprietory right in the design and not merely to learn the design (Md. Abdul Karin Vs. Md. Yasin & anr., Allahabad High Court (1934) re: Design No. 43516).

The application should be made on the prescribed form laid down by the Indian Patents & Designs Rules, 1933 and may be filed at the Patent Office by the applicant himself or by his authorised agent. The application should be accompanied by the prescribed fee and four copies of representations. The application must specify the article and the class in respect of which the design is to be registered. The representation of the design may be drawings, photographs, tracings or specimens. The copies should illustrate one or more perspective views of the finished article so as to clearly illustrate the shape or configuration of the article. If necessary, drawings in plan or elevation may be added or substituted. It is desirable that the applicant should state the features for which novelty is claimed, and must, if required, indorse each representation accordingly. A disclaimer may also be demanded in the following circumstances: (1) if the design is likely to be confused with a trade mark, (2) if the design is very similar to a previously registered design by the same owner, (3) if the representations suggest any mechanical action, and (4) if the representations contain words, letters, numerals, etc.

On receipt of the application, representations and fees in the Patent Office, the application is numbered and dated in the order of its receipt. Thereafter, the office will examine for formal defects and will search earlier registrations to ascertain whether or not the design is new or original. Defects, if any, are communicated to the applicant who is requested to remove such defects and put it in order for acceptance within six months from the official date of the application, failing which the application will be deemed to be abandoned. If the application is accepted, a certificate of registration is issued to the applicant. The registration of a design confers upon the registered proprietor "Copyright" in that design. "Copyright" means the exclusive right to apply a design to any article in any class in which the design is registered. The copyright lasts for 5 years in the first instance; it may, on payment of renewal fees, be extended by two further periods, each of five years.

CANCELLATION OF THE REGISTRATION

Any person interested may present a petition to High Court for cancellation of the registration of a design, at any time after the registration on the following grounds:—

(1) That the design has been previously registered in India or it has been published in India previously;

and

(2) The design is not new or original.

A petition on ground (1) above only may be presented to the Controller within one year from the date of registration. The Controller's order on such petition is appealable to High Court.

INSPECTION OF REGISTERED DESIGNS

Registered designs are not open to public inspection until two years after the date of registration, except by the proprietor or his authorised person or a person authorised by the Controller or the Court. On the expiry of said two years, the designs become open to public inspection and their copies may be obtained on payment of costs.

MARKING OF ARTICLES

Rule 45 of the Indian Patents & Designs Rules 1933 stipulates that before delivery on sale of any articles to which a registered design has been applied, the proprietor of such design shall cause each article to be marked with the word "REGISTERED OR REGD. OR R. D." and also with the number appearing on the certificate of registration. These requirements are, however, dispensed with in cases of (1) textile goods in which the design is printed or woven, other than handkerchiefs; and (2) articles made of charcoal dust, which are brittle and which are not sold in single pieces. If he fails to carry out these directions, the proprietor shall not be entitled to recover any penalty or damages in respect of any infringement of his copyright in the design.

PIRACY OF REGISTERED DESIGNS

If any person contravenes the copyright in a design, he is liable for every offence to pay a sum not exceeding Rs. 500 to the registered proprietor subject to a maximum of Rs. 1000 recoverable as a contract debt. Alternatively, the registered proprietor may elect to bring an action for the recovery of damages for such contravention and for an injunction against the repetition thereof.

ADVANTAGES OF DESIGN REGISTRATION

Much has been talked about the commercial value and usefulness of patents. The same truth applies to registered design. For business purposes, it may be regarded as a minor patent. Technicians very often produce articles which are suitable for patent protection and at the same time they are very simple and attractive in outward appearance and shape; these are, therefore, easily susceptible to copying. In such cases it is well advised to secure registration for the design of the article concurrently with the filing of patent application.

This procedure affords an opportunity of giving quick protection to the article so as to prevent cheap imitating, which otherwise could not be stopped until the issue of a full patent, which might take a year or more. Such registration is very valuable when it is desired to obtain provisional protection whilst the article is being tested for commercial exploitation in the market during the period of provisional protection.

There are articles which are of unpatentable construction or method of manufacture but yet possess characteristics of shape, pattern or ornamentation which render them more appealing and acceptable to the public than other articles of the same type. Experience has shown that as soon as these articles are put into the market, there is a tendency among the rival traders to copy the shape or form of the successful article. It is to prevent this that design registration is desirable. The appearance or design of an article may be a valuable selling asset, and it is for this reason that legal monopolies are being granted for new or original designs.

Another great advantage of design registration is that it can be obtained in a very short period of time say, one or two months, whereas it may take 12 to 18 months or more to obtain a patent. So, on obtaining the certificate of registration, the proprietor is almost immediately able to take steps to prevent copying of his article as soon as it is placed upon the market.

HIGH TENSION INSULATORS PROJECT

The inauguration of the high voltage insulator factory on the 23rd February 1957 by Prime Minister Nehru at Bangalore is a significant step towards attaining self-sufficiency so essential to meet the increasing demands in the country arising from the several electrification schemes undertaken. It may be interesting to know that the factory has its origin which can be traced 25 years ago when the Mysore Government established the Electro-Porcelain Factory. The new factory has been planned to manufacture 3,000 high voltage insulators per day. The Rs. 85 lakh project to manufacture 2,500 tons of insulators annually has been undertaken by the Mysore Government with the technical co-operation of a Japanese firm. It is reported that the only raw meterial that has to be imported from abroad is ball clay as other components namely china clay and feldspar are stated to be in abundant supply in India. It is heartening indeed to learn that the technical experts from Japan have already tested the clay and feldspar in their laboratories in Japan and sent the finished goods to India. It is claimed that the products compare satisfactorily with the imported quality. In the light of increased activity envisaged during the five year plans for power generation, the opening of this factory will greatly help the country in meeting the requirements of high tension insulators.

Indian Machine Tools—Progress in Manufacture

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(Exclusive to "Journal of Industrial Engineering")

IN spite of its importance, it appears that the Machine Tool Industry of India has been given very little publicity and to a certain extent lost sight of in this Atomic Age. The Machine Tool Industry is the main plank on which modern industrialization is based and without it, a nation is placed at a disadvantage in regard to prosperity in peace time and safety during the war period.

It is regrettable that this vital and strategic Industry was not established in our country in an organised manner until the Second World War. Although machine tools were manufactured in India as early as 1890 and this continued throughout the early years of the Twentieth Century, the number of manufacturers was extremely small and the products manufactured were very poor in quality and standardisation. Manufacture of cone pulley lathes, pillar type drilling machines, etc., was undertaken during this period by the factory and workshop owners only to meet their own needs. The first World War of 1914—18 induced certain manufacturers in the north to produce "Shell Turning Lathes". Early in 1930, manufacture of reasonably good quality machine tools in India was undertaken by

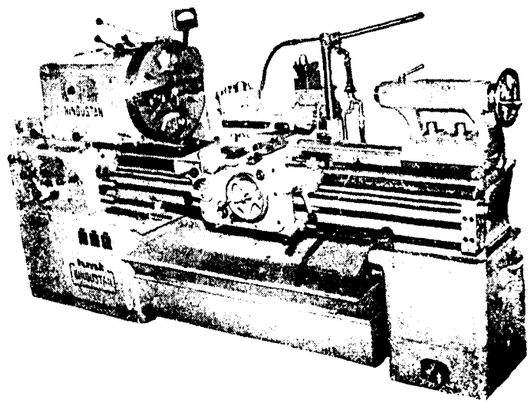


Fig. 1(c)

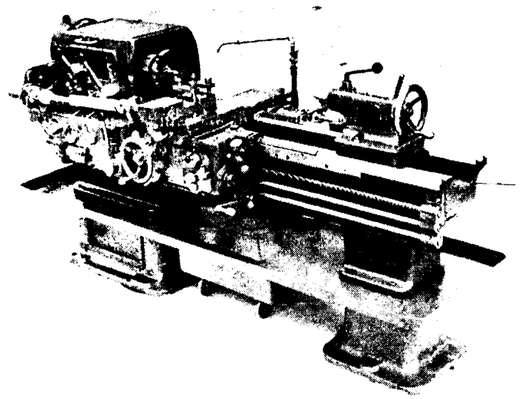


Fig. 1(d)

Messrs. P. N. Dutta & Co. Ltd., Calcutta, who were later followed by Messrs. Cooper Engineering Co. Ltd., in 1935 and India Machinery Company Ltd., Dasanagar in 1937.

The outbreak of the second World War, however, entirely turned the complexion of the Indian Industry which had geared itself to the manufacture of defence equipment with the consequent increase in demand for machine tools. Although, the situation, even as late as 1939, was not very acute, as imports of machine tools, though in reduced number, still continued to come through, the situation was far from satisfactory. Apprehensive of the future, Government of India passed the Machine Tool Control Order in February 1941. The main objects of this Order were to make an inventory of machine tools obtainable in India, regulate and improve production in general and secure for the Armed Forces, Ordnance Factories and other war Industries the best quality machine tools.

Even when Italy entered the war with the resultin closure of the Mediterranean for shipping, machine tool could still be imported, though by a longer route, acros

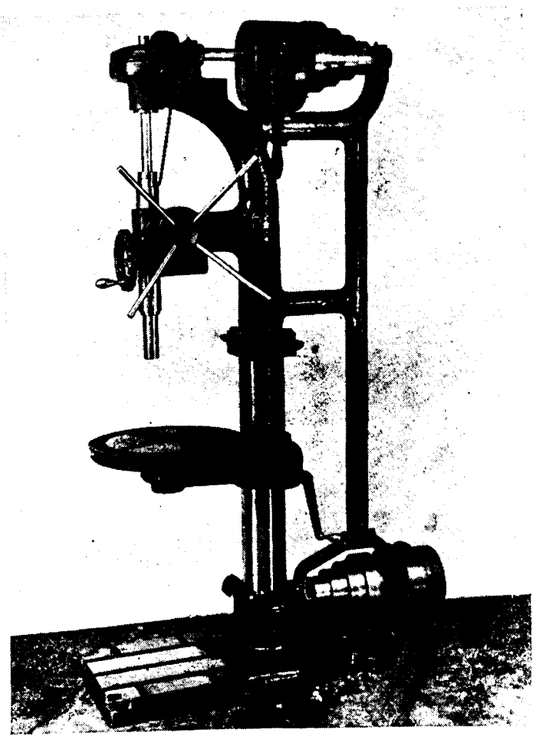


Fig. 2(a)

the Indian Ocean. However, with the entry of Japan into the war, even this route was blocked and a precarious situation was created. Imports being thus more or less completely cut off, the Indian Machine Tool Industry was called upon to make great efforts and fill in the gap to supply the country's requirements.

Plans were drawn up by the Machine Tool Controller to increase the manufacturing capacity of the leading producers who had the requisite plant and equipment, technical supervision and manufacturing experience, by supplying to them new machinery obtained from abroad to balance their plant and equipment. Some five Firms received the Balancing Plant worth about Rs. 2.2 million. In addition, 4 firms were assisted in outright purchase of machine tools from U.K. and U.S.A. A team of 7 Machine Tool Experts were deputed from U.K. to help the indigenous Machine Tool Industry with technical advice and guidance. Inspection organisation was also set up under the Controller General of Inspection which greatly helped to rationalise and control the quality and standards of indigenous machine tools.

As a result, the Industry made a very good progress as could be seen from the fact that whereas in 1942, the total number of graded machine tools manufactured in India was only 273, in 1946 this number had increased to 4,121 valued about Rs. 11.3 million.

Although the Indian Machine Tool Industry made this remarkable progress in comparatively short period, it must be admitted that the general organisation of the Industry had not been specialised with the result it was not competent enough to face the open competition. In the struggle for the survival of the fittest during the post war period, manysmall-scale Machine Tool Manufacturers disappeared. The partition of the country further cut off some 6 graded and about 50 un-graded machine tool manufacturers. The total number of graded machine tool concerns in the country at present is only about 15 (excluding HMT) with a total capital investment of about Rs. 80 lakhs with an annual turn over of approximately Rs. 30 lakhs.

Fig. 2(b)

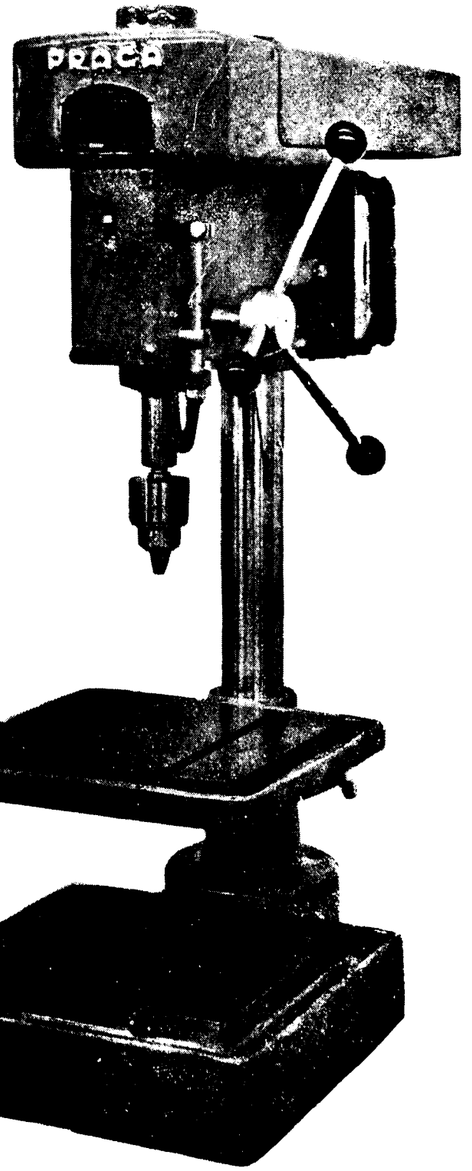


Fig. 2(d)

Manufacture of modern machine tools involves high precision and controlled processes with a very narrow margin of profits and none at all in the early stages. With very little financial resources at their disposal, private Machine Tool manufacturers in the country could not spend large sums of money on initial investment towards highly specialised and precision modern plant and machinery, jigs, tools and fixtures, so essential for this Industry. This therefore, naturally meant the participation of the State in developing this vital and essential industry and make precision machine tools in the country. Hence, the Government of India, after very careful consideration took this responsibility and in co-operation with Messrs. Oerlikon Machine Tool Works, Buehrle & Co., Zurich, have set up a Factory viz. the Hindustan Machine Tools Ltd., Bangalore. The Factory is equipped with one of the finest plants and machinery and possesses great potentiality to handle medium size precision machine tools. A tentative production target has been visualised for a yearly production of 400 High Speed Lathes, 250 Milling Machines, 250 Radial Drills, 150 Cylindrical Grinders and 200 Heavy Duty Production Lathes by 1960-61. As a part of this diversified programme, the factory commenced the manufacture of $8\frac{1}{2}$" Tool Room High Precision Centre lathes in early 1956, and till date has already despatched about 70 lathes with further 80 more under assembly.

The following notes give a brief review of the developments in the manufacture of certain main types of machine tools at present produced in the country.

LATHES

Period 1—Prior to Second World War : Open cone pulley deep gap bed lathes with belt drive from counter shaft, bed having flat guideways; with single tool holder post, main spindle running in bronze bearings with combined leadscrew and feed shaft of no particular degree of precision were manufactured. See fig. 1 (A)

Period 2—Second World War : Cone pulley lathes of improved design with driving motor and tensioned counter shaft housed in cabinet leg; drive through V Belt from motor to counter shaft, thence by flat belt through cone pulleys and back gears; main spindle with screwed nose running in plain adjustable bronze bearing; bed with a slightly more rigid cross section and ribbed; three 'V's and one flat for guideways; Norton Feed Box to cut standard Whitworth pitches and sliding and surfacing feeds in corresponding ratios, combined leadscrews and feed shaft, square tool post etc., were manufactured to grade I standards of Machine Tool Controllers alignment Charts. See fig. 1 (B)

Period 3—After the second World War and present period : The high speed and precision 225 mm. centre lathe manufactured by the Hindustan Machine Tools Ltd., incorporates latest design developments, with 2000/2300

R. P. M. for the main spindle; rigid and totally enclosed gear headstock with hardened and ground gears running on ground multi-splined shafts; hollow strong main spindle to hold the face plate and the chuck on the taper nose and running on two radial double roller bearings and two pre-loaded thrust ball bearings. Drive is from high powered Electric Motor housed in a cabinet leg with arrangements for belt tension and adjustments. The lathe bed with cross ribs is rigid and has its 'V' for saddle guide protected from an extended rack. Totally enclosed quick change feed box with ground gears mounted on ground splined shaft and in combination with super high precision leadscrews can cut all types of threads. Separate feed shaft and clutch shafts are provided. A multi disc clutch with braking device hydraulically operated has been incorporated. A robust quick change tool post of the latest design with full compliments of tool holders is provided. The lathe is capable of tool room accuracy (with half the permissible errors according to Schlesinger's chart) and with hydro copying attachment may be considered as a high production machine. See fig. 1 (C)

Mysore Kirloskars Ltd., Harihar in their series of latest type all gear headstock centre lathes (type RL) have introduced a Relieving attachment. See fig. 1 (D)

CAPSTAN LATHES

Small Capstan lathes (2 ND type) for hand feed bar work were manufactured to the designs of Alfred Herberts Ltd., England, by Cooper Engineering Ltd., Satara Road, during the Second World War. However, after the war, the manufacture of these lathes manufacturers of high quality Capstan and Turret Lathes.

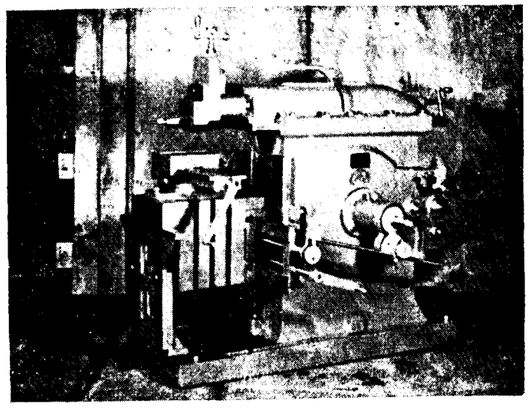


Fig. 3(a)

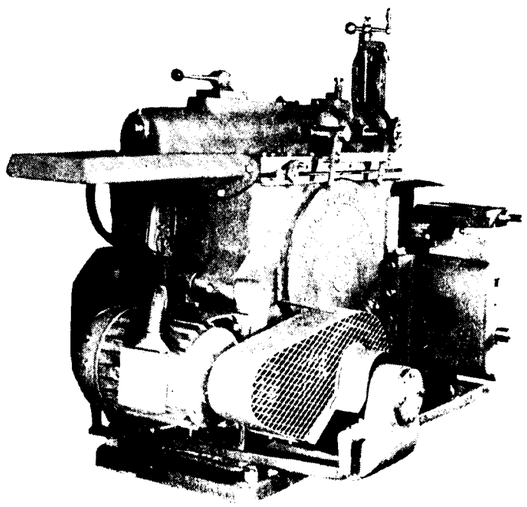


Fig. 3(b)

DRILLING MACHINES

Period 1—Prior to the Second World War:—Small pillar type Deep throat drilling machines with no particular limits of accuracy have been manufactured in the country in the early periods. The type that was common appears to be one with hand feed plain spindle type with belt drive arrangement upto $1\frac{1}{2}''$ capacity. Spindle had bronze bearings housed in cast iron sleeve. See fig. 2 (A)

Period 2—During the Second World War:—The old design was slightly improved and a single, geared spindle auto feed drilling machines with main spindle running on ball bearings were manufactured to Grade I Machine Tool Controllers alignment chart. A taper nose for the main spindle was either accurately reamed or even ground. Attempts had also been made to produce multi-spindle drills but is appears only a few had been made. See fig. 2 (B)

Period 3—After the Second World War and the present time:—Improvements in the design of the drilling machines have not been as fast as in the case of lathes. Till very recently Radial Drills had not been made in the country and only the first India made Radial Drill was exhibited by Investa Machine Tools and Engineering Co. Ltd., Bombay at the last Indian Industries Fair, New Delhi. The machine appears to be rather small with a maximum capacity of only $1\frac{3}{8}''$ drill, with spindle feeds upto 2100 R. P. M It is simple in construction with spindle feeds ranging from

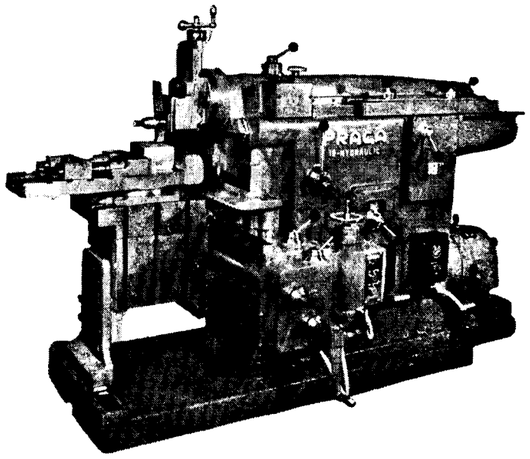


Fig. 3(c). Hydraulic Shaper.

.0047" to .019" and possesses speeds and feeds suitable for tapping and reaming.

Even in the design of Pillar Drills, the pace of progress seems to be rather slow. The design of drive for Drilling Machine with geared spindle auto feed type remained unaltered for a long time. It is only very recently that $1\frac{1}{2}''$ capacity Pillar Drills with directly coupled electric motor are manufactured by Praga Tools Corporation, Secunderabad. See fig. 2 (D)

SHAPING MACHINES

Period 1—Prior to the Second World War: Although no definite information is available to the author, it is presumed that no shaping machines were built during this period.

Period 2—During the Second World War: Shaping Machines is 12", 20", 22" and 24" were manufactured by Messrs. Cooper Engineering Ltd., Satara Road, during this period to the grade I Standards of the Machine Tool Controllers alignment Charts. The 20"—24" machines were designed with well proportioned main body internally ribbed. The Ram with its rectangular slideways was driven by a crank arm, both made in high duty iron castings. Stroke wheel was of spur gear type and mated with fibre pinion. Gear box was a tumbler type and formed a separate unit attached to the main body behind, with gears machined from high duty iron castings. See fig. 3 (A)

Period 3—After the Second World War and present period: Heavy duty high-speed shaping machines with rigid body having buttress side, with Ram having V slides, are manufactured by Cooper Engineering Ltd. This machine has single lever control on gear box which is mounted inside the body. All the gears and shafts are machines from high tensile nickel chromium steel with gears running on multi spindled shafts. Drive is from high power Electric Motor and through expanding clutch with braking arrangements. See fig. 3 (B)

Praga Tool Corporation have recently developed an 18" Hydraulic Shaper. The machine possesses all the latest design features with infinitely variable speeds within 10 to 140 ft. per minute. The machine has not been provided with automatic tool lifting device. See fig. 3 (C)

MILLING MACHINES

Milling Machines to high standards of accuracy were not manufactured in the country even during the Second World War and it is only very recently that Praga Tool Corporation have started the manufacture of small Plain Horizontal and Universal milling machines with maximum spindle speeds of 700 R. P. M. with 6 feed range from 0.629" to 5.51" per minute (longitudinally). These machines appear to be rather small and simple in design and have greater possibilities of further improvements. See fig. 3 (D)

SURFACE GRINDING MACHINES

Small Hydraulic Surface Grinding Machines with maximum wheel speeds of 2300 R. P. M. for 10" dia. grinding wheels with table size $18''\times6''$ and $24''\times8''$ have been recently manufactured by the Machine Tool Proto-type Factory, Ambernath. These machines though small, are of modern design with infinitely variable table speeds from 0 to 60 ft. per minute and cross speeds from .05 to .3". See fig. 3 (E)

Besides these above type machine tools, a few other simple machines like Power Hacksaws, Double Wheel Tool Grinders, Tool and Cutter Grinders, Bench Drills, Power Presses, Shearing Machines, simple type Planing Machines, Slotting Machines, etc., are also manufactured in the country.

The Indian Industries Fair held during the year 1955 in New Delhi, at which about 21 foreign countries participated should have served as an eye opener and indicate how much industrially backward India is today in the making of Machine Tools. Nations like China, Poland, etc., which were considered only a few years back, to be principally agricultural countries and some like China

even underdeveloped and industrially far behind, have shown remarkable progress and seen to be on the way to self-sufficiency in their needs for machine tools. China's progress, in particular, seems really outstanding. Since her participation in the International Exhibition in Bombay in 1952, her Industrial progress in general and in machine tools in particular, appears hardly believable. She has made almost all the basic machine tools like Centre Lathes, Turret and Capstan Lathes, Milling Machines, Planing Machines, Cylindrical and Surface Grinders, Gear Cutting Machines, Radial and Pillar Drilling Machines, Horizontal Boring Machines, Tool Grinders, etc. Whereas in India, we have developed only a few kinds of machine tools viz., Centre Lathes, Drilling Machines, Shaping Machines besides a few others.

The manufacture of Milling Machines and Surface Grinders, has been recently taken up in the country. We have not yet attempted to make any finishing machine tools like Cylindrical Grinders, Gear Grinders, and more complicated machines like Horizontal and Vertical Boring Machines, Slideway Grinders, Broaching Machines, Jig Borers, Profile Grinders etc. The country's need for Heavy Machine Tools has become more and more felt and unless we start new machine tool factories and expand the existing ones to manufacture heavy and special purpose machine tools required for Automobiles, Aero Engines and likewise, we shall never be self-sufficient.

Even the few types of machine tools we are producing viz. lathes, drilling machines, shaping machines, milling machines and surface grinders, the Technological developments in design, as can be seen from the above descriptions, still remain backward as compared to the modern machine tools produced by the industrially advanced countries abroad. For example, machine tools produced in the country are not designed for high powered drives and high speeds for main spindles (perhaps with the exception of lathes produced by HMT) with the result a full and effective use of Tungsten Carbide Tipped Tools cannot be obtained from these machines. In addition, the modern trend in design is to make Machine Tools rigid, close type with centralised controls, and these features are yet to be introduced in most of our presently made Machine Tools. Infinitely variable feeds and speeds are incorporated in the latest design machine tools from abroad where speeds and feeds can be varied by means of Electronic-Hydraulic or Electric or Hydraulic controls, or with close-step gear drives which are hydraulically or electronically pre-selected. None of our Machine Tools have got these modern features.

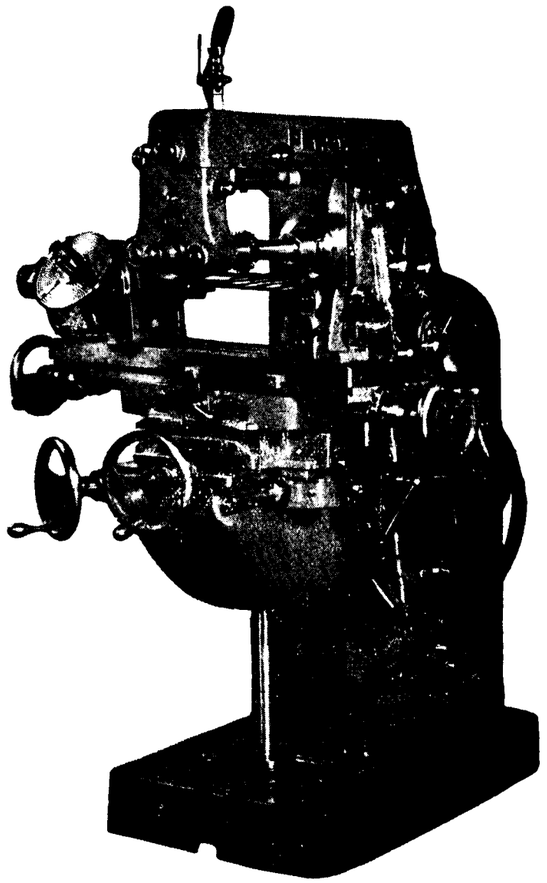


Fig. 3(d). Universal Milling Machine.

Automatic programme control which eliminates speeds and feeds changing by hand and allows automatic repetition of process sequences has recently been developed and may very shortly become an almost common feature in all the modern machine tools employed in the automatised industries. It may take perhaps a long time for us to develop machine tools with this fine control. Machine tools with hydraulic, electric and electronic-hydraulic copying systems have not been developed except for the latest lathes produced by HMT and Kirloskars who supply an imported hydraulic attachment along with their lathes!

The following are some of the main difficulties facing the Machine Tool Industry today:—

Marketing Problem:—With a view to hasten the development programme of manufacture of machine

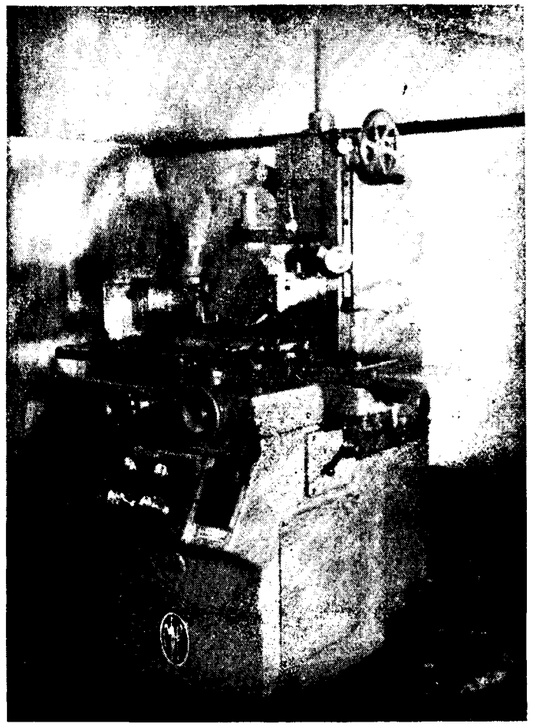


Fig. 3(e)

tools, and produce those machines which are very urgently required for the Industrial development of the country, a thorough market survey seems necessary so that a most dynamic and suitable programme of manufacture of Machine Tools could be drawn up to guide both the public and private machine tool manufacturers. It is understood that the Government has already set up a Machine Tool Committee to look into this problem.

Research & Test Facilities:—Provision of facilities for industrial research and testing materials is being partly met in the country by the establishment of the National Laboratories and the Indian Standards Institution. But the application of purely scientific research to industry, in general, is another aspect which needs greater co-ordination, co-operation and exchange of ideas between the Industry and the Scientific Research Institutions. In the Machine Tool Industry, there does not seem to be much intensive research being carried out so that the Industry could be benefited by the wider dissemination of such research work.

Experienced Technical Supervisory Staff:—There is no doubt there exists a great lacuna of suitable Indian Technical Supervisory Staff to man this Industry. The reason is perhaps there are very limited training facilities in India for our young qualified technicians. Until such time these facilities are available in the country, many of our Engineers will have to be sent abroad for specialised training in the manufacture of machine tools, besides assistance from foreign Technicians. In this connection, Government are rightly considering setting up of "Industrial Technical Service" for higher cadre of Indian Technical Supervisory Staff required by the Industry.

Skilled Labour:—One of the most pressing needs of today is the lack of sufficient number of skilled workmen who form the potential back-bone of any industry. Some of the specified tolerances in the manufacture of machine tools are so close and precise that a slightest deviation would completely damage a particular part. Although there is a decided improvement in the standards of skilled workmen since the last War, very little attempts appear to have been made by the Machine Tool Manufacturers themselves to train young and inexperienced boys from the various Industrial centres and Government sponsored Vocational Schools, so as to give them further specific and intensive training in the different operations in the machine tool manufacture. Unlike reputable European Machine Tool manufacturers who invariably have a Training School attached to their factories, none of the privately managed Machine Tool Industries have any such systematic training facilities in their respective concerns.

Raw Materials:—Machine Tool production requires a large variety of ferrous and non-ferrous metals amongst which fall carbon and alloy steels, high duty iron castings, bronze castings with high percentage of Tin and quality steel and malleable castings etc. Great difficulties are experienced by the Industry to procure these materials readily and most of the alloy steels and bright drawn steel stocks are being imported. Castings both ferrous and non-ferrous of the quality required for the Machine Tools are not easily available with the result the Industry's attention is partly diverted to set up and maintain first-class foundries which if undertaken by specialists in the line may work out more economical and efficient.

Accessories, bought out finished parts, and other proprietary items:—

The pattern of Industries in advanced countries abroad has been so specialised that it tries to obtain most of its

(Continued on page 50)

Conservation of India's Mineral Resources

By Prof. R. V. Sathe
Walchand College of Engineering (SANGLI)

IN the present days of mechanical civilization, we are learning to use a great variety of minerals and mineral products. But compared to many of the Western countries, we are far too behind in exploitation, an advanced technique of mining and metallurgy of the minerals and the manufacture of mineral products though there was a time, several centuries back, when we were well advanced, as is evidenced by the works of art, made of iron, steel and bronze. There is historical evidence to show that 3000 years back, we were trading in salt and mica with the Roman Empire, a fact which clearly indicates that in those times, we were advanced enough to know the art of mining. At present, we are mainly exporters of minerals, there being a negligible production consumed in the country.

Though we are said to be blessed with sufficient mineral wealth, there are certain strategic minerals, we are woefully lacking in. Their inadequacy results, not actually from their entire absence, but to the insufficient data we have got at our hands, about their occurrence, because our vast sub-continent is not thoroughly geologically surveyed and hence this notion of despondency. In these industrially fast developing days, we must make it a point to resort to the advanced techniques in the exploration, mining, and metallurgy of the metalliferous deposits and proper exploitation of the industrially important non-metallics. We have got to keep a cool head and see that our minerals are extracted and exploited without any wastes, as it is a fact, though highly regrettable, that there is a great wastage of our minerals, due to the crude methods of mining, practiced in most parts of our country.

Among a great variety of minerals produced in India, and considered to be of international importance in the world's essential industries, the most important are iron ores, chromite, manganese ores, ilmenite among the metallics; barytes, mica, magnesite, monazite, talc, gypsum, corundum, kyanite and King Coal among the non-metallics. However, the unfortunate fact is that we have as yet on accurate data about their reserves. Our position with regard to tin, lead zinc, mercury, silver and platinum is somewhat unsatisfactory and to a certain extent in the case of copper it is distinctly unfavourable. However, such a state of affair need not

(Continued from page 49)

normally bought out finished parts, accessories and other proprietary items to any exacting standards, readily from the local markets. This gives rise to net work of small scale industries each specialising in its own line. But in our country the circumstances are different and any Industry set up is planned more or less to be self-sufficient and it is possible even today to find instances like say, Machine Tool Manufacturers trying to make their requirement of standard quality nuts and bolts in their factories. This not only increases the responsibilities of the parent precision industry, but also does not give scope for establishment of small scale auxiliary industries in the country.

Plant and Equipment :—Indian Tool Manufacturers with one or two exceptions generally suffer from an acute shortage of good plant and equipment. In certain cases, the tooling capacity available in the manufacturing plants is unsuitable for machine tool standards. Financial stringency with most of the private manufacturers of machine tools appears to be one of the main causes for this shortcoming, but if new type of machine tools, to the latest designs and comparable in standards of accuracy and performance to any imported machine tools, are to be manufactured in the country, some means and alternative methods have to be found to get over this difficulty, as otherwise the progress of the Industry will be stagnant.

Whatever may be the reasons for the delay in developing this vital industry in the country, it is high time we give up all the internal controversies between the private and the public sectors and shake off the air of foreboding and work with complete harmony in establishing this strategic industry in the wider interests of the National prosperity and security. Otherwise, we are bound to be left behind and there is even a probable danger, in these days of nuclear developments, that in spite of our hard won independence, we may still be under the " economic subjucation " of other industrially advanced countries of the World.

unduly discourage us, as it may be quite possible after thorough prospecting of the areas, which yielded these materials in the ancient times, to locate vast untapped reserves.

Mining in former times being developed in this country largely through foreign capital, the advanced technique of mining was not resorted to for the simple reason that our minerals were intended to be merely raw materials for the industries of foreign lands. The minerals were extracted indiscriminately without a thought for their proper exploitation. Even a few years back our Railways were consuming very high grade coal which is fit to be used in metallurgical plants.

Thus, taking into account the wantom and unfettered exploitation of our minerals in preindependence time, our lack of knowledge of the reserves of minerals like iron ores, manganese, chromite etc. which are supposed to be found in inexhaustible quantities, and of other minerable reported to be totally absent or occurring in quite negligible amounts, it is no wonder, that we have to go all out to effect conservation of these resources. The idea of conservation partly results from a thought for posterity. Secondly minerals are, unlike vegetation, an exhaustible quantity. Once extracted from the earth, they are lost for ever. Their loss is not replaceable. Hence it is quite essential to exploit these resources to the greatest advantage without any wastage in the process of their extraction.

Various factors contributing to the conservation of mineral resources are, export restrictions, new discoveries of mineral deposits improved technique of mining, milling and concentration of ores, researches on the metallurgy of light metals, fuels and reclamation of metals from the scrap and other economic products from the gaseous emanations from the metallurgical and smelting plants.

As the fickle nature is not uniformally liberal in the allocation of mineral wealth to any one particular country, it is evident that no country can boast of its self-sufficiency in its mineral requirements. Consequently, for the industrial development, minerals have to be imported as well as exported to maintain favourable trade relations. Government of India, have since 1948, imposed restrictions on the export of manganese ores, chromite, iron ores, kyanite and sillimanite, while the export of beryl and monazite is totally banned. The export quota of the various minerals is based upon our calculation of the reserves for the next twenty five years, our annual consumption, and our surplus production.

The importance of discoveries of new deposits can hardly be minimized. New discoveries are certain to add to our reserves thereby giving us a measure of potential stocks to allow us to allocate quotas for export and internal consumption. In all the industrially advanced countries, new methods of prospecting, based upon geophysical investigations are being used more and more for the discovery, particularly of hidden deposits. To keep pace with other nations in the mineral production, we too must make use of the geophysical methods like the use of Eotovos Torsion Balance to detect ores of Wolfram, iron, tungsten etc., the artificial earthquakes, method for the detection of petroleum etc.

Another factor of great importance in relation to conservation is adoption of systematic and approved methods of mining to avoid wastes and if possible, wholesale mechanization of mining operations, which would lead to efficiency and improved recovery. As the things as stand at present in the mining operations there is considerable scope for improvement thereof.

In recent years technological advances in concentration of minerals, have brought about a great improvement in the recovery of minerals. Improved technique of beneficiation i. e. upgrading of ores can make possible, the mining and concentration of low grade ores profitable, thereby conserving high grade ores for some more fruitful purposes. Similar results would be obtained if efforts are made to recover useful materials from the dusts and fumes from chimneys of metallurgical plants. For example the example of sulphur may be cited. This important substance is the chief raw material for the manufacture of sulphuric acid, which in itself is the foundation of several chemical industries. In fact the annual consumption of sulphuric acid is considered to be the index of a nation's industrial development. Sulphur worth about Rs. 1 crore and a half is annually imported. In our Mosaboni Copper smelting plant every day about 20 tons of sulphur passes into the atmosphere as fumes! If attempts are made to catch hold of this escaping sulphur by putting on condensers, a good deal of import of sulphur can be restricted.

Where the ores are finely granular or they occur in powdery form, they can be profitable worked by employing sintering, nodulizing and briquetting practices. The use of these processes has made it possible to treat huge tonnage of fine grained mixtures of various minerals, thus considerably assisting their conservation.

(Continued on page 53)

The Manufacture of Timken (Made in U.S.A.) Tapered Roller Bearings

By Plant Engineer, CANTON, OHIO

THE Timken Roller Bearing Company of Canton, Ohio, U. S. A., has manufactured the only complete line of tapered roller bearings for over fifty-five years. (2) Suppose you were going to provide a bearing to ease the rotation of a wheel or shaft—a bearing which would virtually outlast the job it has to do. A bearing whose sturdiness would actually add to the life of the machine of which it is a part. A bearing that other people could take for granted. One thing you would want to do is design a bearing that would take all loads, regardless of the changing directions from which the loads might come. The second would be to produce it of materials so tough that it could endure these loads with practically no wear. And your third aim would be to construct it so accurately that it would turn out to be as ideal in fact as it was in theory.

LET US DESIGN THAT BEARING

Very little friction is present to impede the progress of a rolling object. Only a little gravitational force will start it and keep it going. An object that must rub instead of roll is confronted with a greatly increased impeding force of friction. What you want to do, then, is to get rid of as much of these rubbing motions as you can and replace them with rolling ones. If only one force at right angles to the axis of the bearing needed to be considered, such as the dead weight which the

(Continued from page 52)

Fundamental research on the metallurgy of light metals like aluminium, magnesium etc. which are finding a great variety of uses in industry, would greatly relieve strain on iron, manganese, chromite etc. which could be better employed in the most important industries, for it is evident that the new metals and alloys can replace the older ones, because of their special properties, thereby assisting in the conservation of more important ores.

Govt. must be congratulated in this connection for some of the schemes undertaken. Entire responsibility for the exploration of oil in India, thorough prospecting of the lead-zinc mines of Zawar in Rajputana, a complete geological survey of the Amjhor pyrites deposits in Bihar, nationalization of gold and diamond deposits of the country, establishment of the Atomic Energy Commission and Indian Bureau of mines, establishment of technological institute at Kharagpur, expansion of the geological survey of India, etc. are some of the noteworthy features.

It is gratifying to note that in order to ensure conservation, scientific exploitation and the development of the mineral resources, as well as promotion of the mineral export trade, Govt. of India have set up a Mineral Advisory Board, under the Chairmanship of the Minister of Natural Resources and Scientific Research aided by members from the Ministries of Finance, Railways, Commerce and Industry, Production, Indian Mining Association, Indian Mining Federation, etc. and several representatives from Associations and Industries dealing with minerals and mineral products. Also among the important members are, the Directors of G. S. I. and Indian Bureau of Mines, respectively and the Geological Adviser to Govt.

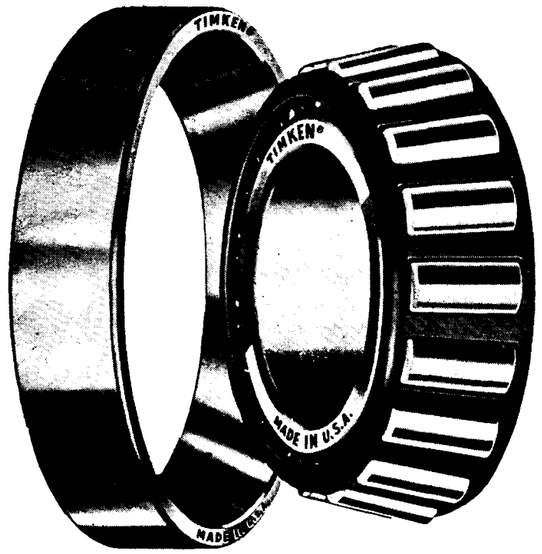
The main functions of the Board are :

(a) To review the production, internal distribution and consumption of minerals.

(b) To review export of minerals from India, and advice Govt. on fixing quotas.

(c) To advice on import of minerals and mineral products ; export of minerals, import tariffs on minerals, field investigations, research programme of G. S. I. and Indian Bureau of Mines, measures for increasing internal manufacture and utilization of minerals mined in India.

It would thus seem from all these considerations, that adoption of conservation methods and implementation of the recommendations of the Mineral Advisory Board, in regard to conservation, would stand us in good stead in times of war and peace.

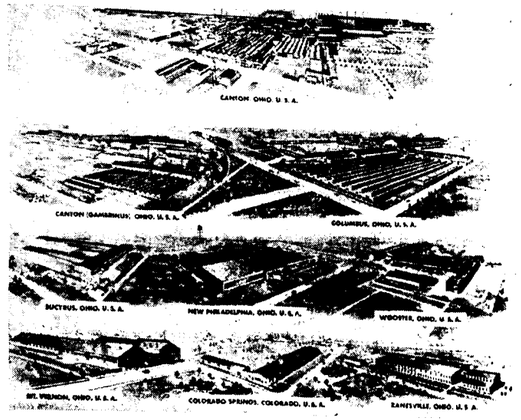


(1) This is the standard, single-row Timken (Made in U.S.A.) tapered roller bearing showing the cup, or outer race, on the left and the cone, rollers and cage on the right.

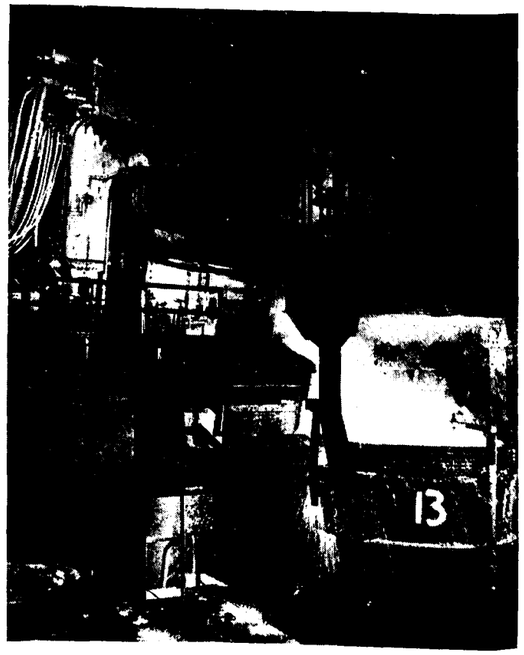
bearing supports, straight rollers would provide a complete answer. But the force acting on wheels and shafts rotating in everyday use is rarely, if ever, wholly axial or wholly radial. It is an ever-varying combination of dead weight and dynamic thrusts, bounces and lurches.

Timken (Made in U. S. A,) bearings are designed to take radial and thrust loads separately or in any combination. All Timken (Made in U. S. A.) bearings are designed with one geometric proposition in mind—lines drawn coincident with all rolling surfaces must meet at a point somewhere along its axis. This point is determined by the angles of the rollers. The Timken Company produces twenty-seven different types of tapered roller bearings in 5,850 sizes. There are bearings with one row, two rows and four rows of rollers. There are bearings which will carry loads up to two million pounds at 500 revolutions per minute and others which easily handle screaming speeds of many thousands of revolutions per minute. There are shallow-angle tapered roller bearings for applications in which radial loads are the main factor. And there are steep-angle tapered roller bearings for applications where thrust loads predominate over radial loads.

But basically, the component parts of the Timken (Made in U. S. A.) tapered roller bearing are the cup or



(2) These are the manufacturing units of The Timken Roller Bearing Co. in the United States.



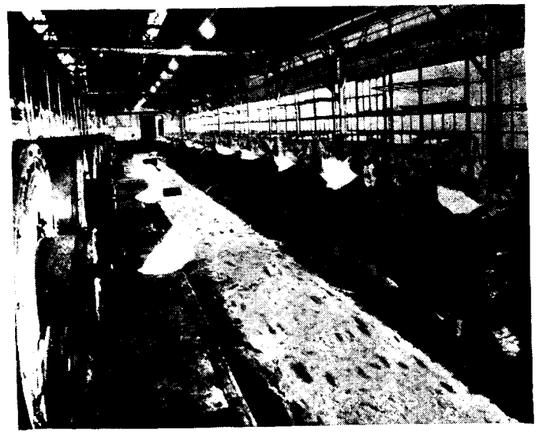
(3) An electric furnace melter (shown at the middle left) checks a heat of Timken steel as it pours into a ladle.

outer race; the cone or inner race; the tapered rollers themselves which roll between the cup and cone; and the cage, which bears on load, and does no work other than the light but important job of keeping the rollers spaced evenly around the peripheries of their raceways.

(4) A few of the four-spindle screw machines which perform the "green" machining operations on cups and cones.

(5) A general view of the Header Department where small—and intermediate—size rollers are formed.

Just as important as the design of the bearing and its components, when we are after bearings that other people can take for granted are the materials of which they are made.



(6) A general view of the Carburizing Department, showing the retort furnaces where Timken (Made in U.S.A.) bearing parts absorb carbon from the carbon-containing atmosphere.

(7) These are a few of the cage presses which perform the blanking, sizing, perforating, winging and spreading operations.

THAT'S WHY THE TIMKEN COMPANY MAKES ITS OWN ELECTRIC FURNACE STEEL

The Timken Company is the only bearing company in the United States that makes its own steel and thus is able to control bearing quality from melt shop to finished product. (3)

The first operation in the "green" machining of Timken (Made in U. S. A.) bearing parts occurs in the single-and multiple-spindle high production screw

(8) These machines, designed by Timken Company engineers, split a thousandth of an inch into many parts and sort the rollers into groups in which the maximum variation can be as small as 125 millionths of an inch.

machines used to make the small—and intermediate-size cups and cones from Timken seamless steel tubing. After machining is completed, the parts are chamfered and the part number is stamped on each piece. (4)

Since the machining of bearing parts is followed by precision grinding methods, and since the Timken Company believes that quality is put into the product at the machine, quality control charts are used at these machines to make sure that the parts are held within specified dimensional tolerances. Special indicator-type gauges have been developed by Timken Company engineers so that quality control inspectors at the machines can constantly check the product and plot the resulting on the measurements on the charts. Machine operators interpret the chart information and make immediate machine adjustments, when necessary, thereby insuring a minimum loss of product.

Cups and cones larger than ten and one-half inches diameter are made, not from seamless tubing, but from forged steel rings. They call for larger, less automatic machines such as chucking lathes which rough out rings up to a foot and a half outside diameter. Cups, cones and rings as large as six feet across are rough turned and then finished on boring mills. These larger parts must be brought to size in two steps—first, they are rough cut; then, after being inspected and tempered, they are remounted on the boring mills for the finishing turn.

In the manufacture of rollers, the Timken Company is faced with the problem of the great variety of sizes. Small rollers up to 1—1/2" diameter by 2—1/8" long are produced on cold heading machines. (5) Rollers larger than header size, which may weigh as much as thirty-two pounds, must be machined on turret lathes from solid bar stock.

The next step in the manufacturing process is one of the most important with respect to bearing quality—heat treating. Timken (Made in U. S. A.) bearings must have hard-wearing surfaces, but also must be able to withstand shock loads. To meet these rigid requirements, the parts are first case-carburized and then hardened and tempered.

If your steel is right in the first place—and if you make it yourself, you know it is—then you can heat the machined parts to a controlled temperature . . . keep them in a carbon-containing atmosphere for a controlled length of time, and the steel parts will absorb carbon from the atmosphere. A rapid quench in oil, and the carburization is complete. (6)

Each carburized part is then reheated for hardening. To prevent distortion of the larger sizes of cups or cones, they are first centered in a hardening machine. Automatically a plug-like fixture engages the I. D. of the part to hold it in alignment while the sudden shock of an oil quench effects structure changes to produce a hard, wear-resistant surface and a softer but tough and shock-resistant core.

To complete the heat treating operations, the parts are tempered, usually in air, at about 350°F. in order to relieve stresses and brittleness created by oil-quenching hot steel. Any iron oxide scale found on the parts is removed by shot-blasting since this scale would be detrimental to grinding operations.

Now comes the wizardry of grinding, as dimensional accuracy and surface smoothness almost impossible to comprehent is imparted to the hardened surfaces.

The first operation on cones and cups is to grind the faces until they are parallel and an exact distance apart. Once again for small sizes, the work is rapid and automatic while larger parts call for larger, less automatic

machines which grind one face at a time. Surface after surface the cups and cones are brought to gleaming perfection. The inside diameter of a cup is the tapered, outer raceway of a bearing; therefore, the grinding of its surfaces is critical. Quality control techniques are employed to control the stand (the equivalent measurement of size), taper, runout, surface finish and visual characteristics. Machines vary in type and volume of production with changes in kind and size of parts, but the end objective is invariably the same—incredible accuracy.

Cone bores, which are not tapered, are ground on I. D. grinders very similar to those used for grinding the I. D. of cups.

Next the cone ribs are ground on Timken Company-designed grinders. The rib adds the mechanical feature of positive alignment. It is this surface which the large ends of the rollers contact as they move between the receways. From the rib grinders the cones are O. D. ground. And here again, quality control is rigidly maintained.

Meanwhile, rollers by the millions are being brought to the same smooth, dimensionally-exact perfection on other grinding machines—some slowly and painstakingly—still more at twinkling high production rates, but still painstakingly, for no matter the method or the size of the roller the taper must be exact and the surface must be right to make bearings that other people can take for granted.

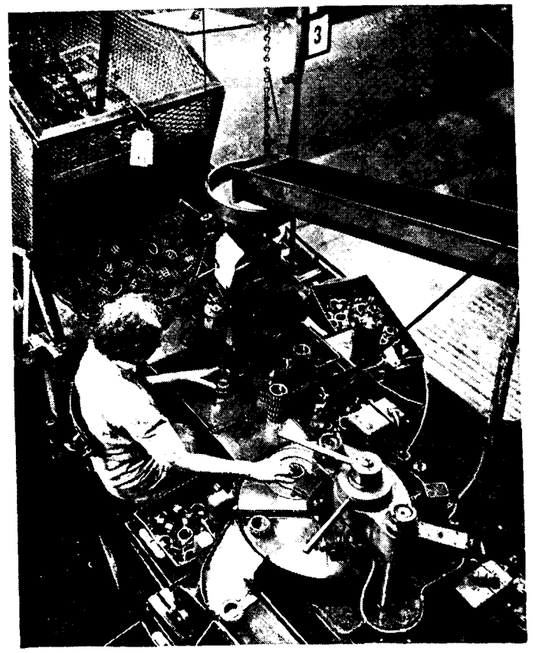
Parts for the larger bearings go through the same basic grinding operations as the smaller ones. The huge grinders in the Special Finishing Department at Canton, Ohio, U. S. A., are capable of handling product up to six feet in diameter while holding dimensions to a tolerance which can be as small as two thousandth of an inch.

The bearing surfaces of the smaller parts are finish ground to around twenty-five micro-inches. If bearings could be made with perfectly smooth surfaces, their races and rollers would be absolutely smooth—that is, zero micro-inches. To make these surfaces as smooth as possible, the Timken Company hones them until their surface finishes measure within two to eight micro-inches. The Profilometer is used to measure surface finish of Timken (Made in U. S. A.) bearing parts.

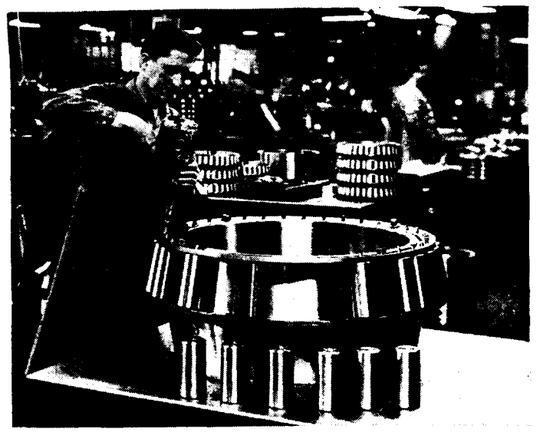
Timken (Made in U. S. A.) bearing cages, which position each roller around the cone, are stamped from strip steel on presses ranging from 45 tons to 800 tons capacity. (7) The processes through which the cages go include blanking, sizing, perforating, winging, annealing, spreading and finally phosphating for protection against rust.

There is one more point to consider in our production story and once again it deals with the great variety of sizes of bearing parts. Finished and flawless, rollers of any one size will not vary in diameter more than a thousandth of an inch. But this is far too much so in a special machine with an uncanny ability to split a thousandth of an inch into many parts, the rollers are sorted into groups in which the variation in diameter can be as small as 125 millionths of an inch. (8) Rollers in any one group are then ready to share their work equally when a set of them are assembled in a bearing.

Now we arrive at the inspection, assembling and shipping operations. In the Finishing and Inspection Departments, cups, cones and rollers are visually inspected for surface defects and gauged on critical



(9) This is one of the automatic assembly machines which assembles the small-and intermediate-size bearings. The operator is shown filling a cage with rollers with her left hand while the right hand moves as assembled cone to the closing-in press. Her right arm has interrupted an electric eye beam which automatically indexes the press, moving completed assemblies out of the press and onto the conveyor at the bottom of the picture.



(10) A mill-size bearing is assembled, using large cage rings. The pins which hold the rollers are a few thousandths smaller than the holes through the rollers to insure proper running clearance.

dimensions. To pass inspection each cup must also be within the tolerances specified for stand and taper measured on specially-designed gauges. The Timken Company employs the physically handicapped when possible and several blind persons are now inspecting cups with electronic sound devices. The company has found that the quality of work done by the blind gaugers electronically is as high as that done visually.

Cones are visually inspected for steel and grinding defects the same as cups. They are also gauged for proper bore tolerances and sorted into size groups for matching with rollers on gauging machines.

Rollers are inspected on company-designed machines on which the rollers are automatically positioned in a circular spider. As the spider moves the rollers from left to right, a dial underneath the spider revolves counterclockwise thus rotating the rollers so the inspector can see the entire surface.

In the fastest assembly operation for small bearings, rollers are cleverly turned large end up as they enter the home stretch. The assembler positions a cage on a fixture and the machine automatically positions one roller in each cage pocket. The assembler then places a cone inside the cage of rollers and moves the assembly to the closing-in press which automatically closes-in the cage so that the assembly can't fall apart. (9)

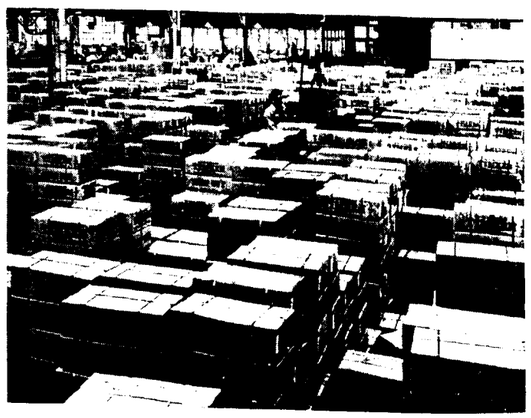
The assemblies are finally automatically washed, greased and packed.

Of course, the mill-size bearings are inspected, assembled and packed under quite different conditions from the automotive-size bearings. Inspecting and gauging a roll neck bearing, for example, is a delicate proposition even though the completed bearing may weigh as much as four tons.

The rollers are first positioned around the cone and between two cage rings by means of cage pins. Pipe threads on the bottom end of the pin engage and lock in the tapped hole of the lower cage ring. The driven end of the pin protrudes above the upper cage ring and is welded into place. The diameter of the hole through the rollers is several thousandths of an inch larger than the cage pin to enable the roller to rotate freely. (10) The completed mill-size bearings are then given a thorough coating of oil or grease prior to packing and shipping. (11)

This then is how the Timken (Made in U. S. A.) tapered roller bearing is manufactured from scrap metal to finished product. It would not be complete, however, without a further word about the Timken Company's efforts to maintain its long-standing reputation for manufacturing the world's finest tapered roller bearing.

Precision tools and gauges are needed to manufacture a precision product like the Timken (Made in U. S. A.)



(11) A general view of the Shipping Department at the Canton, Ohio, U. S. A. bearing factory.

roller bearing. The Main Tool Room at Canton, Ohio, U. S. A., contains the lathes, milling machines, drill presses, shapers and precision grinding machines used in making these tools and gauges. In grinding master gauges, the toolmakers work to limits of fifty-millionths of an inch. The Precision Gauge Laboratory, the finest of its kind in the United States, inspects all work done in the tool room.

Some of the finest American-, Swiss-, German-, Swedish-, and English-made measuring instruments are located here. Angles may be checked to an accuracy of one second of an arc. If two straight lines, each one mile long, were made to form an angle of one second of an arc, they would be approximately 5/16 apart at the open end. This department is kept at a constant temperature of 68° and humidity is maintained at a percentage least conducive to rust.

Before production starts, research and development work is necessary. During the course of manufacture, constant testing is required to see that the raw material is up to standard, that the steel is being made properly, that it is of the proper hardness and structure, and that it is being machined to the best advantge. After the bearing is completed, it must be tested to see that it is best for the purpose, to determine its life in service and its resistance to special conditions such as overload and fatigue.

Highly trained, skilled chemists, metallurgists, engineers and research specialists are constantly working to maintain and improve the quality of Timken (Made in U. S. A.) tapered roller bearings; seeking new ways to adapt materials and products to the ever-increasing demands of modern industry; developing new tests to determine just what causes certain results; how to attain desired properties consistently; how to reduce costs.

Timken Company employees are proud of the part they are playing in a highly specialized society. They know that Timken (Made in U. S. A.) tapered roller bearings met the requirements of the "machine age" and will meet the more rigid conditions on the "jet age."

HEAVY MACHINE-BUILDING PROJECT

According to a report, the first meeting of the Technical Committee appointed by the Government of India under the chairmanship of Sir Jahangir Gandhi to study the project reports submitted by the British and Russian experts on the proposal to establish a heavy machine-building industry in India will be held sometime this month. Besides the two reports, the Committee will also consider the report, submitted a few days ago by a team of Russian experts on manufacture of coal mining equipment in India. The Russian project, which is estimated to cost about Rs. 13 crores, provides for a foundry force exclusively for the plant for producing mining equipment. The British report of heavy machine-building plant includes on the other hand, a provision for production of coal mining equipment. The proposal which does not include foundry is expected to cost Rs. 3 crores.

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STANDARD GUIDE

The Indian Standards Institution has published an Indian standard guide for inter-conversion of values from one system of units to another. This standard is intended to serve as a guide in converting numerical values of physical quantities from one system of units of measurement to another system of units. In particular, it should assist the designer and the draftsman in converting dimensions and tolerances on engineering drawings from inches to millimetres. It also deals with the conversion of monetary values, of interest to administrators, traders and industrialists. The preparation of this guide became particularly necessary because of the Centre's decision to adopt the metric system as the only system of weights and measures within a period of 10 years.

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ALUMINIUM CASTINGS FOR CARS

The General Motors, New York is to build an Aluminium-Casting Foundry for motor car parts. The Foundry will be close to an aluminium reduction plant, planned by Reynolds Metals Company. This Foundry will be operated by the Chevrolet Division. In an agreement with Reynolds, the two plants will be close enough for molten aluminium to be carried from Reynolds electrolytic potlines for use in casting in the Motor Foundry. This would eliminate the casting of the metal into ingots and then remelting it. The Foundry is expected to be operated by June 1959.

The Old and New Crushing Concepts

By C. Dasarathy,
Lecturer, Mech. Engg., Madras.

INTRODUCTION

COMMUNITION or crushing is one of the most important processes in the field of Ore dressing. The object of crushing and grinding materials is two-fold. In one case the reduction is effected so that values may be extracted from the ore and in the other case the entire mineral or product being communited is utilised for commercial purposes such as felspar and silica in the pottery trade, limestone and cement in the cement trade, coal for burning under boilers and in other furnaces and etc. When a solid body is subjected to chemical changes the action producing such changes is first confined to the surface of the solid and the reaction is a function of the surface exposed. Hence to complete a reaction in a minimum time the area/unit weight must be made as large as possible. This is done by first crushing the solid to small pieces and then grinding to smaller size ranges.

This paper is presented in the following sections.

(1) A survey of crushing and grinding phenomena.
(2) The old theories of crushing.
(3) Recent findings in communition phenomena and mineral structure.
(4) Summary.

A SURVEY OF CRUSHING AND GRINDING PHENOMENA

A number of physical factors such as hardness, resistance to crushing, abrasiveness, moisture content and/or cohesiveness, feed size etc. enter into communition mechanics. Normally it is felt that size reduction of an ore body be done to a sufficiently coarse size fraction such that the desired release of the mineral and gangue to an economically good extent is attained. Viewing the communition phenomena from a number of angles one is bound to think that coarse size fraction reduction is certainly good. It is economical in power consumption and easy for handling and does not cause much trouble if treated wet because of the absence of sliming.

Reduction to fine sizes is advantageous from the point of view of chemical reaction since fines have very large surface area values. In fact the relationship between the surface area and particle size for a given weight of ore is exponential. But to bring the force to bear upon an individual fine particle a large amount of energy has to be unnecessarily expended which tells upon the power consumed. The stress needed to crush fine particles is greater than for the coarse because the coarse particles are more weakened by the imperfections. Hence the energy for crushing through a given reduction ratio will increase almost in the inverse proportion to the size. The fundamental need of communition problem seems to demand a crushing energy factor which increases with the fineness and is related to the size distribution of the fragments produced by crushing.

Ores and various materials to be industrially communited vary in their hardness values and it is quite reasonable to say that the soft ores are much easier to crush and grind than the hard ones. Further, different type of equipment can be used to advantage in different classes. For soft ores more complicated and less expensive machines may be employed but for hard ores the crushing and grinding machines must be of very sturdy and simple construction in order to withstand the severe strains encountered in bringing about the desired reduction. The ores encountered in metallurgical practice are on the whole considered hard as compared with many materials ground for commercial uses.

The dividing line between crushing and grinding is not sharp. But generally crushing is applied for large feed sizes and grinding is applied for small ones. Crushers are operated on the principle of a large nut cracker wherein the main agent is the direct pressure exerted by the advancing crushing face on the ore body.

To obtain the optimum results at each crushing stage the quality, quantity, and size analysis of the feeds to each crusher are important. In any type of crusher, it is desirable for any given horse power per ton to obtain the maximum efficient size reduction for the minimum wear of crushing faces.

It is by now well known that the main agents bringing about communition are impact, direct pressure and attrition used either alone or together. Hence to investigate communition phenomena, one has to establish the

relationship between the feed-product sizes and the energy expended.

THE OLD THEORIES OF CRUSHING

The study of the crushing laws enables us to find out what happens during the reduction process. Their qualitative value is far greater than their quantitative value. Further for the evaluation of the crushing efficiency it is needed to have a theoretical basis for estimating the relative amounts of energy involved in a given size reduction.

Kick's Law was the first to be formed in communition mechanics about fifty years back. It states that the energy needed for producing similar changes of form of similar bodies of the same substance of equal technological state varies as the volume or weight of these bodies. Hence the energy needed for any change is proportional to the size reduction ratio involved. This law deals with energy absorbed during deformation of the mass BEFORE rupture and states that the energy increases in arithmetical progression as the particle size decreases.

Assuming that the body has been subjected to a gradually increasing crushing force, it will be seen that the first increment of deformation does not need so much pressure as the last. If the body is deformed beyond its elastic limit either the entire mass gets reduced to the molecular state by the releasing of their bonds from adjacent particles or the fracture takes place along the clevage planes by breaking down some of the weaker bonds and the new particles thus formed are free to resume their original shape in so far as they are not held between the machine surfaces. The former condition seems to be improbable and hence the latter is in vogue. The energy given up by them may set up energy waves which are probably used for making fracture planes and this creates heat. Hence it seems that the energy absorbed according to kick's law does not stay in the particle ofter the pressure is released. The energy is absorbed by the creation of heat and not by crushing. This factor is of course in agreement with the law of physics which states that all energy expended is finally dissipated as heat in some form. The modern review of Kick's law is that it applies only to the plastic deformation within the elastic limit which under normal crushing conditions takes very small energy.

Rittinger's law is based on the conception that the process of communition is concerned primarily with the surface energy so that the energy required for communition is considered as proportional to the fresh surface produced. The Rittinger's surface energy conception is quite empirical. Here the energy spent is proportional to the reciprocal of the diameter of the final product, of course under the assumption that mass has all been reduced to one exact size, a condition that is only theoretically possible. This theory deals with the energy consumed upon actual rupture in contrast to the Kick's law dealing with the energy before rupture. Rittinger's theory states that the work increases in geometrical ratio as the particle size of the product decreases. This theory seems to be true since the energy needed to fine crush is greater. Because, as already mentioned the load or ball cannot easily be made to bear upon a fine particle and hence a large amount of energy has to be needlessly thus expended.

If x units of work are needed to crush
a ton of ore to 1/8″ cubes.
then 2 x " " 1/16″ "
4 x " " 1/32″ "

Comparing Kick's and Rittinger's laws the latter seems to be more satisfactory and in fact practical. MARTIN, GROSS, & ZIMMERLEY on experimentation with quartz sand found the surface area before and after crushing by a chemical dissolution method with dilute hydrofluoric acid and they found Rittinger's law to be true. These two laws can also be compared in terms of a crushing coefficient defined as the energy corresponding to a given ratio of reduction say 2 : 1. For simplicity two natural distribution systems could be considered of which one carries particles twice as great as the other. The crushing coefficient would then be the energy to reduce one natural to another in which the particle could be half the original size.

Then as per Kick's law

Crushing coefficient KWH/$T_{\frac{1}{2}}$—constant independent of size.

As per Rittinger's law

Crushing coefficient KWH/$T_{\frac{1}{2}}$—constant/D. i. e., it increases with fineness.

Rittinger's law gives coefficients which are more in agreement with practice than Kick's law. Thus until very recently only these two laws have been keenly followed and also believed to be true to a certain degree.

RECENT FINDINGS IN COMMUNITION PHENOMENA AND STRUCTURE OF MINERALS

A new theory known as the third theory of communition[1] has been developed by FRED. C. BOND of

U. S. A. The Rittinger's law it is known states that the work in put or energy of communition is inversely proportional to the diameter of the product particles. But this new theory states that the energy so expended is inversely proportional to the SQUARE ROOT of the product particle diameters. Let the feed be such that 80% of it passes a diameter of F microns. Let the product be such that 80% of it passes a diameter of P Microns. If W is the work in KWH per short ton to bring about this reduction then

$$Wi = W\left(\frac{\sqrt{F}}{\sqrt{F}-\sqrt{P}}\right)\sqrt{\frac{P}{100}} \quad \text{....equation (1)}$$

where Wi is the "work index" or KWH/ton needed to reduce from a theoretically infinite particle size to 80% passing 100 microns.

The term Wi can be deduced from laboratory crushing and grinding tests. It mainly expresses the resistance of a material to crushing and grinding. If Wi values calculated from different operations are compared then the relative mechanical efficiencies of these operations may be computed.

If the work index Wi is known then the work in put W needed for any feed size F and products size P can be found by transposing equation (1)

$$=W = Wi\left(\frac{\sqrt{F}-\sqrt{P}}{\sqrt{F}}\right)\sqrt{\frac{100}{P}} \quad \text{..equation (1a)}$$

Let the reduction ratio Rr be F/P

Then $$\frac{\sqrt{F}}{\sqrt{F}-\sqrt{P}} = \frac{\sqrt{Rr}}{\sqrt{Rr}-1}$$

& $$\frac{Wi}{W} = \left(\frac{\sqrt{Rr}}{\sqrt{Rr}-1}\right)\sqrt{\frac{P}{100}} \quad \text{.....EQ(2)}$$

The size in microns which 80% passes was selected as the criterion of feed and product size because it is easy and reproducible to plot. When the percentage passing is plotted on log-log paper against the sieve openings in microns, the size 80% passes is found to be definite and reproducible. Further, the size of the larger particles is important in most communition operations especially when the object is to unlock or liberate minerals grains and hence selection of a smaller size than that which 80% passes would not give a valuable indication of the work done.

This new theory states that the work in communition results mainly in the formation of cracktips in the ore body and so the work done is directly proportional to the length of the crack thus formed. The KWH/ton needed to crush is hence directly proportional to the work index. The presence of fissures, veinlets and partly developed cracks in the feed particles greatly affects the crushing resistance of these so that the work index used for crushing may be different from that of grinding.

The impact crushing resistance C in foot pounds/inch of thickness needed to break a material is determined by laboratory tests. Let the specific gravity of the material be S. Then FRED. C. BOND says that the work index Wi = 2.5 × C/S Eq. (3) Now the KWH/ton is calculated using equation (1a).

By about 1953 another new concept of communition[2] was developed in U. K. by CAREY and STAIRMAND, this being known as the free crushing concept.

Here the forces are applied to individual particles being present as separate entities until each ruptures such that it ultimately shatters without any form of restraint from its environment. As a result, the crushed fragments have a size distribution which exhibits a characteristic and specific grading. This grading is known as a natural for the substance. If the largest particle of a particular natural be crushed and added to the remainder of the natural, the resulting grading is again a natural. By adding the energy needed to crush freely from a larger natural to a smaller one, it is said to be possible to obtain by laboratory experiments the energy for free crushing between natural size distribution of any given maxima sizes.

Free crushing affords a rational method of assessing efficiency and hence it is said that it may ultimately lead to more economic methods of milling. From the various free crushing test used on industrial crushing mills, it is found that

(1) Most mills use 20—30 times as much energy as would be demanded by free crushing.

(2) Most of the losses occur at the crushing surfaces.

In commercial mills, the particles are broken by compression, impact or shear. But still, in an ideal mill in which there are no energy losses, it is said that all these mechanisms, demand the same amount of energy as free crushing carried out in the laboratory. Hence free crushing is said to afford a scientific measure of grindability which could be applied to practical problems if it were possible to find the free crushing energy

needed to convert the feed to the grading of the product from industrial mills.

Thus this free crushing concept it is said provides a yard stick by means of which a practical value may be obtained for the grinding efficiency of industrial mills. At the present stage this technique is only applied to brittle solids.

In 1955, mineral engineers in the U. S. A. have been instrumental in finding out a few radically important factors in communition practice by ingenious methods. Of these, the most important one seems to be the work done by R. J. Charles and P. L. deburyn of M. I. T. Cambridge.[3] These two studied the energy transfer to the charge of ore body by impact. A brief review of their experimental procedure and results is given below.

The transfer of kinetic energy of translation to other forms of energy by impact is a well known fundamental process in most crushing and grinding processes. After the impact process the original source of energy may be present in any of the following possible forms.

(1) Strain energy of the components of the system or as residual stresses.

(2) Kinetic energy of translation of both the impacted and impacting bodies.

(3) Kinetic energy of vibration of the system.

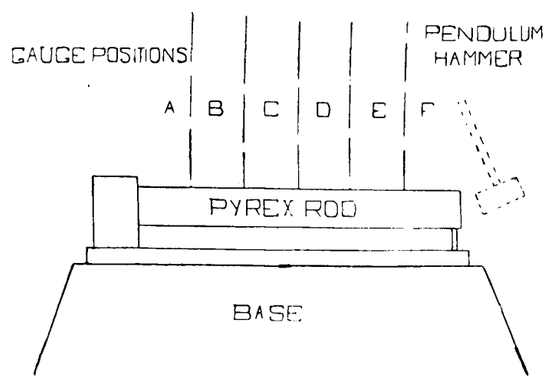
(4) New surface energy of the fractured surfaces.

(5) Heat generated by internal friction during the period of plastic deformation.

The fundamental fact is that at any instant during the impact process only the strain energy of the components of the system can directly bring about the brittle fracture process. Hence the deduction from this is that if fracture is the ultimate result, the aim should be to attain the maximum possible conversion of the original kinetic energy of translation to the strain energy of the impacted bodies within a single impact.

In figure (1) a pyrex glass rod is shown to be horizontally mounted and one end fixed on to an anvil leaving the other end free. The whole unit is mounted on a concrete bedding. Pyrex glass was selected because of its good elastic properties and similarity of fracture between pyrex and many materials encountered in crushing and grinding operations. Electronic equipment was used for observation of strain changes occurring in this rod. The impacts on the free end of the rod were got either by a pendulum hammer of 600g

FIGURE 1



or a spring loaded gun giving fairly light projectiles of 60g for impingement.

It was desired to get a strain-time history of the rod as a function of

(1) The mass of the impacting hammers.

(2) The kinetic energy of the impacting hammers.

For this 5 electrical wire resistance strain gauges were used at five equidistant gauge positions along the rod and the leads were taken to an oscilloscope and camera through a selector switch and amplifier in the said order. This gives the voltage-time relationship in the oscillograph. But use is made of the equation relating strain and voltage change across a strain gauge for a constant current flow.

$e = v/i\,RF$ where e—strain.

v—voltage change

i—gauge current.

F—gauge factor.

R—gauge resistance. eq (4)

Thus the strain-time relationship was got. The time of contact between the impacting object and the rod is an important variable and this is found by permitting the impacting components when in contact to act as a closed electrical switch which discharges a condenser. This discharge was observed and photographed on a time basis on the oscilloscope screen.

The experimental results:—Hooke's law and the law of elastic resilient strain energy stored up states that the

strain energy stored up at any point in single compression or tension is equal to

$$U = \frac{P^2}{2E} \Big/ \text{Unit Volume} \qquad \ldots\ldots\ldots EQ(5)$$

U = strain energy stored up per unit volume, P = stress and E = young's modulus. Since the region is within the elastic limit the stress is proportional to the strain and therefore the equation can be re-written as

$$U = e^2/2E \qquad \ldots\ldots\ldots eq\ (6)$$

Therefore the strain energy stored up is proportional to the square of the strain at that point.

An analysis of the plots of strain energy stored up at any point showed " the maximum strain energy obsorption occurred at that place where the maximum elastic deformation occurred. The results showed that the maximum strain energy absorbed was either at the fixed end or the struck end of the rod but under certain conditions could occur at positions near the rod centre. Interpretation of Oscillographs :—Figure 2 shows the oscillograph for 600g weight impact. The line 11' denotes the end of impact. The line 22' denotes the time after the beginning of impact at which strain values were measured. The line 33' denotes the beginning of the impact. The gauge section of the specimens from which oscilloscope signals were obtained have been designated by two letters at the left of the figures which correspond to gauge position in figure (1) i.e., between A and B signal is equal to AB and so on. All the traces show an initial increase and decrease during impact and then a period after impact when the rod is left in a state of vibration.

In figure 2 the trace of the gauge section EF (the struck end) shows two peaks during the time of impact. This shows that the rod had actually received two successive and separate blows, one following the other so rapidly that without such sensitive set up the impact would appear as one blow. Hence the multiple blow effects were obtained when hammers weighing more than 200g were used (600g in this case).

Figure 3 shows the corresponding trace for a 60g blow. Here it must be observed that (1) the duration of impact time is shorter; (2) there is only a single blow during this impact time as against the double peak for a 600g impact at the struck end; (3) the blow varies sinusoidally with the time and (4) the time during which the impacting objects remain in contact is directly proportional to the mass of the hammer in such a manner that the heavier the hammer the longer the contact time.

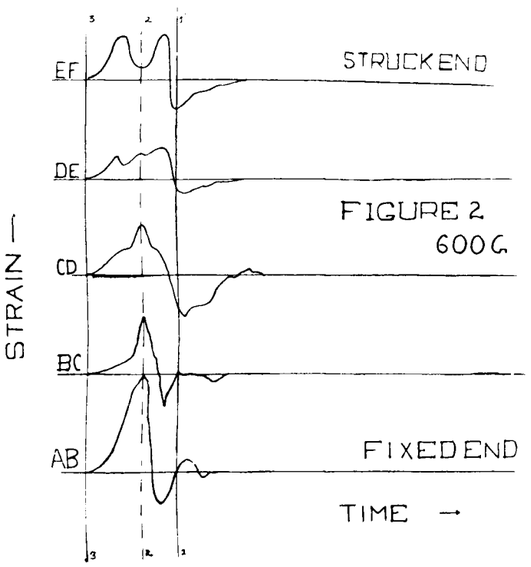


FIGURE 2
600G

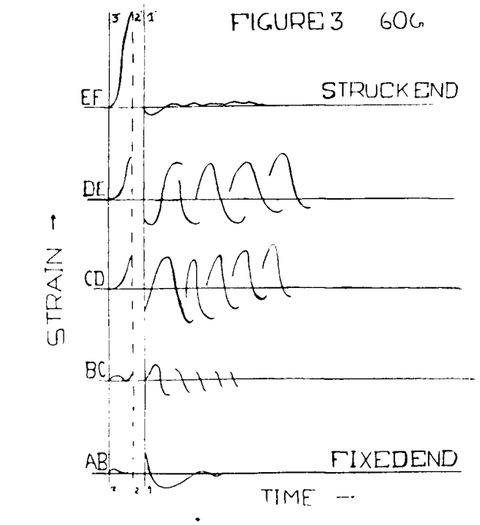


FIGURE 3 60G

Hammer weights of 600g gave rise to longer impact times (3-1-of figure 2 being greater) and the forces developed at the struck end of the rod showed two peaks (at EF in figure 2).

Hammer weights of 60g gave rise to shorter impact times (3-1-of figure 3 being smaller) and the traces for the struck end showed only one peak. (EF of figure 3)

Energy of rebound after impact :— Considering figure (2) after the beginning of the impact the contact force increases to a maximum and then decreases almost to zero as they hammer decelerates to zero velocity and loses all its kinetic energy. The hammer remains at rest for a short time (denoted by the small horizontal line). The rod now in extension accelerates the hammer in an opposite direction and thus causes rebound. The rebound gives a second peak. When this force again falls to zero (trace crossing the abcsissa) of the strain-time diagram the impact ends and the objects separate.

The rebound mechanism for 60g body is different. Here a single strain peak is evident at the struck end of the rod during the time of contact (EF of figure 3). The hammer is at rest when the contact force is a maximum as against its being at rest when the contact force is a minimum for 600g weight. For the 60g the rebound occurs when the forces decrease from a maximum to zero.

In figure 2 the trace for gauge section AB indicates a strain conditions near the fixed end. Here a single strain peak occurs, considerably after the beginning of impact. At this very same instant when the strain at the fixed end AB reaches a maximum the strain at successive gauge sections in the direction of struck end EF becomes progressively smaller until at the struck end it is very nearly zero.

EAB> EBC> ECD> EDE> EEF for Fig. (2)

In figure 3 (60g) however, the maximum strain occurs at the struck end of the rod and at this instant the strains at successive gauge sections DE, CD, BC and AB decrease in intensity.

EEF> EDE> ECD> EBC> EAB for Fig (3)

Hence summarising it is said that " if the loading pulse consisted of two strain peaks the maximum strain was developed at the fixed end of the rod AB (figure 2)".

" If the loading pulse consisted of a single strain peak the maximum strain was developed at the struck end EF " (figure 3).

Strain vs. time *after* impact :— The amplitude of vibration of the rod after the impact is now taken up. When the hammer rebounds after impact the rod continues to oscillate. Considering the rod centre (gauge CD) for short impact time the maximum amplitude of the rod after impact is almost equal to the maximum peak amplitude during impact, i. e., for figure 3. But for long impact times figure 2 at the centre (CD) the maximum amplitude of vibration of the rod after impact is much less than the maximum amplitude of rebound of 600g during impact. Hence heavy hammers during rebounding extract a much greater proportion of strain energy from the rod thus causing low amplitudes of oscillation of rods after impact. Discussion :—(Determination of transfer of kinetic energy of the impact to strain energy) In the impact process when hammer decelerates to zero velosity all the original kinetic energy of translation of it is changed to other forms and at this point the strain energy of the impacted rod is near its maximum. As the impact continues the strain energy of the rod is partially reconverted to kinetic energy of translation of the hammer and hence it rebounds. Hence the only form of energy that is directly usable in communition is the strain energy that has been momentarily stored in the rod and also in the hammer. The investigation permits the calculation of the maximum amount of strain energy absorbed by the rod. This is expressed as a fraction of the original total energy of impact.

The total strain energy of the bar may be calculated as follows for a bar where the strain at various cross sections along the length of the bar AB, BC,—are variable.

Let Ws be the strain energy density (strain energy/unit rod length) be the rod length. Ws be the total strain energy of the whole rod. Therefore Ws is equal to

$$\int_0^1 Ws.\, dL \qquad \ldots\ldots\ldots eq(7)$$

The strain energy density at any section is related to the strain at that section by Ws =

$$\frac{AEe^2}{2}$$

A—cross sectional area, E—young's modulus, e—strain.

$$Ws = \frac{AE}{2}\int_0^1 e^2\, dL \qquad \ldots\ldots\ldots eq(8)$$

Let the original kinetic energy of impact be equal to Wo. Then fraction of strain energy in the rod at any time as a fraction of the total kinetic energy of impact Wo is equal to

$$\frac{Ws}{Wo} = \frac{AE}{2}\int_0^1 \frac{e^2}{Wo}\, dL \qquad \ldots\ldots\ldots eq(9)$$

Hence for conditions of absorption of maximum strain energy emax, the important factor becomes

$$\frac{(eMAX)^2}{Wo}$$

Plots were made of the values of the term

$$\frac{(eMAX)^2}{Wo}$$

vs. gauge positions on the rod and a smooth curve was got. The figures 4 and 5 thus obtained showed the relative distribution of strain energy in the rod as a function of impact energy for the instant when the strain energy absorbed was a maximum.

FIGURE 4 600G

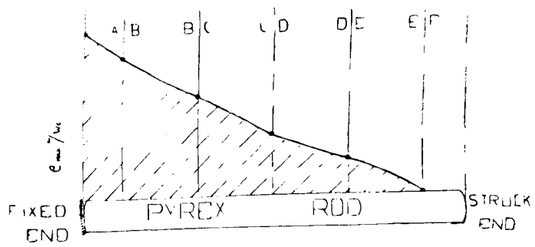
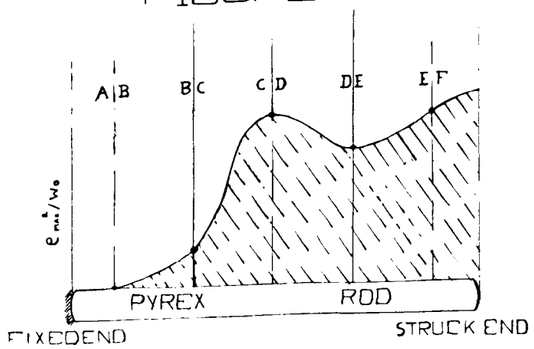


FIGURE 5 60G.



Thus CHARLES and debruyn conclude their work by pointing out the following important factors.

(1) A maximum transfer of the original kinetic energy of impact to the strain energy to be retained by the rod is highly desirable.

(2) The impact time should be very small and a fractional part of the period of vibration of the impacted object and the loading pulse should consist of a single blow. There is a specific impact time for maximum energy conversion.

(3) The intensity of impact should be as large as possible. This assures the development of stress values sufficient to initiate and propagate the fracture.

(4) Only with small impacting hammers short impact times are attained. Only then the maximum stress is developed at the point of contact. Thus the energy of impact would be transferred to strain energy within the impacted mass and the major portion localized near the point of contact. Hence only a small fraction of energy would be dissipated by the supports of fixed ends and thus rendered useless.

In using small hammers the rebounding causes only slight damping of vibrations set up during impact. Then successive rapid impacts may have a cumulative effect on the internal vibrations set up in the rod. Hence the successive impacts the internal vibrations would increase in intensity. Thus fractionation and size reduction may be got by a succession of rapid light blows of which any one taken singly would have on lasting effect on the rod but the cumulative effect is really predominant.

Another team consisting of SOLLENBERGER and GREENAWALT are now investigating the application of energy to glass balls[4] of selected diameter to the point of brittle fracture with the energy applied by slow compression at different rates of loading.

In New England, U.S.A. an investigation of the impact strength of limestone at temperatures upto 900°F has shown that the impact strength of materials at this temperature is about half the value at room temperatures. Advantage is taken of this fact by heating quartz to red heat in a rotary furnace and discharging it to a hammer mill for communition.

JK. MOORE of the U. S. A. has invented a grinding machine operating on an entirely new principle of size reduction. The machine accelerates the particles to high speeds and then discharge them against a curved surface, causing the particles to spin about their axes. Moore claims that the centrifugal force thus created is sufficient to cause them to explode. Because they spin at velocities proportional to their weight, the larger particles are reduced more quickly and uniformly sized product is obtained.

With increasing scientific knowledge nowadays crystal chemistry has become an important though a relatively new subject. Dr. WELSCH[5] of U. K. points out that any crystal of appreciable dimensions is a " Mosaic " of interpenetrating small blocks of roughly

parallel orientation within each of which regularity in the arrangement of the lattices may be assumed to exist. Between its mosaic blocks a lattice is considered to contain fissures often fairly wide. The mineral engineer is specially interested in this new field since the tensile strength of a crystalline solid is very materially reduced by the fissures resulting from a mosaic structure The fissures in the surface and body of the lattice facilitate the development of localized strains which ultimately lead to fracture of the solid under relatively low stress. But for mosaic structure solids would have been for more difficult to grind.

The use of Radioactive isotopes has also been made in communition research. GAUDIN, SPEDDEN and KAUFMAN[6] in U. S. A. have done some experiments using a radioactive isotope to follow the breaking of a particular piece in its normal environment of other pieces. This signifies a marked improvement on the size distribution studies. The mineral used was Sodium bearing feldspar, albite. The feed was sized and radioactivity (due to Na^{24}) was induced in a particular size fraction. This was then returned to the remainder of the charge for the communition experiment.

Thus this method of using induced radioactivity to label specific pieces of material for use is crushing and/or grinding researches is quite novel. These workers have said that the use of radioactive isotopes will be extended considerably to study some of the many variables in the communiting operations.

SUMMARY

The subject of communition is still classified as an art rather than a science since its fundamental laws are not yet well established and experience and emperical relationships are needed to solve its problems.

In communition a number of physical factors such as the hardness, resistence to crushing, abrasiveness, moisture content and/or cohesiveness and etc. important. On a general basis crushing to large and medium sizes and crushing of soft ores are more economical of power than fine crushing or grinding and crushing of hard and super hard ore bodies.

In fine grinding, a large amount of energy has to be needlessly expended in bringing the force to bear upon the body. Here the relationship between the particle size and surface area is exponential. Fine ground material if wet may cause a lot of handling problems.

50 years back, the laws of Kick and Rittenger have been proposed and out of these, the Kick's law seems to be concerned about the energy needed for deformation only upto the plastic deformation stage. This in actual practice consumes only a small amount of energy. Rittinger's law seems to be the better of the two and is more in agreement with the practical points. MARTIN, GROSS and ZIMMERLEY tested the validity of this law by a chemical dissolution method using hydro fluoric acid on quartz sand and found this to be true.

FRED. C. BOND of U. S. A. has proposed the third theory of communition where the work in put or energy of communition is inversely proportional to the square root of the diameter of the product particles. As per this theory, if the feed be such that 80% of it passes a diameter of F microns and the product be such that 80% of it passes a diameter of P microns and W is the work in KWH/short ton to bring about this reduction, the new factor known as work index Wi becomes

$$Wi = W \times \frac{\sqrt{F}}{\sqrt{F} - \sqrt{P}} \times \sqrt{\frac{P}{100}}$$

This Wi is the KWH/ton needed to reduce from a theoretically infinite size to 80% passing 100 microns. Wi denotes mainly the resistance of a material to crushing and grinding. This new theory states that the work done in communition results mainly in the formation of cracktips and so the work done is directly proportionate to the length of the cracktips.

CAREY and STAIRMAND developed the free crushing concept in communition practice. They define that free crushing is done such that the forces are applied to individual particles such that they ultimately shatter without any form of restraint. The energy consumed under such free crushing condition is measured and hence is said to afford a scientific measure of grindability which could be applied to practical problems.

In 1955, CHARLES and deburyn of U. S. A. experimented energy transfer by impact using pyrex glass rods being impacted by 60g and 600g weight bodies. The strain time records were made in oscillograph and extensive experiments were conducted. The results proved that

(1) The ideal case should be for the maximum transfer of the original kinetic energy of impact to the strain energy retained in the rod.

(2) This condition could be had by using small impacting hammers which give shorter impacting times.

(3) This also gives the maximum strain energy absorbed at the struck end and thus it gets localized reducing the dissipation of energy into areas other than those directly struck and in their immediate vicinity.

(4) The intensity of impact should be as high as possible thus causing initiation at propagation of the fractures.

SOLLENBERGER and GREENAWALT of the U. S A. are investigating the mechanism and rate of failure of glass balls being subjected to varying rates of application of compressive loads.

In New England, U. S. A. another worker heats up quartz upto 900°F and reduces it in a hammer mill since he feels that the impact strength of this materials is half the value at room temperatures.

J. K. MOORE of the U. S. A. using a machine accelerates the particles to be crushed to high velocities and makes them inpinge on a curved surface. The particles spin about their axes and he claims that the particles by virtue of their centrifugal forces explode. Larger particles because of their greater centrifugal force are reduced more quickly and a uniformly sized product is got.

Dr. WELSCH of U.K. is advancing the crystal chemistry basis and says that any crystal consists of a "mosaic" of interpenetrating small blocks of roughly parallel orientation within each of which regularity in the arrangement of the lattices exists. Between its mosaic blocks, a lattice is said to contain fissures often fairly wide. These fissures reduce the tensile strength of the crystalline solid and facilitate the development of localized strains which ultimately cause fracture of the solid under low stress values.

GAUDIN and associates have used radioactive isotopes in communition researches to follow the breaking of a particular piece in its normal environment of other pieces. Use was made of induced radioactive Na^{24} of a particular size fraction. This was later returned to the remainder of the charge and communitted. Thus this tracer study will be certainly beneficial in furthering our knowledge of communition mechanics.

Hence of late considerable work has been and is being done throughout the world with the intention of promoting a better understanding of the communition phenomena. This paper is an attempt to bring out a few of the important works in the sphere of communition mechanics.

Acknowledgments:—I am greatly indebted to the services of the United States Information Library and Mr. M. P. Kathirvelu of Madras, for their help.

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WONDER METAL

Molybdenum is a new candidate for the title of "wonder metal". Tremendous strength at red-hot temperatures makes it one of the best materials for to-morrow's jet engines and the fancier dreams of aircraft designers, but the metallurgists say that it is ideal; except that it goes up in smoke when it gets hot in the vicinity of air, or oxygen in any form. This unfortunate fact about molybdenum has been known for years, but now metallurgist think they are on the right path toward getting the problem tackled and are now definitely encouraged about the possibilities. They are of the opinion that Molybdenum with a proper coating to keep oxygen away from it—may be a key to the door through the horrible bogey called "heat barrier." Although molybdenum may be the next "wonder metal," many guess that basic researches now being conducted to learn about the atomic structure of metals and alloys—and their processing are likely to produce even better high-temperature—materials in future.

Ailsa Craig's Marine, Industrial & Traction Engines

By Plant Engineer

FOUNDED in 1891, Ailsa Craig Limited were early pioneers in the development of the internal-cumbustion engine for marine propulsion and auxiliary purposes. Over 50 years of specialized knowledge in the production of oil engines for the strenuous service called for by users of marine engines are embodied in the present-day design of the Company's products, with a range of 10 to 100 b.h.p. for marine propulsion, marine auxiliary, industrial and rail traction purposes. Initially designed for marine propulsion duties, the robust construction thus called for has enhanced the reputation of Ailsa Craig engines in their applications to industrial and traction services.

The marine engines built by the Company are in use in all parts of the world, installed in commercial and pleasure craft. In 1926 the Company was appointed under Royal Warrant as makers of marine motors to the late King George V.

The works are present arranged for flow production of the RF series, with a range of from 10 to 60 b.h.p. A new works specifically laid out and equipped with the latest specialized machinery is now in full production. The range will be increased to 100 b.h.p. during 1950 by putting into production an additional series designed in co-operation with Ricardo and Co., Engineers (1927) Ltd., and embodying the Ricardo patents.

The ability of Ailsa Craig engines to operate under the strenuous conditions of marine service led to their utilization by leading British and overseas makers of industrial plant, such as welding sets, excavators, cranes, locomotives, tractors, road rollers, generating sets, pumps, etc.

For after-sales service the Company have spare parts stores iudependent from their engine-production stores, stocked not only to supply spares for the engines in present production but also for older types. During the past five years they have supplied spares for engines manufactured by them over 30 years ago.

Ailsa Craig Marine Propulsion and Auxiliary Engines

Vertical. Four-stroke. Used with reverse gear. Normal aspiration. Bore, 4⅛ ins. (104.78 mm.). Stroke, 5½ ins. (139.7 mm.). B.m.e.p. at maximum output, 97 lb. per sq. in. Maximum mean piston speed, 1,100 ft. per min. Ricardo Whirlpool combustion chambers. Guaranteed full-load fuel consumption, 0.43 lb. per b.h.p.-hr.

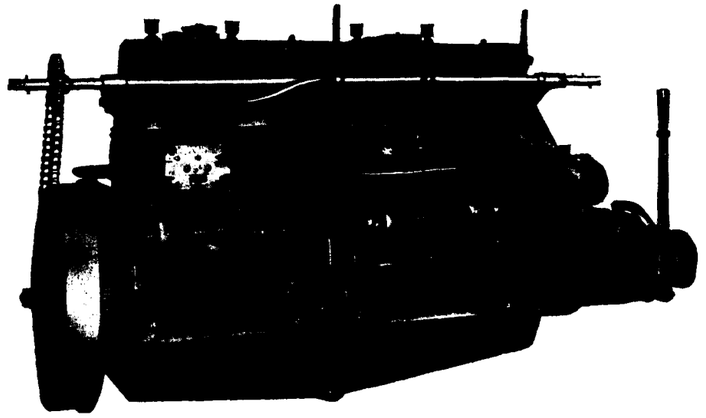
Model designation	**RF1**		**RF2**		**RF3**		**RF4**		**RF6**	
Normal b.h.p.	**10**		**20**		**30**		**40**		**60**	
Maximum b.h.p.	**11**		**22**		**33**		**44**		**66**	
Speed range, r.p.m.	**300-1, 200**		**300-1, 200**		**300-1, 200**		**300-1, 200**		**300-1, 200**	
Number of cylinders	1		2		3		4		6	
Starting system	Hand*		Hand*		Hand*		Elec., hand emergency		Elec., hand emergency	
Engine weight (without gear), lb. and kg.	610	280	870	394	1,120	507	1,430	648	2,100	953
Length to coupling face, including reverse gear, ins. and mm.	34	864	40¼	1,022	48½	1,232	60	1,524	72½	1,791
Width over bearers, ins. and mm.	23½	596.9	23½	596.9	23½	596.9	23½	596.9	23½	597
Overall height, ins. and mm.	37½	953	37½	953	38	965	38¼	972	38¼	972
Flywheel diameter, ins. and mm.	20½	521	20½	521	21	533	21	533	21	533
	A		**B**		**C**		**D**		**E**	

* Electric by arrangement.

The whole range of the RF series is available for marine propulsion or auxiliary work, giving a power range of 10 to 60 b.h.p. as shown in the table. They have been specially designed for such duties and constructed in every detail to stand up to the strains and stresses experienced at sea, often in the hands of unskilled operators.

Paramount importance has been placed on clean design and moderate weight whilst maintaining maximum strength in the construction. The crankcase is a monobloc casting carried up to the cylinder heads; it is a one-piece box-section framing, giving the utmost rigidity and strength. Perfect accuracy of alignment is thus secured between cylinders and the crankshaft and camshaft, everything being enclosed and protected.

On the single- and twin-cylinder models the sump is cast integral with the crankcase, whilst the three, four- and six-cylinder engines have detachable sumps. Large inspection doors are a special feature, rendering easily accessible the main bearings, connecting-rods and camshaft.



Ailsa Craig Type RF6 marine propulsion engine: 60 b.h.p. at 1200 r.p.m.

Removable cylinder liners of the " wet " type are fitted. Centrifugally cast in special wear-resisting cast iron, they are accurately ground and pressed into the cylinder block, with joints formed by cork compression rings.

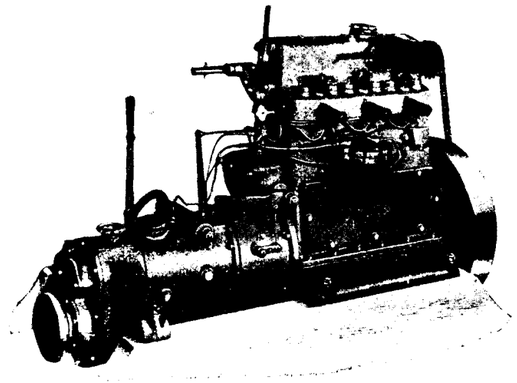
Combustion loads are evenly distributed throughout the box framing. The crankshaft is supported by a bearing on each side of each throw. Crankshafts of the single-, twin- and six-cylinder models are forged from high-tensile Siemens Martin steel billets, whilst the three- and four-cylinder engine crankshafts are special Meehanite castings. All shafts are accurately machine balanced and ground, with balance weights provided for each cylinder line to ensure the smoothest running, also relieving the main bearings of considerable loading.

Pistons of low-expansion light alloy are fitted with three compression and two scraper rings. Steel gudgeon pins, hardened and ground to size, are secured by circlips. Connecting-rods are drop forgings of high-tensile steel, accurately machined and balanced with their respective pistons; the big ends have shims to facilitate bearing adjustment when required.

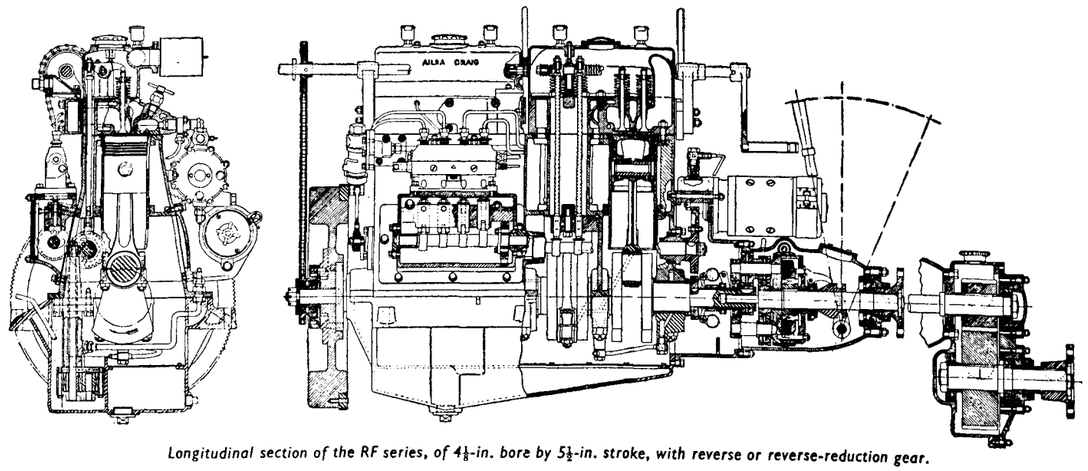
Main and big-end bearings are steel and gunmetal shells, lined with the highest-grade white metal, whilst the gudgeon-pin bushes are of chill cast phosphor-bronze. All bearings are of ample length and diameter, and are easily renewable when necessary.

COMBUSTION CHAMBER

The cylinder head is a Meehanite casting of simple design; it embodies the Ricardo Whirlpool combustion chamber, which ensures easy starting from cold combined with a high mechanical efficiency and low fuel consumption. Made from stainless steel, the Ricardo Whirlpool combustion chamber is accurately fitted to the cylinder head. Valve seats are renewable, the inserts being of centrifugally-cast iron, containing chromium.



Type RFR3 30 b.h.p. marine propulsion engine with 2 to 1 reduction gear.



Longitudinal section of the RF series, of 4⅛-in. bore by 5½-in. stroke, with reverse or reverse-reduction gear.

Valves are of tulip pattern, made from silchrome steel, with hardened caps and carried in long renewable guides, which are a press fit in the cylinder heads. Valve operation is by push rods of moderate length from the camshaft carried in the crankcase. Camshafts are machined from solid steel, case hardened and ground; they have adequate bearings, are fully enclosed, automatically lubricated and have a silent gear drive. The overhead valve gear is enclosed by a rocker cover which includes the air intake and carries an air cleaner.

A. C. A. V. pump and injectors constitute the fuel system. The pump is conveniently mounted on the pump-box door, and its camshaft is gear driven from the main camshaft.

Cooling is provided by a sturdy gunmetal plunger-type pump, delivering the requisite quantity of water to maintain the cylinders at the correct working temperatures. Particular attention has been paid to ensure adequate cooling of the cylinder head under all working conditions, and the water jackets are carried around the valve seats and the fuel injectors.

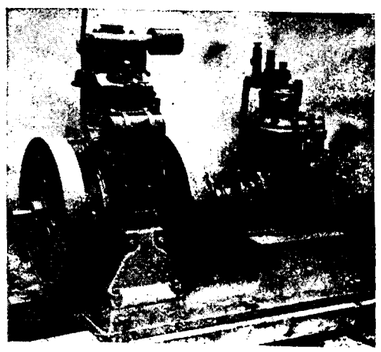
Lubrication is fully forced to all parts, including main bearings, big ends, camshafts, valve rockers, timing gears and reverse gear, by a substantial gear-wheel pump, directly driven. Screen and fine-mesh filters are provided in the sump, which is of ample size to carry the requisite amount of lubricating oil, and an oil cleaner is standard equipment, whilst on the four-and six-cylinder models an oil cooler is also fitted.

An automatic centrifugal governor controls the speed of the engine from maximum to below 200 r.p.m., according to the setting of the hand control lever.

Easy starting, so essential for marine work, is a particular feature of the RF series, and all models can be started by hand. A compression-release lever is fitted in the rocker cover, convenient to the raised adjustable marine-type hand-starting gear, operated either at the forward or aft end. On the four- and six-cylinder engines electric-starting equipment is fitted as standard.

DIRECTION REVERSAL

The reverse gear is of the epicyclic pattern and is very sturdy; it is lubricated from the engine's pressure system and operated by one lever in the direction of motion required. Hardened steel gears, bronze bushed and always in mesh, are so arranged that they run only in "neutral" or "reverse." In the "ahead" position the gear rotates as one unit. The "ahead" clutch is formed by multiple steel and bronze plates, running in



Marine auxiliary air compressor set with type RFI 10 b.h.p. engine as power unit.

oil, and can be slipped almost indefinitely. Ample adjustment is provided for both clutches. The gear is completely enclosed in a substantial casing which forms an integral part of the engine unit; it embodies an exceptionally heavy radial thrust block. Reduction gears of 2 : 1 or 2¾ : 1 ratio are supplied when specified; they comprise special helical wheels fully enclosed in a casing; they are lubricated from the engine and have ample bearings to take the propeller thrust. For twin-screw installations, engines are supplied for opposed rotation.

Real marine accessibility is provided by the very large inspection doors on both sides of the engine, enabling the big ends to be removed without any special tools and with the greatest ease when installed in the boat. Cylinder heads complete with valves can be removed in a few minutes, and pistons and connecting-rods can be withdrawn upwards, whilst cylinder water jackets can be cleaned through the large ports provided in the joints between cylinder and head. The reverse gear and reduction gear also each have a large inspection door and are removable as one unit. All models can be built under the survey of the M.O.T., Lloyd's, or Bureau Veritas when so specified.

Ailsa Craig Industrial Engines

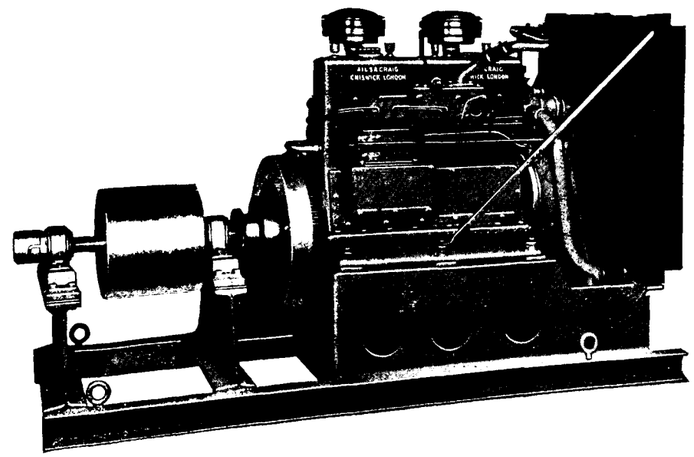
Vertical. Four-stroke. Normal aspiration. Bore, 4⅛ ins. (104.78 mm.). Stroke, 5½ ins. (139.7 mm.). Full-load b.m.e.p., 88 lb. per sq. in. Maximum mean piston speed, 1,100 ft. per min. Ricardo Whirlpool combustion chambers. Guaranteed full-load fuel consumption, 0.43 lb. per b.h.p.-hr.

Model designation	**RFS1**		**RFS2**		**RFS3**		**RFS4**		**RFS6**	
12-hr. b.h.p. rating (B.S.I.)	**10**		**20**		**30**		**40**		**60**	
Maximum governed speed, r.p.m.	**1,200**		**1,200**		**1,200**		**1,200**		**1,200**	
Number of cylinders	1		2		3		4		6	
Standard starting system	Hand		Hand		Hand		Elec., hand emergency		Elec., hand emergency	
Complete engine weight (dry), lb. and kg.	645	292	895	406	1,210	549	1,520	690	2,220	997
Overall length, ins. and mm.	26½	673	29¾	756	35¾	908	45	1,143	59¾	1,518
Overall width, ins. and mm.	25½	648	25½	648	25½	648	25½	648	25½	648
Overall height, ins. and mm.	41½	1,054	41½	1,054	41½	1,054	43½	1,105	43½	1,105
	A		**B**		**C**		**D**		**E**	

Ailsa Craig industrial engines embody in their basic design the features specified in detail in the marine type described in the previous pages. For stationary engine work, iron castings are adopted for the bedplate, so that the design is definitely that of an industrial engine, as distinct from an adapted marine type.

The models for belt drive to the load have standard flat-belt pulleys. In the case of the 10 and 20 b.h.p. sizes the pulley is spigoted and bolted directly to the

40 b.h.p. radiator-cooled power take-off unit.



flywheel. On the 30, 40 and 60 b.h.p. engines the driving pulley is mounted on an extension shaft bolted to the flywheel and provided with plummer block outer bearings. Multi vee-belt drives can be supplied in place of the standard flat-belt drive.

Engines supplied for coupling to electrical generators, pumps, air compressors, etc., are fitted with a 3-or 6-point flexible coupling mounted on the flywheel.

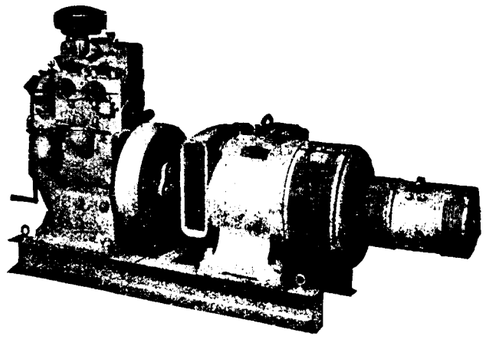
Three types of semi-portable industrial engine are available, comprising :—

(a) Engine mounted complete with pulley on a fabricated steel baseplate, having eyebolts for slinging. Water, fuel and exhaust connections for this type are made in the conventional manner, to suit the engine-room.

(b) Semi-portable, radiator-cooled engines similar to (a), but having a radiator mounted on the engine, leaving only the exhaust and fuel arrangements to be carried out in the engine-room.

(c) Complete power take-off units, as (a) and (b), but in addition the fuel tank and exhaust silencer are mounted on the baseplate and coupled to the engine, forming a complete working unit ready to be put into use without making any external arrangements. This type can also be supplied when so specified with a steel canopy and side curtains, forming a completely enclosed working unit suitable for operation under outdoor conditions.

A cooling-water pump of the centrifugal type is standard on all industrial models and is vee-belt driven ; provision is also made in type (a) for the mounting of a fan.



Diesel alternator set with type RFS2 20 b.h.p. engine as prime mover.

On all models hand-starting is fitted at the opposite end to the flywheel, and on the 40 and 60 b.h.p. sizes, electrical starting is included as standard equipment. Oil-bath air filters are standard fitments on all industrial engines, to ensure a clean supply of air under working conditions.

A control lever is conveniently mounted on the engine by which the revolutions of the engine can be set, if desired, to any speed below the maximum rated speed of 1,200 r.p.m. The automatic centrifugal governor controls the speed from maximum to below 200 r.p.m. according to setting of the hand lever. A constant-speed governor set at the required speed can be supplied in lieu of the hand-controlled variable-speed governor if required.

The RF series of industrial engine has for many years been adopted for excavators, tractors, cranes, road rollers, etc. For such purposes engines with bearers to suit individual requirements are available, including three-point mounting.

Ailsa Craig Railway Traction Engines

Vertical. Four-stroke. Maximum. b.m.e.p., 97 lb. per sq. in. Bore, 4⅛ ins. Stroke, 5½ ins. Transmission system as desired.

Model designation	**RFST1**		**RFST2**		**RFST3**		**RFST4**		**RFST6**	
Maximum b.h.p.	**11**		**22**		**33**		**44**		**66**	
Speed range, r.p.m.	**300-1,200**		**300-1,200**		**300-1,200**		**300-1,200**		**300-1,200**	
Number of cylinders	1		2		3		4		6	
Starting system	Hand		Hand		Hand		Elec., hand emergency		Elec., hand emergency	
Engine weight (dry), lb. and kg.	630	286	890	404	1,140	516	1,450	656	2.120	961
Overall length, ins. and mm.	24½	622	29¾	756	35¾	908	45	1,143	59¾	1,518
Overall width, ins. and mm.	25½	648	25½	648	24	610	24	610	24	610
Overall height, ins. and mm.	40¾	1,035	40¾	1,035	41¼	1,048	42½	1,080	42½	1,080
	A		**B**		**C**		**D**		**E**	

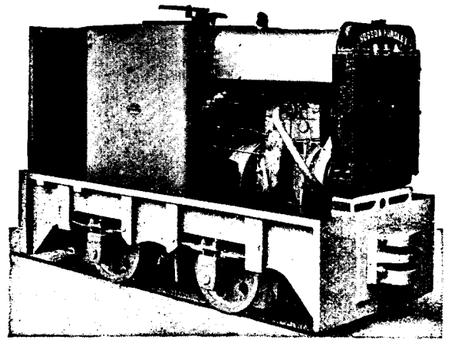
As power units for small oil-engined locomotives and railcars, the RF series Ailsa Craig traction-type engines have been incorporated for many years by leading builders. Their compact design, medium weight and smooth running throughout the speed range are particular features for this class of work.

The standard design includes full provision for mounting in the frame of a rail vehicle, with either three-point suspension or the conventional four bearers. Water circulation is by a centrifugal pump, the spindle of which carries the radiator fan.

In the case of mechanical transmission, the 20 b.h.p. model is provided with a taper on the crankshaft to carry the hydraulic coupling, and the 30, 40 and 60 b.h.p. engine crankshafts are flanged and spigoted for the same purpose.

A centrifugal governor operates throughout the speed range, from idling up to maximum, and provision is made for extension of the speed control for cab operation.

The general specifications of the traction types follow those of the marine models described. All models can be hand-started, but on the 40 and 60 b.h.p. sizes, electric starting is incorporated as standard, and on smaller sizes as an extra, if so specified.



20 b.h.p. Diesel locomotive with Ailsa Craig type RFST2 engine.

Lubrication is fully forced to all working parts, and an oil-pressure gauge is provided for remote mounting in the cab. An oilbath type of air filter is fitted to ensure a clean supply of air under all working conditions.

As in the marine type, special attention has been paid to accessibility; ample inspection doors and covers enable running adjustments to the working parts to be made without the necessity of removing the engine from the frame.

BRITISH MISSION RECOMMENDATION

According to a report, the U. K. Heavy Engineering Mission which visited India in November, 1956, has recommended the establishment of four independent and self-contained heavy works each costing Rs. 5 crores to meet the future requirements of heavy plant and machinery. These four works will be a Heavy Structural and Fabricating work, Heavy Plate and Vessel work, Heavy Machine Shop, Heavy Industrial Machinery and a Heavy Machine Tools work. These are recommended by the Mission to be in addition to the Heavy Castings and Forgings Unit proposed to be set up by the Government of India. The recommendations were submitted on the 4th February last in a report which is presently being studied by the Government along with the report submitted by the Russian team.

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WORLD'S LARGEST NUCLEAR POWER STATION

The South of Scotland Electricity Board proposes to build at Hunterston, near Largs, Ayrshire, the largest nuclear power station in the world. This station—estimated to cost about £ 37,000,000—will have an annual output of electricity to the value of about £ 4,000,000. It will cover about 160 acres. The White Paper presented to the British Parliament in 1955 entitled *Programme for Nuclear Power* envisaged the construction of reactors of 50,000 to 100,000 kilowatts, but it is now possible to plan for reactors of 150,000-plus kilowatts. The Scottish station now proposed would have at least two reactors, each giving an output of at least 150,000 kilowatts.

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

PART II. Efficiency of the Materials in Removing Fluorine from Water

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Department of Biochemistry, Indian Institute of Science, Bangalore.

(Continued from JOIE/Decr. 1956—Vol. I No. 2)

THE presence of over one part per million (p. p. m.) of fluorine in water has been found to cause mottling of enamel of teeth in children. Concentrations of 3 p. p. m. or over cause irregular outgrowth of osseous tissue on the long bones and ossification of the inter-costal ligaments[1]. Cattle lose their condition and develop dragging gait. Exostoses may develop on the ribs and long bones[2].

The occurrence of fluorides in the drinking waters has been reported from practically all parts of the world. In India, fluorides have been reported to occur in parts of the Madras presidency[3], in Travancore[4], in Hyderabad[5] and in the Punjab. [6,7]

The various methods which have been suggested from time to time for employment in the removal of fluorides from water may be classified broadly into (1) those involving treatment with chemicals, such as aluminium sulphate[8], lime, magnesia[9] or calcium phosphate which may be added as powder[10] or precipitated *in situ*[11], (2) those involving percolation through beds of contact materials, such as processed bone[12], activated carbon[13], activated alumina[14], or granular tricalcium phosphate[15], and (3) those involving percolation through beds of ion-exchange materials. Methods in the first group suffer from the disadvantage that they require elaborate treatment plants and careful control over the dose of the chemicals and the pH. In some cases, a second treatment may be necessary to restore the pH of the treated water to normal level. On the other hand, percolation methods do not call for much skill in operation and are hence worthy of study.

Robertson[16] observed that fluorides were removed from a water containing fluorides when it was percolated successively through beds of phenol-formaldehyde (cation-exchange) and amine-formaldehyde (anion-exchange) resins. Benson *et al.*[17] reported that fluorides could be reduced from 10 p. p. m. to 1 p. p. m. by successive passage through beds of a cation-exchanger ('Zeokarb H') of sulphonated coal-type and an amine resin 'Nalcite B'.

Venkataramanan *et al.*[18] reported that alum-treated cation-exchange resin from 'Avaram' bark could be used as an effective material for removing fluorides from water. They found that the use of this material possessed several advantages over the ion-exchange systems in that (1) only one bed was used, (2) the anion-exchange resin which was difficult to obtain was dispensed with, and (3) a comparatively cheap chemical as alum was used for regeneration instead of acid or alkali.

In view of the above and other observations given in Part I of this series, trials were made to utilise the ion-exchange materials prepared from tea waste, jute waste, groundnut shell and coir fibre, by treating them with alum, for the removal of fluorides from water. The experiments carried out are briefly described below.

EXPERIMENTAL

20 gms. of the sulphonated carbon (prepared as described in Part I of this series) was converted into the sodium form by treatment with 1% sodium carbonate solution till the effluent was alkaline to phenolphthalein, and then washing the bed with distilled water in order to remove the excess sodium carbonate. The washed material was taken in a glass tube of 1 inch diameter and was further treated with 100 c. c. of 1% alum solution twice and the effluents were rejected; and then 100 c. c. of the alum solution was kept in contact with the carbon overnight. The bed was then washed free of soluble aluminium ions as tested by hæmatoxylin, and a solution of sodium fluoride in tap water (equivalent to 2.5 p. p. m. fluorine) was percolated through the bed at the rate of 25 c. c. per minute. One litre lots of the effluents were collected successively and tested for fluorine and aluminium. When residual fluorine reached the toxic limit (1.0 p. p. m.), the percolation of sodium fluoride was stopped and the carbon regenerated with alum solution as indicated above. Five such cycles were completed and the results are presented in Tables 1 to 4.

TABLE 1

Efficiency of the ion-exchange material prepared from tea waste in removing fluorine from water

Lot No.	Amount of fluorine in the effluent (p. p. m.)				
	1st cycle	2nd cycle	3rd cycle	4th cycle	5th cycle
1.	0.1	0.4	0.1	0.1	0.1
2.	0.7	0.3	0.2	0.1	0.3
3.	0.9	0.6	0.2	0.2	0.3
4.	>1.0	0.6	0.4	0.2	0.6
5.	>1.0	0.7	0.4	0.3	0.6
6.	—	0.9	0.9	0.7	0.8
7.	—	>1.0	1.0	0.8	>1.0
8.	—	>1.0	>1.0	>1.0	>1.0
Blank	2.5	2.4	2.4	2.5	2.6
Volume of water treated to non-toxic level of fluorine (in litres)	3	6	7	7	6

The amounts of aluminium present in the effluents were negligible.

TABLE 2

Efficiency of the ion-exchange material prepared from jute mill waste in removing fluorine from water

Lot No,	Amount of fluorine in the effluent (p. p. m.)				
	1st cycle	2nd cycle	3rd cycle	4th cycle	5th cycle
1.	0.4	0.3	0.1	0.1	0.2
2.	0.7	0.6	0.1	0.2	0.2
3.	0.8	0.6	0.3	0.2	0.3
4.	>1.0	0.8	0.3	0.4	0.6
5.	>1.0	0.9	0.5	0.7	0.6
6.	—	>1.0	0.8	0.9	0.9
7.	—	>1.0	>1.0	>1.0	>1.0
Blank	2.5	2.6	2.5	2.4	2.4
Volume of water treated (in litres)	3	5	6	6	6

The amounts of aluminium present in the effluents were negligible.

TABLE 3

Efficiency of the ion-exchange material prepared from groundnut shell in removing fluorine from water

Lot No.	Amount of fluorine in the effluent (p. p. m.)				
	1st cycle	2nd cycle	3rd cycle	4th cycle	5th cycle
1.	0.2	0.2	0.1	0.1	0.1
2.	0.7	0.4	0.3	0.2	0.4
3.	0.7	0.5	0.6	0.6	0.7
4.	0.8	0.6	0.7	0.8	0.8
5.	>1.0	0.8	0.8	0.8	0.8
6.	—	0.9	0.8	0.9	>1.0
7.	—	>1.0	>1.0	>1.0	—
Blank	2.4	2.5	2.5	2.6	2.6
Volume of water treated (in litres)	4	6	6	6	5

The amounts of aluminium present in the effluents were negligible.

TABLE 4

Efficiency of the ion-exchange material prepared from waste coir fibre in removing fluorine from water.

Lot No.	Amount of fluorine in the effluent (p. p. m.)				
	1st cycle	2nd cycle	3rd cycle	4th cycle	5th cycle
1.	0.3	0.1	0.2	0.3	0.4
2.	0.7	0.3	0.2	0.4	0.7
3.	0.8	0.6	0.5	0.4	0.7
4.	>1.0	0.7	0.6	0.7	0.8
5.	—	0.9	0.8	0.8	>1.0
6.	—	>1.0	>1.0	>1.0	—
Blank	2.6	2.5	2.5	2.4	2.5
Volume of water treated (in litres)	3	5	5	5	4

The amounts of aluminium present in the effluents were negligible.

It may be seen from the Tables 1 to 4 that 20 gms. of the carbons prepared from tea waste, jute waste, groundnut shell and waste coir fibre could treat 3 to 7, 3 to 6, 4 to 6, 3 to 5 litres of water respectively (i. e., 1 lb. of the materials could treat about 15 to 35, 15 to 30, 20 to 30 and 15 to 25 gallons of water respectively) before toxic amounts of fluorine came through.

SUMMARY

The carbons prepared from a few waste materials were further treated with alum. The treated carbons were examined for their efficiency in removing fluorine from tap water to which a known amount of sodium fluoride was added. The experimental observations indicate the possibility of utilising such carbons in the treatment of fluoride-bearing waters.

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A CEMENT PLANT NEAR BHILLAI STEEL WORKS

It is learnt from a report that preliminary steps have been taken for the establishment of a cement factory near the steel plant at Bhillai. This factory reportedly will produce cement by the "Dry process" (as opposed to the wet process) as a bye-product of the production of steel. The dry process cement is reported to be cheaper. The proposed cement factory will get its limestone from Deorjhal, electricity from Korba and sand and clay from Rasmada.

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A CENSUS OF IRON & STEEL FACTORIES IN INDIA

According to a census of manufacturing industries, there were altogether 131 iron and steel smelting, rolling and re-rolling factories in India during 1954 which included three big producers of Iron and Steel viz; Tata Iron & Steel Co., Indian Iron & Steel Co., and the Government Steel Works in Mysore. Total productive capital employed in the industry was Rs. 70.19 crores comprising a fixed capital of Rs. 35.9 crores and a working capital of Rs. 34.29 crores.

The industry employed altogether 85,600 persons who received Rs. 18.13 crores as salaries, wages and other benefits.

During the year, the industry consumed fuels, electricity and lubrications worth Rs. 8.8 crores of which Rs. 6 crores was spent on coal. In addition, purchase of raw materials such as iron ore, spelter, iron and steel etc. increased the industry's expenses by Rs. 30.79 crores.

The value of goods produced by the industry in 1954 was placed at Rs. 8.072 crores of which finished steel products accounted for Rs. 64.38 crores; Blooms, Billets and Slabs for Rs. 6.81 crores; pig iron for Rs. 3.38 crores and others for Rs. 12.45 crores.

After allowing for depreciation and other charges, the value added by manufacture was estimated at Rs. 42.36 crores.

Driving Motors for Textile Industry

Messrs. Veb Elektromotorenwerk's contribution to the Electrical Industries.

By A German Technical Correspondent

VEB Elektromotorenwerk, Grunhain, German Democratic Republic, one of the oldest manufacturers of Electrical Motors for Industrial purposes, besides various other equipments and machineries, have increased recently their export potentiality in this respect.

Everywhere, where technical engineering calls for utmost economy of regulating drives, there is a widespread application of rotor-feed three-phase shunt motors on three phase mains; because of its adjustability free from losses and of its high efficiency, remaining constant all over the regulating range.

Constant and practically no loss adjustment of the speed, high efficiency, strong starting torque even on low speed, insignificant speed drop on load, high power factor, low starting current and simple way of operation, these and other factors that are of importance for electric textile machine drives.

DRIVE TO COTTON RING SPINNING FRAME

The following three-phase shunt commutator motor is used for driving a spinning frame with a maximum of 500 spindles:

Type SPM 8,5/6 — Voltage: 220, 380 or 500 volts
Capacity: 4.1/10.6 HP. — (other voltages, if desired)
Speed: 500/1250 RPM. — Net weight: 742 lbs.

The speed of this motor is infinitely variable and can be controlled almost without any loss. The variation of the motor speed to suit the spinning process is easily effected by means of a thread tension regulator mounted on to the motor and controlled by the spinning frame. The motor is an all-enclosed one, has its own ventilator, and is arranged for connecting on to the ventilating channels. The power from the motor is transmitted over a flexible leather ring coupling. This guarantees a smooth setting into operation of the spinning frame. An auxiliary switch coupled to the brush-adjusting lever enables the motor to be started with only the lowest speed, thus guaranteeing a smooth start.

WORSTED YARN RING SPINNING FRAME

Two of the following three-phase shunt commutator motors fed on to the rotor and equipped with a built-on spur gear, are used for driving a spinning frame with a maximum of 400 spindles:

Type SPMG 6,8/6 — Voltage: 220, 380 or 500 volts
Capacity: 2,05/9.3 HP. — (other voltages, if desired)
Motor speed: 360/1440 RPM. — Net weight: 750 lbs.
Gear speed: 230/920 RPM.

The speed of this motor is infinitely variable and can be controlled almost without any loss. The variation of the motor speed to suit the spinning process is easily effected by means of a thread tension regulator mounted on to the motor and controlled by the spinning frame. The motor is an all-enclosed one, has its own ventilator, and is arranged for connecting on to the ventilating channels. The power from the motor is transmitted over a flexible leather ring coupling. This guarantees a smooth setting into operation of the spinning frame. An auxiliary switch coupled to the brush-adjusting lever enables the motor to be started with only the lowest speed. This, together with a special starting switch, ensures a specially smooth start. A reversing switch is incorporated, which facilitates the reversal of the direction of rotation. This makes it possible to spin yarns with right-handed and left-handed twists.

WORSTED YARN RING SPINNING FRAME

Two of the following three-phase shunt commutator motors fed on to the rotor and equipped with a built-on spur gear, are used for driving a spinning frame with a maximum of 400 spindles:

Type SPMG 6,8/6 –S 1 — Voltage: 220, 380 or 500 volts
Capacity: 2.05/9.3 HP. — (other voltages, if desired)
Motor speed: 360/1440 RPM. — Net weight: 750 lbs.
Gear speed: 400/1585 RPM.

The speed of this motor is infinitely variable and can be controlled almost without any loss. The variation of the motor speed to suit the spinning process is easily effected by means of a thread tension regulator mounted on to the motor and controlled by the spinning frame. The motor is an all-enclosed one, has its own ventilator, and is arranged for connecting on to the ventilating channels. The power from the motor is transmitted over a flexible leather ring coupling. This guarantees a smooth setting into operation of the spinning frame. An auxiliary switch coupled to the brush-adjusting lever enables the motor to be started with only the lowest speed. This, together with a special starting switch, ensures a specially smooth start. A reversing switch is incorporated, which facilitates the reversal of the direction of rotation. This makes it possible to spin yarns with right-handed and left-handed twists.

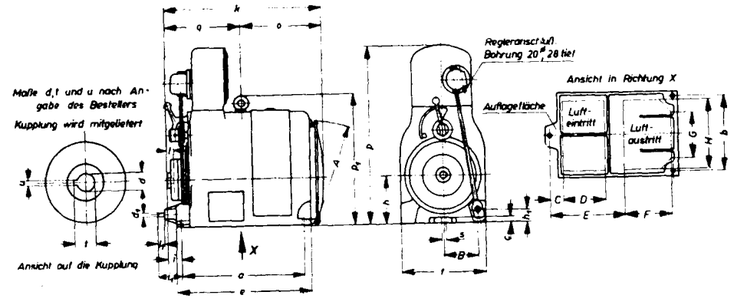
All the spinning frame motors mentioned here can also be supplied with a simple thread tension regulator, which is arranged only for the fundamental regulation, and, if desired, without the tension thread regulator.

COTTON LOOMS

The following three-phase shunt commutator motor fed on the rotor is required for driving a cotton loom with a maximum of 28 working points:

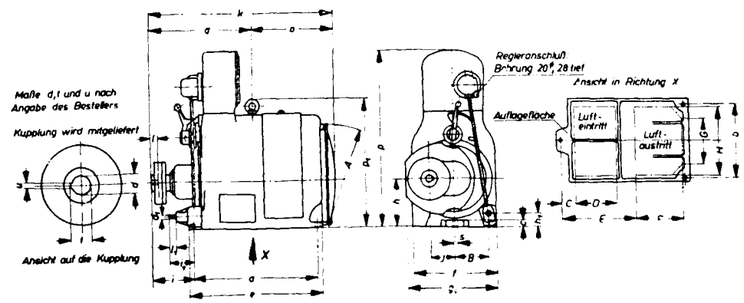
Type CDM 727—Sp 1 — Voltage: 220, 380 or 500 Volts
Capacity: 0,27/3,4 HP. — (other voltages, if desired)
Speed: 100/2100 RPM. — Net weight: 360 lbs.

The variation of the motor speed is controlled by the cotton loom by means of a special coupling brought on to the motor.



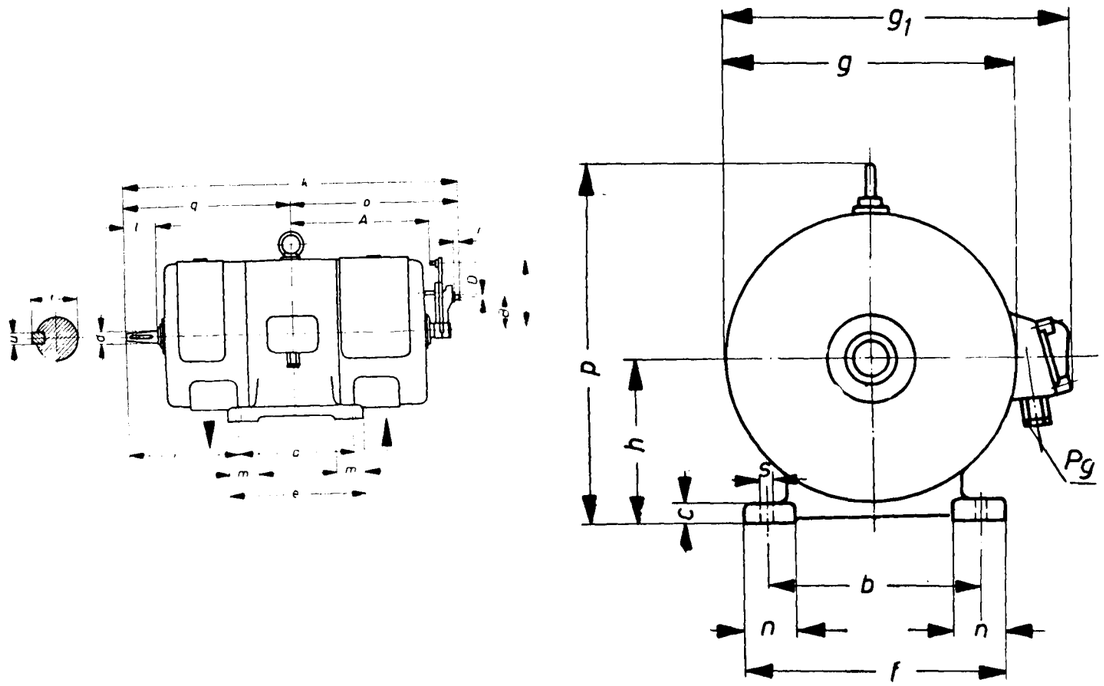
1) Top view on the coupling. 2) Controller joint: Bore ⌀ 20, depth 28. 3) View in the direction of x. 4) Supporting surface. 5) Air intake. 6) Air outlet. – Measures d, t, and u according to the statements of the purchaser. Coupling will be delivered simultaneously.

Type	a	b	c	d1	e	f	h	h1	i	i1	k	l	l1	o	p	p1	q	s	A	B	C	D	E	F	G	H
SPM	8,5	6	632	370	30	16	677	450	240	63	75	110	795	52	25	425	900	656	370	22	495	173	75	215	385	240	230	350

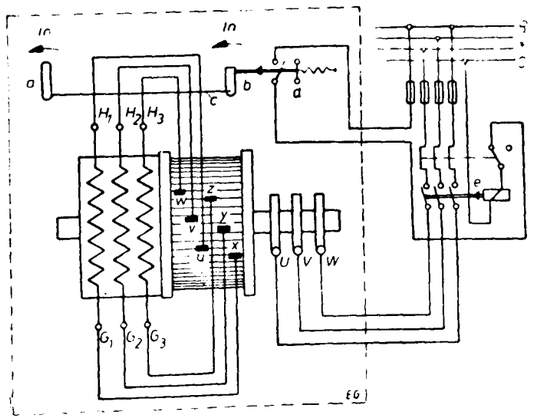


1) Top view on the coupling. 2) Controller joint: Bore ⌀ 20, depth 28. 3) View in the direction of x. 4) Supporting surface. 5) Air intake. 6) Air outlet. – Measures d, t, and u according to the statements of the purchaser. Coupling will be delivered simultaneously.

Type	a	b	c	d1	e	f	g1	h	h1	i	i1	k	l	l1	o	p	p1	q	s	A	B	C	D	E	F	G	H	I
SPMG 6,8	6	632	370	30	16	677	450	460	240	63	214	110	939	52	25	425	900	656	514	22	495	173	75	215	385	240	230	350	120



1) Section through the shaft end in the centre of the fitting spring 2) Air outlet 3) Air intake.



The design for this motor corresponds to the requirements of the textile industry. The motors have a smooth outer surfaced and can, therefore, be easily cleaned of the dust and flying threads which adhere them during the operation. They are provided with large-size service openings, which facilitate an easy maintenance of the motors.

Tropical finish : The motors type SPM and SPMG can also be supplied with a tropical finish.

They are then suitable for a cooling medium temperature from 0–50°C and a relative humidity of the air upto 40%. The machines are further protected against drip water and salt-containing atmosphere.

1. Design, method of operation, and operating characteristics of the rotor fed three-phase shunt commutator motors:

a) Design :

The motor rotor incorporates a three-phase winding, which is connected to the slip rings and is feed from the supply circuit. Over this winding and in the same slots is located a direct current winding, whose ends are connected to a commutator. The voltage of the appropriate frequency and phase collected by two adjustable brush rings, which rotate in directions opposite to each other and which are situated at the commutator, is connected by very flexible cables to the three-phase windings in the stator. The adjustment of the brush-rings and thereby the regulation of the speed can be

effected either by hand over a hand-wheel by means of a motor driven remote control attachment or over a special control.

b) Method of operation

The commutator winding is laid out as a standard direct current, drum winding for satisfactory commutation. The commutator winding is situated in the same slots as the three-phase winding fed from the supply circuit but entirely electrically separated from the latter. Both the windings are linked together in a transformer manner. In the three-phase winding is generated a rotating field, which induces a voltage in the commutator winding, which, with the usual motors depending on the method of laying in, amounts to 80 volts.

The ends of the three-phase winding situated in the stator are led on to the brushes by means of highly flexible cables. The brushes pertaining to the beginnings and the ends of the same winding are held by separate brush carrier rings. The brush carrier rings can be adjusted in opposite direction.

The minimum and maximum speed of the motor depends on the ratio of the maximum regulating voltage to the standstill voltage of the stator, and these on the laying in of the windings. If, for example, it is proposed to regulate the speed of a motor from 50 to 150% of its synchronous speed, which corresponds to a regulating range of 1 : 3, then the regulating voltage should be half as much as the standstill voltage of the stator. Usually the rotor-feed three-phase motors are arranged for a regulating range of 1 : 3. The greater range of regulating, is however, possible. It should always be remembered that a magnification of the regulating range leads to a diminution in the type capacity of the motor.

2. The thread tension regulator

a) Advantages of a thread tension regulator

Should the spinning process take place at a constant speed, then the tension of the thread varies, when it is wound on a coil, because of the variation in the coil diameter. The winding up of the thread is done in tapered layers. The large winding diameter corresponds to a small thread tension, whereas a small winding diameter to a large tension of the thread.

The results of this are :

1. Many breakages of the thread, mainly when finishing the spinning.
2. uneven thickness of the yarn giving rise to :
3. incomplete utilisation of the spinning space.

Having regard to the diminution of the yarn breakages during the finishing spinning, one is compelled to choose the constant speed at a lower value than is necessary in the case of a continuous spinning process.

All these disadvantages of spinning at a constant speed are done away with, when the drive to the spinning frame is by means of an infinitely variable speed motor, and the motor has its speed regulated by means of a spinning frame through the incorporated thread tension regulator.

The spinning is commenced in this case at a correspondingly lower speed, which can be abjusted on the motor, so that it results in the minimum yarn breakage. After the spinning has commenced, the speed can be increased to the extent it is possible, having regard to the number and quality of the yarn.

The variable thread tension is reduced to a constant value, because the motor speed and thereby the spindle speed is continuously varied, to suit the stroke of the ring bench. A too high thread tension is reduced by reducing the motor speed, and a too low thread tension is enhanced by increasing the speed of the motor.

The advantages obtained by using the thread tension regulator are as follows :

Excellent and uniform properties of the yarn (rigidity, flexibility, and hardness of coil winding), greater quantity produced than in the case of spinning at a constant speed, better quality of yarn and lowering of the frequency of yarn breakage, approximately uniform distribution of yarn breakage, while finishing the spinning.

These advantages very favourably affect the spinning process, as also the manufactured products.

Principal switches

a) Hand operated adjusting lever

b) Trip cams

c) Brush adjusting shaft

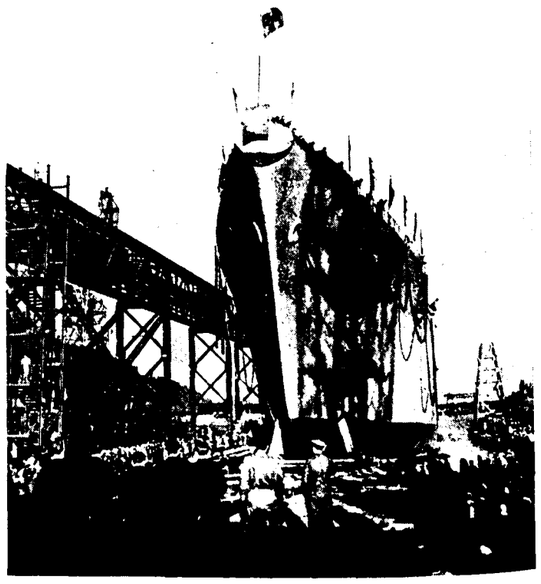
d) Tapped type limiting switch for the control current

e) Motor isolating switch

M/s. Centromor's Contribution to Ship Building Industry

"Launching of the first 10.000 TDW M/s. Marceli Nowotko"

THE first cargo ship 10.000 TDW, m/s. " Marceli Nowotko ", was recently launched at one of the Polish Shipyards. Built by the famous Polish manufacturers of ships, Messrs. Centromor, Warsaw, this first cargo ship in 10.000 TDW category, is now on her voyage to Singapore.



GENERAL ARRANGEMENT AND EQUIPMENT

The vessel is a modern motor cargo liner, built as an open shelter decker in accordance with the rules and under special survey of the Register of Shipping of U. S. S. R. for the classification ⚓ ★ P ⅄ C (strengthened for navigation in ice). The ship is principally designed for general cargo with a capacity—total deadweight ratio of 63.7 cu. ft./t for grain and 60.1 cu. ft./t for bales. Two deep tanks for vegetable oil are provided. The action radius amounts to 20,000 miles.

The hull is devided into 9 W. T. compartments. Three large holds are for'd and two aft of the engine room. All living compartments are amidships. The hull is of welded construction. The only riveted connections are the stringer bar of the shelter deck and the upper seam of the bilge strake. The frame spacing amounts amidships to $30\frac{1}{16}$ in. (770 mm.), from the collision bulkhead to frame 155—27 in. (685 mm.) and $23\frac{5}{8}$ in. (600 mm.) in the peaks. There are no pillars in the holds, but longitudinal centre line bulkheads are mounted from the transverse bulkheads to the hatch ends. The hatches on the shelter deck have steel covers. A Simplex rudder is operated by an electro-hydraulic steering gear. Luxurious cabins are provided for 12 passengers. The crew's accommodation is of highest standard.

PROPELLING AND AUXILIARY MACHINERY

The vessel is propelled by an eight cyl. double acting, two stroke, direct coupled FIAT Diesel engine, type 688 D, with a cyl. bore of $26\frac{3}{4}$ in. (680 mm.), stroke $47\frac{1}{4}$ in. (1,200 mm.) and an output of 8,000 BHP at 125 r. p. m. The fuel consumption under normal conditions amounts to 0.364 lbs./HPh (165g/HPh). 220 V D. C. is supplied by three 240 kW sets and one emergency diesel-generator-compressor set of 15 kW.

Steam at a pressure of 100 lbs./sq. in. (7 at) is generated by an exhaust gas boiler with an output of 1.2 t/h, resp. 2.0 t/h, when additionally oil-fired.

ACCOMMODATION

NAVIGATION DK. : Wheelhouse - wireless station - chart room - accumulators - radar

BOAT DK. : Captain's suite - 2 single off's cab's - 1 double off's cab'n - lav. - 3 stores - gyroalternators - emergency set - 2 thermotanks - telephone exchange - accumulators

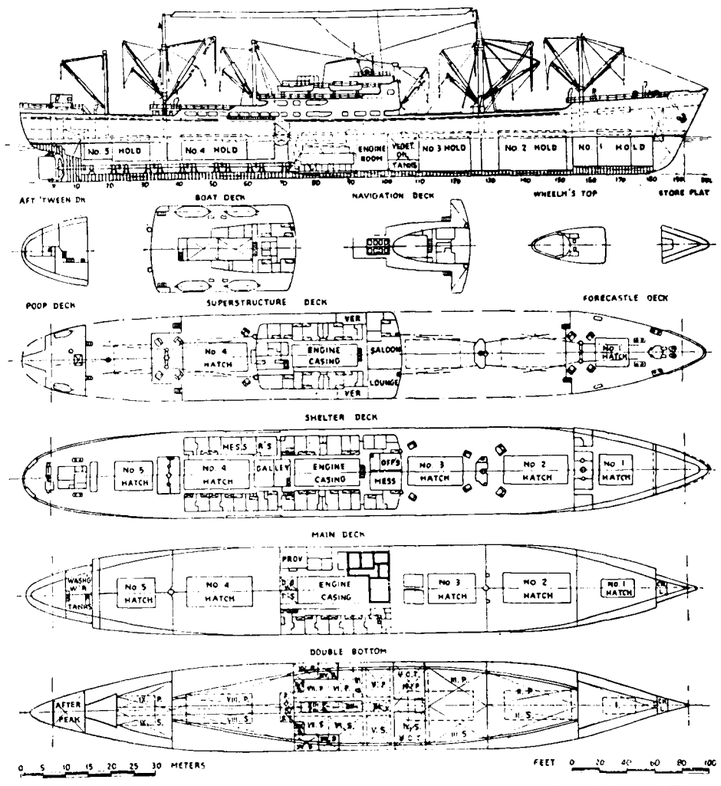
SUPERSTRUCTURE DK. : Suite de luxe - 2 single pass. cab's - 4 double pass. cab's - pass. lounge, saloon & pantry - bathroom - verandahs - chief eng. suite - 3 single off's cab's - office - hospital - dispensary - linen - lav

SHELTER DK. : Chief officer's suite - 13 single off's cab's - off's mess & lounge - 4 single crew's cab's - 6 double crew's cab's - 2 crew's messes & recreation r'm - 2 pantries - galley - 4 offices - 4 lav's 8 stores - CO_2 - contactors

'TWEEN DK. : Chainlkr - 2 bosun's stores - mail r'm - cargo lkr - laundry - dry'g r'm - dirty linen

MAIN DK. : 6 double crew's cab's - 2 triple crew's cab's - lav - dry provision - beer - bonded store - 6 refrigerated chambers - refr. set - bosun's store - aft chain lkr - steering gear

MOTOR CARGO LINER 10 000 T. DW.



PRINCIPAL DIMENSIONS AND OTHER LEADING CHARACTERISTICS

Length overall	504 ft. 11 in.	153.90 m
Length B. P	464 ft. 7 in.	141.60 m
Breadth mld.	63 ft. 8 in.	19.40 m
Depth to main deck	31 ft. 2 in.	9.50 m
Depth to shelter deck	41 ft. 2 in.	12.55 m
Design draught	27 ft. 4 in.	8.34 m
Corresponding deadweight, tons	10,000	
Gross tonnage	7,589	
Net tonnage	4,012	
Cargo capacity, bale	600,920 cu. ft.	17,016 cu.m
Cargo capacity, grain	636,595 cu. ft.	18,026 cu.m
B. H. P.	8,000	
Corresponding r.p.m.	125	
Service speed, knots	16	

WEIGHTS IN METRIC TONS - ALL PARTICULARS BELIEVED TO BE CORRECT BUT NOT GUARANTEED

CARGO HANDLING GEAR

Deck	Hatch	Dimensions ft. – in.	Dimensions m.	Derricks No.	Derricks Support	Derricks Cap. tons	Length ft. – in.	Length m.	El. winches No.	El. winches Cap. tons
Forec'le	No. 1	24 – 8 × 21 – 4	7.52×6.5	2	Derrick posts	5	57 – 5	17.5	2	5 – 3
Shelter	No. 1	24 – 8 × 21 – 4	7.52×6.5							
Main	No. 1	24 – 8 × 12 – 5	7.52×3.8							
Forec'le				2	Derrick posts	5	59 – 1	18.0	2	5 – 3
Shelter	No. 2	47 – 1 × 21 – 4	14.36×6.5	2	Fore mast	10	55 – 9	17.0	2	10
Main	No. 2	44 – 7 × 21 – 4	13.59×6.5	1	Fore mast	50	59 – 1	18.0		
Shelter	No. 3	39 – 5 × 21 – 4	12.30×6.5	2	Fore mast	5	55 – 9	17.0	4	5 – 3
Main	No. 3	35 – 5 × 21 – 4	10.80×6.5	2	Derrick posts	5	39 – 5	12.0		
Main	No. 3	2x14–6 × 9 – 6	2x442×2.9							
Superst'r	No. 4	47 –10 × 21 – 4	14.60×6.5	2	Derrick posts	5	47 – 7	14.5	4	5 – 3
Shelter	No. 4	47 –10 × 21 – 4	14.60×6.5	2	Main mast	5	57 – 5	17.5		
Main	No. 4	47 –10 × 21 – 4	14.60×6.5	1	Main mast	25	59 – 1	18.0		
Superst'r							55 – 9	17.0	2	5 – 3
Shelter	No. 5	27 – 8 × 21 – 4	8.45×6.5	2	Main mast	5				
Main	No. 5	27 – 8 × 21 – 4	8.45×6.5							
Poop	Locker	8 – 2 × 5 –10	2.50×1.8							
Shelter				1	Derrick post	1.5	42 – 8	13.0	2	1 . 5

CARGO CAPACITIES

Compartment		Frames	Capacity Grain cu. ft.	Grain cu. m.	Bale cu. ft.	Bale cu. m.
Hold	No. 1	155 – 181	33,445	947	30,300	858
'Tweendeck	No. 1	155 – 181	32,420	918	29,380	832
Forec'le 'tweendeck	No. 1	161 – 182	15,575	441	14,090	399
Hold	No. 2	128 – 155	92,915	2,631	88,290	2,500
'Tweendeck	No. 2	128 – 155	48,595	1,376	46,155	1,307
Hold	No. 3	110 – 128	75,080	2,126	72,045	2,040
'Tweendeck	No. 3	100 – 128	47,285	1,339	45,380	1,285
Hold	No. 4	37 – 72	124,380	3,522	118,445	3,354
'Tweendeck	No. 4	37 – 68	53,430	1,513	50,855	1,440
Hold	No. 5	12 – 37	34,890	988	32,205	912
'Tweendeck	No. 5	16 – 37	35,245	998	32,525	921
Mail locker		25 – 14	2,365	67	2,120	60
Cargo locker		4 – 14	4,240	120	3,815	108
Total for dry cargo			599,865	16,986	565,605	16,016
Cargo tanks P. a. S.		101 – 110	36,730	1,040	35,315	1,000
Total			636,595	18,026	600,920	17,016

TANK CAPACITIES

Compartment	Frames	Capacity, cu. m. water ballast	Fuel oil	Lub. oil	Fresh water
Double bottom					
No. I	155 — 180	135	135	—	—
No. II P. and S.	128 — 155	261	261	—	—
No. III P. and S.	111 — 128	241	241	—	—
No. IV P. and S.	101 — 111	149	149	—	—
No. V P. and S.	93 — 100	—	—	—	92
No. VI P.	82 — 89	46	46	—	—
No. VIa	89 — 92	20	20	—	—
No. VI S.	82 — 92	66	66	—	—
No. VII P. and S.	72 — 82	127	127	—	—
No. VIII P. and S.	37 — 71	468	468	—	—
No. IX P.	21 — 37	160	160	—	—
No. IX S.	21 — 37	139	139	—	—
No. X S.	98 — 100	—	—	3	—
No. XI	94 — 100	—	—	14	—
No. XII	85 — 94	—	—	20	—
No. XIII P. and S.	72 — 85	—	—	29	—
No. XIV P. and S.	79 — 85	—	275	—	—
No. XV P. and S.	72 — 79	—	320	—	—
No. XVI P. and S.	72 — 75	—	95	—	—
Total double bottom		1,812	2,502	66	92
Fore peak	181 — stem	57	—	—	—
After peak	1 — 12	—	—	—	133
F. O. Daily supply tanks	68 — 72	—	45	—	—
Drinking water tanks	68 — 73	—	—	—	56
Washing water tanks	5 — 14	—	—	—	123
Total		1,869	2,547	66	404

EQUIPMENT

3 bower stockless anchors (1 spare), of 89 cwt. (4.5 tons) – 1 stockless stream anchor of 35 cwt. (1.75 tons) – 1 Admirality type anchor of 30 cwt. (1.5 tons) – stud link chain cables. 2 – 164 fths. (300 m.) $2\frac{5}{8}$ in. (67 mm.), 1 – 136 fths. (250 m.) $1\frac{7}{8}$ in. (37 mm.) – 9 s.w. ropes, total length 1005 fths. (1840 m.) – 6 manila hawsers.

Large Rotary Pump for Oil Handling

IT is a long jump from the making of wooden ploughs some 165 years ago to the present manufacture of rotary pumps, known and used all over the world.

The story of Plenty & Son Ltd. of New Bury covers a long and varying engineering experience. The company still possess the papers and drawings of a humble millwright, William Plenty, who founded the business as an agricultural engineer in 1790, when George III was King.

The Plentys were nothing if not enterprising for in the following reign the firm produced a patent lifeboat of a type which was later to be supplied to the Royal National Lifeboat Institution for service at many points on our coasts. The brothers James and Edward Plenty were awarded third prize for their lifeboat out of 250

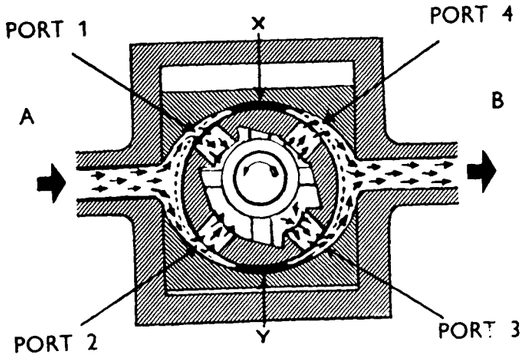


Fig. 1 A

The pump in action with flow from A to B.

entrants in a competition sponsored by the Duke of Northumberland and this same design won a bronze medal at the Hyde Park Exhibition in 1851.

The opening of the Kennet and Avon Canal, which passes through Newbury, and the continued success of the lifeboats, no less than the Plenty spirit of enterprise, started the firm on the manufacture of marine steam engines. Plenty engines have been supplied for service in Venice, for the ferries between Hong Kong and Kowloon, for tugs in India, for vessels operating from Bermuda to the Sudan and from Bristol to Buenos Aires.

During the First and Second World Wars many sets of propulsion machinery were produced for Royal Navy frigates and corvettes together with other miscellaneous machinery for naval auxiliary vessels. It is a matter of pride to the firm that Plenty engines were supplied for the first practical submarines. This project was sponsored by Mr. Nordenfeldt in 1885/87 and the two submarines were ultimately sold to the Turkish Navy.

To-day, Plenty marine propulsion machinery up to 2,500 i. h. p. is manufactured for the Admiralty, the British Tanker Company Ltd., Shell Tankers Limited and very many British and overseas ship-owners. Plenty service, to the ship-builders at home and abroad, embodies the supply of the complete propulsion equipment from funnel to propeller.

Messrs. Plenty & Son Ltd. have supplied 'J' Type 'Universal' Pumps for the Burmah Shell Refinery at Bombay. The capacity of this pump is 915 gallons per minute, at 140 r. p. m. when absorbing 250 B. H. P. This output can be maintained with a variety of oils ranging in viscosity from 50 seconds Redwood No: 1 at 100°F, to 1,100 seconds Redwood No: 1 at a delivery pressure of 200 lbs. per sq. inch. Oils up to 20,000 seconds Redwood No: 1 with pressures up to 300 lbs. per. Sq. inch can be handled when the Pump will absorb about 400 B. H. P. The Prime Mover is a Blackstone 'EV6' Engine developing 250 H. P. at 600 r. p. m. The Drive consists of two—V-rope Pulleys 18.¼" and 77.3/8" pitch circle diameter holding 18 V-ropes supplied by Messrs. Frank Wigglesworth & Co., Ltd. The Pump can develop 26.5" mercury vacuum, and is entirely self-lubricating. On top of the Pump is fitted a Plenty full bore Relief Valve which can

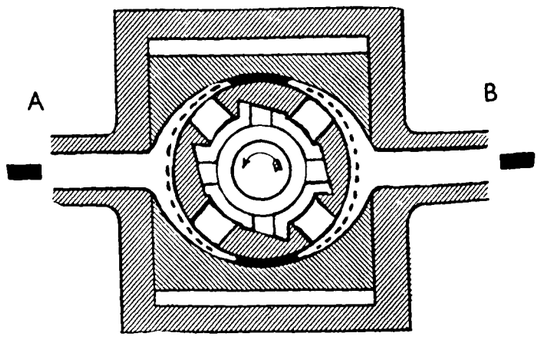


Fig. 1 B.

The working parts concentric, no pumping action and driving equipment free from load.

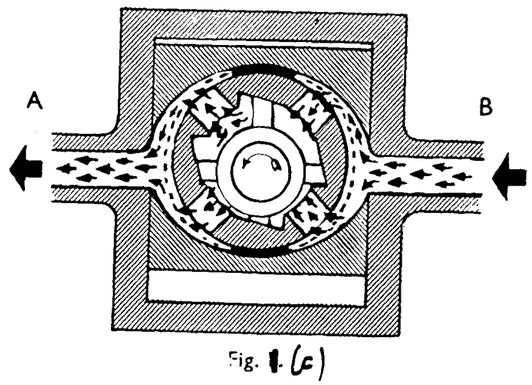


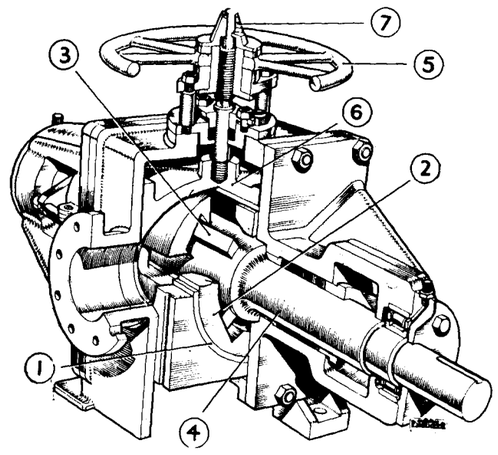
Fig. 1 (c)

Flow reversed by raising the sliding block: direction of rotation of driving shaft unchanged.

be adjusted to byepass the oil at any pressure between 50 and 500 lbs. per sq. inch.

The design of the Plenty Universal pump allows for reversible and infinitely-variable flow. The main body of the pump has the suction and delivery branches mounted in the horizontal plane. Inside the main body there is a sliding block which can be raised or lowered relative to the shaft centre line. The cylindrical rotor, which is mounted in this block and rotates in a specially ported liner, has four rectangular ports 90 degrees apart. This rotor acts purely as a distributor; it is turned by blades on the driving shaft which slide freely in two slots cut through the shaft at right angles. Ball and roller bearings support the shaft concentrically with the main body. As the shaft is turned the blades slide radially in the slots and traverse angled faces in the rotor bore, forming four oil chambers.

The diagrams below show the method of operation of the pump. In Fig. 1a the sliding block is in its lowest position, that is, the centre of the rotor is below the centre of the driving shaft and it is this eccentricity which gives the pumping action. With the pump running anti-clockwise, port 1 is increasing in volume and drawing liquid in whilst post 2 has almost reached



A model of the Plenty Universal Pump.

1. Ported Liner, 2. Cylindrical Rotor, 3. Blades sliding in slots in driving shaft, 4. Driving Spindle, 5. Flow control wheel, 6. Sliding inner body, 7. Flow indicator.

(By courtesy of the "Overseas Engineer")

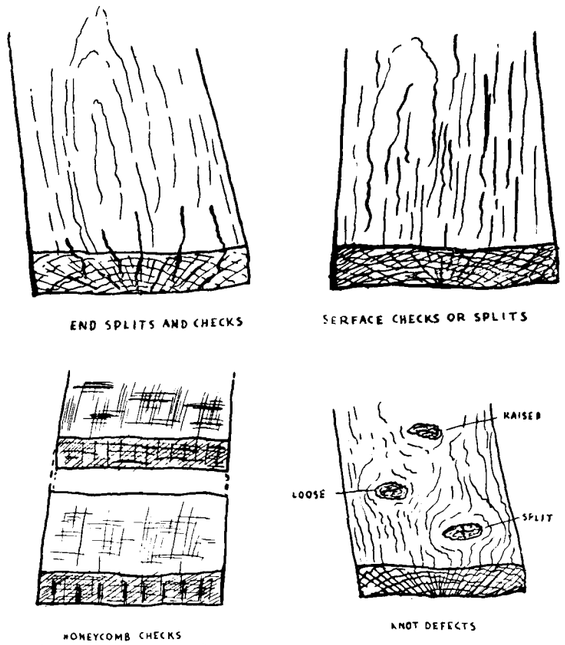
The Plenty Bunkering Pump, "J" Type Universal Supplied to Burmah Shell Refinery at Bombay.

its maximum volume and is about to pass the seal (Y) to the discharge side. Port 3 has passed the seal and is decreasing in volume and port 4 has almost completed discharge. In Fig. 1b the working parts are concentric, with the result that there can be no pumping action. From Fig. 1c it will be observed that the sliding block has been raised to its highest position. The centre of the rotor being now above the centre of the shaft, the flow is reversed, although the direction of rotation remains unchanged.

Thus it can be seen that by varying the eccentricity it is possible to obtain an infinitely-variable flow in either direction from zero to maximum output; further, when the pump is in the neutral position as shown in Fig. 1b the prime mover or driving equipment can be started up free from load.

(Continued on page 90)

A Few Other Examples of Seasoning Defects.



It is due to the fact that wood shrinks or moves so little in the longitudinal direction, that it is so widely used for measuring rules and the like. Because of the radial shrinkage of the timber being always considerably small that quarter-sawn timber is more suitable than slash-sawn for flooring, etc., where movement needs to be at a minimum.

The difference in shrinkage along the three directions is responsible for much, if not all, the warping that takes place in timber. Other forces responsible are of course minor and are mechanical deformation due to bad piling during drying, forces present in the growing tree which are released when timber is cut from it, etc.

A tangentially (flat sawn) or slash-cut plank, will tend to shrink less along the face cut nearer the centre of the tree than on the other, and so naturally tends in drying to become concave at the face away from the centre and convex at the face nearer the centre. This form of deformation is known as cupping and is a natural consequence of unavoidable shrinkage difference taking place radially and tangentially.

If the grain is crooked or twisted or is not truly parallel to the axis of the plank, this distortion effect produced by the radial and tangential shrinkages pulling one against the other will also be apparent in the length causing one or other or a combination of the various forms of longitudinal warping usually known as either spring, bow or twist.

The shrinkage is also responsible for such defects as the splitting and checking that may occur in the process of timber drying. Any piece of timber while drying gives up moisture most freely from its surfaces and the moisture, remote from the surface, has to travel through the structure before it can be evaporated into the surrounding air. Because of the rapid drying of the surface relative to the centre, the surface tends to shrink in advance of the centre. Should the variation in moisture content from surface to centre become appreciable, the surface layers, in attempting to shrink on to the unyielding centre, become stretched and may rupture. Fractures so formed are known as surface splits and checks. Even if fractures do not occur, due to the greater tendency to shrink of the outer layers being resisted by the centre portion, a state of stress develops in the timber in which the outer layers are being pulled and the inner are being compressed. When further drying takes place and this state of affairs is allowed to become too severe—and yet not sufficiently severe as to cause splitting—internal stresses of a more permanent character are set up which reveal themselves only when the dried plank is rip-sawn or machined into thinner boards. This process upsets the balance of internal stresses and the thinner sections cut from the plank then tend to bend or cup. Internal stresses of this nature are known as case-hardening stresses and a plank so stressed is said to be case-hardened.

A test for case-hardening may be made in the following way :—

(a) A section is cut from the timber

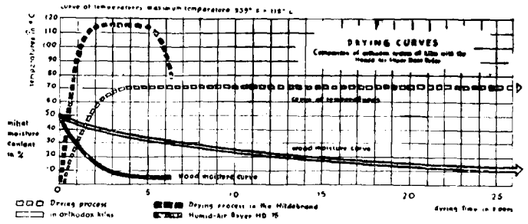
(b) Two saw cuts are made in the section

(c) The centre portion is chipped off

(d) If the prongs spring in, the timber is case hardened.

Probably the most common form of fibre rupture in timber is the end-splitting. This is caused not only due to rapid drying of the timber through the end grains and consequent tendency of the ends to shrink before the timber as a whole, but also due to the introduction of forces due to the difference in radial and tangential shrinkage.

Knots are responsible for a number of drying defects since they shrink most radially where the main piece



shrink least longitudinally and vice-versa. The knot defects generally comprise in split knots, raised knots and loose knots.

Many of these defects that might result from the shrinkage of timber may be minimised in intensity or entirely avoided by controlled methods of drying, and the object aimed at in the proper seasoning of timber is to reduce the moisture content to such a value with the minimum of degrade that little further movement and consequent troubles will take place in service.

There is a fairly definite relationship between the moisture content of most timbers and the conditions of the surrounding air with regard to the temperature and humidity. Wood being a hygroscopic material, continues indefinitely to pick up and lose moisture in accordance with changes in atmospheric conditions. The practice followed in seasoning timber is to dry it to a moisture content which corresponds with the average of the fluctuating temperature and humidity conditions to which it is likely to be subjected.

METHODS OF SEASONING

The two common methods of seasoning timber are : air-drying and Kiln drying. While the former is often referred to as natural seasoning and the latter artificial seasoning, both employ air as the drying medium with the only difference that in the case of the latter the condition of the air is at all times controlled and regulated to suit the timber.

Timber has been air-seasoned from time immemorial as the great advantage of air-seasoning lies in the fact that no special apparatus is required.

In this case, sawn timber is usually stacked in the open in horizontal layers, each separated by transverse piling stocks. The method of stacking depends considerably on the sizes to be dried and on the ultimate use to which the timber is to be put.

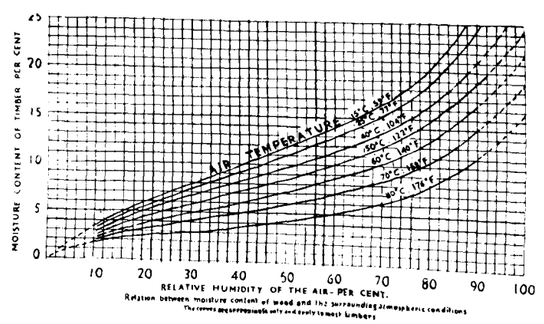
The following factors are to be considered in constructing air seasoning pile :—

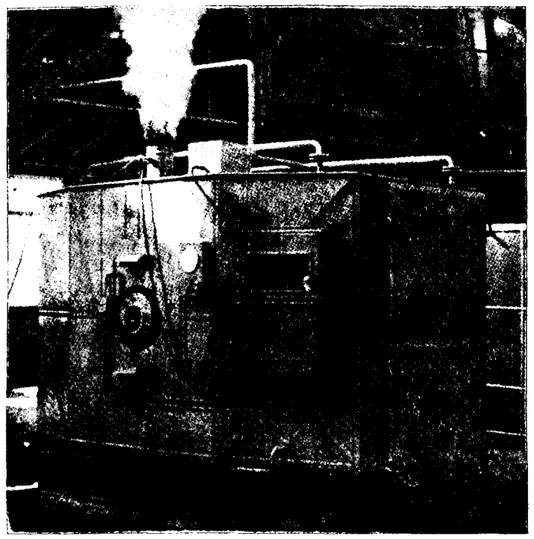
(a) The Site— It should be level, well-drained ground with all weeds and grass removed and if possible a layer of ashes spread.

(b) Foundations— The foundations should be firm and strong and in order to permit ample ventilation, the bottom layers of timbers are to be raised between 18″ to 32″ clear of the ground with the help of piers of bricks or concrete piers which should be laid in three lines at 2—feet centres. A good foundation is always essential in order to avoid the accumulation of damp air beneath the pile and to impede harbour insects or fungi.

(c) Piling sticks— The employment of these sticks, two sizes of which are generally required viz., 1″×1″ and ½″×¾″ for the separation of the layers of timber, is greatly advantageous not only from the view point of a free circulation of air but also in restraining some of the warping that is liable to occur. Vertical rows of sticks should be formed at intervals not too wide and each should be fully supported from the ground and in absolute vertical alignment. The spacing should be generally of 2 feet apart but in some cases it may be as little as 9 inches apart depending upon the thickness of the timber and its liability to warp.

(d) Roof— Pile under cover obviously will not require any roof but when it is in the open some overhead protection is desirable for keeping off heavy rain and scorching heat of the mid-day sun. The usual practice is to provide the pile with weather-board roof suitably sloped to carry off the water and well overhanging the pile.





External View of a Humid Air Dryer.

(e) Size of Pile— As a rule a stack should not be much wider than 6 ft. but the height is limited only by stability and case of piling. When piling the timber, sticks should be placed on all the cross bearers previously spaced to suit the arrangement of sticks to be adopted. A gap of 1" should be allowed between adjacent boards or planks to permit the air to pass both vertically and horizontally through the pile.

CONTROL THE DRYING

Success or failure in air-drying depends to a great extent on the weather. The only control that can be made in this connection is that by employing different sizes of piling sticks the drying is either accelerated or retarded by providing optimum ventilation or restricting the flow of air over the timber.

In air drying, it is common and sound practice to cut and stack green hardwoods in late autumn or early winter. This ensures that in such woods, in which moisture does not travel readily from centre to surface, because of their structure being more complicated and dense, the rate of withdrawal of moisture from the early stages of drying will not be so rapid as to form a dry skin sufficient to cause fractures.

The amount of drying that will normally take place in the autumn and winter months will in effect be insufficient to set up a sufficiently steep moisture gradient to cause the timber to split, and by the following spring and summer, the timber will be better able to withstand the more severe drying conditions imposed.

In the case of soft woods which are relatively fast driers and more tolerant of severe drying conditions, summer piling is desirable from the staining aspect.

In case of such timber as Semul or Salai, which are extremely liable to the rapid formation of mould or blue stain, vertical seasoning i. e. placing the planks upon ends against a horizontal support for a week or two after conversion, should first be resorted to, before stacking them horizontally to follow the normal procedure of air seasoning.

End-splitting or checking is a defect very likely to occur with any timber while air-seasoning. The best method of dealing with this trouble is to protect the ends with a moisture resistant paint. The best paint for the purpose is known as hardened Gloss Oil developed by the U. S. Forest Products Laboratory, Madison, Wisconsin, U. S. A. This gloss oil is made "by thoroughly mixing 25 parts (by weight) of barytes and 25 parts of magnesium silicate with 100 parts of a hardened gloss oil made according to the following formula : Resin 100 parts by weight ; hydrated lime 6 to 8 parts by weight and mineral spirits, 57.8 parts by weight." White lead paint or ordinary coal tar or aluminium paints may also be applied. Other end-protecting methods having merits are : a plater of cowdung mixed with mud, canvas, sheets of scrap plywood and metal or wooden cleats.

KILN DRYING

The essentials of both the Kiln drying and air drying are the same as both use air as a medium for evaporating and removing moisture from the surfaces of the boards. The only real difference lies in the fact that whereas in case of the latter air conditions are uncontrollable, in case of the former it is possible to condition and control air conditions and air circulation by the use of artificial heat.

The greatest advantage of Kiln drying method is that it produces faster drying than air-seasoning because of the following two factors : (1) rapid and positive circulation of air over the surfaces of the timber and (2) use of higher temperature accelerating thereby the movement of moisture from within the timber to the surfaces.

Care is however taken to ensure that at no time the rate of moisture evaporation from the surface greatly exceed the rate of transfusion of moisture to the surface from within the timber. This rate of transfusion may, however, be increased by raising the temperature and it is possible to keep the rate of moisture removal from the surface in step at any temperature by controlling the humidity of the air.

A Kiln seasoning plant comprises a chamber for the placement of timber for drying, complete with the arrangements for circulating air through the timber, heating the air and humidifying it as necessary.

Obviously the same air cannot be continually recirculated through the timber as it would pick up moisture from the timber and get itself saturated or attain humidity in equilibrium with the moisture content of the wood.

This difficulty is got rid of in various ways and they are : (a) introducing fresh air at every cycle, heating the same, passing it through the load and then exhausting it into the atmosphere, (b) Cooling the air as it comes out of the load by contact with cold bodies so as to condense the moisture and drain it and then re-use the same by re-heating and re-humidifying, (c) Venting some of the damp air and introducing the same amount of fresh air. While the method (a) is not economical and results in heat waste, and the method (b) requires some means of artificially cooling the air, the method (c) is generally favoured.

The simplest and most convenient as well, of providing heat in a Kiln is by means of steam heating pipes as by injecting suitable amounts of steam to the circulating air from these pipes, it is possible to humidify the air to any desired degree.

TYPES OF TIMBER-DRYING KILNS

There are two main types of timber-drying Kilns viz. : progressive Kiln and compartment Kiln. In the progressive Kiln the timber travels progressively from one end to the other either on trolleys or conveyor belt through a tunnel type Kiln. The heating units are usually located towards the unloading end, and the air is made to travel from this end to the other via the timber. While in the old days air circulation depended on natural draught, to-day fans are used for the purpose.

In a compartment type Kiln, the timber is held stationary and the air is gradually heated up and dried as the moisture content of the timber falls.

Two types of compartment types are in common use : (a) natural-draught Kiln, (b) forced-draught Kiln.

In the natural-draught type the air-circulation is dependent on the difference in temperature, i. e. hot air rising and cold air falling, as a result of which the rate of circulation is very slow.

The forced-draught kiln makes use of fans for the purpose of circulating the air and depending on whether the air-circulating mechanism is outside or within the Kiln chamber, such Kilns are known as External-Fan Kilns or Inter-Fan Kilns.

Depending on the heating arrangements, the Kilns are again divided into two categories : the steam-heated Kilns and flue-heated Kilns.

The later type specially commends itself to utilising wood scrap and saw dust as fuel since it employs a specially designed furnace suitable for burning saw-dust.

CONTROL OF KILN

Since Kiln drying is effected by passing hot, moist air through the timber stack, the general practice is to vary the temperature and humidity conditions in accordance with a pre-determined schedule, known as Drying Schedule. This schedule is born of experience and based on the current moisture of the timber.

When the timber is green and prone to rapid surface drying and splitting the humidity is kept relatively high. This is generally 80 to 85 per cent to start with for almost all green timbers. As the timber dries and the centres dry out, the humidity is progressively lowered, the finishing range being depending on the final moisture content required.

The temperature on the other hand is kept relatively low while the timber is green and plastic and this is raised only after drying has continued for some time. The principle of kiln drying lies in the fact that humidity controls the surface rate of drying and hence the splitting and the temperature controls the transfusion rate of moisture and consequently distortional degrade. To obtain best results it is imperative that arrangements should be such as to measure both temperature and humidity at any instant and this is done with control hygrometers.

DRYING TIMES

It is not possible to indicate with any exactitude the period that is involved in drying timber in a kiln as much depends on the specy of the timber, the initial moisture content, the final moisture content, thickness of the timber and the temperature applied.

With modern dryers, some of the results actually obtained are quoted below :—

(i) 1″ spruce dried from 30% to 10% in 6 hours
(ii) 1″ spruce dried from 70% to 10% in 10 hours
(iii) 1½″ Walnut dried from 110% to 10% in 47½ hours
(iv) 1¼″ Mahogony dried from 40% to 10% in 39 hours
(v) 2¼″ pine dried from 54% to 10% in 8.8 hours

A few wood moisture percentages as they should be after treatment are as follows :—

Flooring	about 12—14%
doors	about 8%
windows	about 12%
Carpenter's wood	about 8%

In general it has been found from experience that a figure of about 12% is suitable for most timbers destined for indoor use in buildings and 20% for those meant for outdoor use. Timber which will be exposed to weather on one face and to unheated air on the other should be seasoned to a moisture content of about 16 to 18 per cent.

MODERN TIMBER DRYING

In step with the march of time, new plants incorporating the features of high temperature and high pressure have recently been designed and introduced in the continent. These plants are not only capable of reducing the drying time but also can deal with wood sections up to 5 inches.

For example in the type what is known as Humid Air Dryer, the advantage of increasing the drying temperature and entering the temperature of 100 deg. Centigrade and over has been availed of.

This type of air dryer consists of a steel frame and sheet metal which in vapour proof welded and treated on the surface with preservative against corrosion. For drying hardwoods, where acids are extracted during the drying process, the dryers are constructed in aluminium.

The dryer inside contains the heating elements, the fans for the air circulation, the steam spray for humidifying and air deflectors. The insulation consists of glass wool, lined by the outside walls. The dryer is operated on a high air velocity and the air circulation is reversible, as a result of which an equal final moisture content is guaranteed. Further reversible air circulation offers the advantage of wider timber stacks and uniform drying results.

To ameliorate the control and regulation of dry and wet temperature, the dryer is semi-automatically steered with the help of two-needle control instrument.

The dryer can be operated purely as a super Heat Dryer without fresh air but also with air ventilation and humidity control.

The heating system by electricity, consists of heating elements and the heating coils, which are of high frequency wire, are fitted into steel tubes.

The dryer incorporates horizontal air circulation which allows smaller height because of the fans being fitted on to the side-walls. The air passes through the timber stacks twice in one revolution as a result of which the power demand for the fans is very small.

DIFFERENT METHODS OF SEASONING

Among the other seasoning methods are radio frequency heating, the chemical method of seasoning or Salt Seasoning and the Vacuum Drying.

The application of electricity to timber drying has been investigated into from time to time and it has been observed that rapid drying can be achieved by the application of ultra-short waves.

The radio frequency drying, which is a recent innovation operates on the principle that when the timber is exposed to a high frequency electric field, the induced currents cause the wood to heat and dry. This method however suffers from the limitations that it requires a very expensive and complicated apparatus and will make heavy demands upon the electric supply. At present this method is confined to the setting resin glues in laminated and plywood constructions.

In chemical seasoning which consists in introducing into the surface layers of the wood before drying some hygroscopic substance, or salt, the principle involved is that when this salt is dissolved in water, the vapour pressure of the solution is lower than the normal vapour pressure of the water. This means that whereas air which is less than saturated will evaporate water, it will not evaporate moisture from the solution. This will enable the inside to dry in advance of the outside with consequent reduction of the tendency to cause external splits.

The vacuum drying operates on the principle that when air is exhausted from wood, the moisture content can flow out much more readily. This means that if

the timber is placed in vacuum and heat applied to it the moisture will evaporate and pass out readily. The difficulty however arises from the fact that in a vacuum it is virtually impossible to transmit heat for which it is considered that a combination of a vacuum and high frequency drying might prove to be very efficient in evaporating moisture from timber.

It should however be clearly understood that seasoning is not drying only. Had it been so, the process would not have been difficult. To dry wood is not difficult, but to dry it without damaging it is often very difficult indeed.

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ERECTION OF CONSTRUCTIONAL STEELWORK, by Thomas Barron, Iliffe and Sons Ltd., Dorset House, Stamford Street, London, S.E.1., 250 pages, 15 sh/- net.

The erection of steel structures forms one of the most diversified and interesting fields of activity in engineering and no industry can be run without the incorporation of structures in steel. This text specially prepared for the British Constructional Steelwork Association, is a comprehensive, authoritative and an uptodate publication on the subject and should be of great value to students and junior site engineers who have to supervise and superintend the construction of steel structures.

There are in all 17 chapters, a bibliography and an index. The author opens his account with the general organisation of the firms carrying on with this class of work including the duties of the various personnel. The next five chapters cover thoroughly the descriptions and use of tools and tackle required in the job. These cover hand operated and power driven scotch derricks; guy derrick cranes and poles; shear legs; and mobile cranes, such as goliath and loco. cranes; hand and power winches; various types of pulley blocks and jacks; small drills; spanners and wrenches commonly used in steel erection; shackles, grips, wedges and clamps, hemp and wire ropes; and chain slings. Included in these sections is a very practical account of the modes of erection and the best manner in which the foregoing tools and tackles can be used to enable the steelwork to be erected speedily and efficiently. These chapters are followed by two others on the erection of buildings and one on the erection of bridges. The first covers the scope of multi storey buildings, while the second deals with "shed-type" structures. As regards bridge construction, the variety of design renders it impossible to describe the procedure for each and every type and as such a general survey of erections methods is outlined, serving the student to get a clear idea of the work involved.

A large proportion of construction is carried out by bolting or riveting, and these techniques are next taken up for discussion, followed by two chapters on welding and flame-cutting. According to the author it is not a good practice to weld structures after they are erected, since according to him, welding becomes difficult because of the weather, and because welders have to work from scaffolding and must weld joints on steelwork that is already fixed and cannot be turned over as in shops. The reviewer differs from this viewpoint, since he has experience of welding being carried out quite efficiently after structures are erected. The last five chapters deal with miscellaneous topics such as elementary surveying; glazing and fixing of sheets; general estimating and costing; the planning and control of erection work and notes on British Building Regulations. The bibliography is purely limited to B. S. S. and could have included some good books on the subject. Among the topic not covered is the erection of steel cofferdams and sheet piles commonly employed in the construction of hydraulic structures such as docks and wharves.

On the whole it is a good text for site engineers who wish to know the rudiments of steelwork erection.

S. K. G.

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ENGINEERING FLUID MECHANICS, by Dr. Charles Jæger, translated from the German by P.O.Wolf, Blackie and Son Ltd., 17 Stanhope Street, Glasgow, Scotland, 547 pages, 60 sh/-.

This work was first published in German, by Verlag Birkhauser, Basle, in 1949, under the title of Technische Hydraulik, and summarized the lectures given by Dr. Jaeger at the Federal Institute of Technology, at Zurich. This English translation has been read and approved by the author, who has also taken the opportunity of revising the original text and making certain additions to both the text and diagrams in the light of

the intense post-war activity in the field of hydro-electric engineering, in which Dr. Jaeger is an acknowledged authority.

The book covers the methods of analysis and calculation required to design water-power schemes and assumes a knowledge of mathematics above-the-average standard of the engineer. In view of the vast diversity of schemes, the selection of material for incorporation is based essentially on the author's many years personal experience. As a result, the text is divided into four parts, covering successively, the physical basis of hydraulics; hydraulics of steady flow; hydraulics of unsteady flow; and the principles and applications of ground-water flow. The first part contains one chapter and forms an introductory analysis of elements of hydraulics covering such subjects as the physical properties of water, ratios and dimensional parameters, laminar and turbulent flow, laws of similarity in pipes, and theoretical investigations on head losses in pipes.

The hydraulics of steady flow deals with the basic hydrodynamic equations and introduces the readers slowly into the theory of flow in open channels as a function of discharge, energy and momentum, passing on to gradually varied flow in open channels and later to rapidly varying flow or discontinuous flow. The third part on unsteady flow covering three long chapters discusses in detail mass oscillations in surge tank installations of various types and with water hammer including mechanical stability and surges in open tanks. In dealing with ground water in the last part, the author clearly defines the subject covered within the scope of the present discussion stating that it represents that body of water which fills all the small, but inter-connected pores in the soil and whose motion is virtully determined by gravity and by the frictional forces provoked by the motion itself. Water in cracks and fissures and water in the zone where motion is wholly or largely affected by capillary forces is not included in the definition of the term and as such excluded from the perview of the survey. There are in addition three appendices covering such miscellaneous topics as empirical flow coefficients, theory of flow over an erodible bed, and on density currents.

The wide range of author's important contributions in the field of hydraulic engineering are clearly brought out here, while his erudite scholarship is visible in the extensive footnote-type bibliography covering references of British, American, German, Spanish, Italian and Portugese origin.

The text should be of inestimable value to practising engineers and for the study of hydro electric schemes and a stepping stone to their applications.

S. K. G.

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COMMERCIAL WAXES, A Symposium and Compilation, Edited by H. Bennett, Chemical Publishing Co. Inc, 212 Fifth avenue, New York, N. Y., 688 pages, $ 15.00.

The use of natural waxes and waxlike substances is shrouded in antiquity from ancient times, although it is fairly well known that they have been used for candles, waterproofing, sealing, decorative and other purposes. The technical data on these substances is not readily available except in scientific journals inaccessible readily to chemists, technologists and engineers. The text under review therefore fulfills a dire need in this respect and presents an exhaustive survey in the field.

There are in all seven sections logically arranged for easy reference and understanding. The introductory section defines waxes, classifying them according to their usage, source of origin, and characteristics such as adhesiveness, clarity, edibility etc. This is followed by an interesting account of natural waxes. It may not be known to many that paraffin wax is the most widely used commercial wax, and is mainly derived from the high-boiling point fractions of petroleum. The annual production of paraffin wax in the United States is between 500 and 600 million pounds. The characteristics of other groups of this type are enumerated, including vegetable waxes, animal waxes and insect waxes that is beeswax.

The next section covers the properties and manufacture of synthetic waxes such as cetyl alcohol, fatty acids, polyglycols, hydrogenated oils, chlorinated naphthalenes, acrawaxes, and miscellaneous synthetic waxes. The large and varigated physical chemical, and engineering properties possessed by waxes is described in the next two sections, with tables and diagrams. Industrialists and technologists will find the last three sections of use as herein are given accounts of use of waxes in industry such as in dentistry, lipsticks, pyrotechnics, paper finishes, waterproofing of kraft paper, tropical waxed paper, plastic moulding, polishes, stencils and carbon paper inks. The glossary of terms and the formularly

(Continued on page 102)

ALL ABOUT STANDARDS

DETECTION AND ESTIMATION OF DAMAGE IN CELLULOSIC TEXTILE MATERIALS DUE TO MICRO-ORGANISMS

THE draft Indian Standard Method for Detection and Estimation of Damage in Cellulosic Textile Materials Due to Micro-Organisms, has been prepared and circulated for eliciting comments to interested parties by the Indian Standards Institution.

Cellulosic textile materials are liable to attack and deterioration by micro-organisms like bacteria and fungi, while in transit, in storage or in use; deterioration is facilitated by climatic conditions prevalent in tropical and subtropical countries. Formulation of standard methods for the detection and estimation of damage in cellulosic textile materials due to micro-organisms is, therefore, necessary.

For the purpose of detection of damage, the use of a microscope has been prescribed and for the estimation of damage, the use of Mullen's Bursting Tester has been specified in the draft standard.

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METHODS FOR TESTING TAR AND BITUMEN

The Institution has circulated for public comment 20 Draft Indian Standards covering Methods for Testing Tar and Bitumen.

(Continued from page 100)

should serve the uninitiated to fully comprehend the utility of waxes in industry and technology.

As Technical Director of Glyco Products Co. Inc, the editor, has rendered a valuable service to wax technology in compiling and presenting this account.

S. K. G.

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ENGINEERING INSPECTION MANUAL: Henry A. Roy, Chemical Publishing Co. Inc, 212 Fifth avenue, New York, 10 N.Y., U.S.A., 160 pages, $ 5.75.

The wide developments in engineering tools and plant have necessitated a closer and profound understanding of the laws governing their manufacture and processing. In this, inspection, plays a very salient part since without close inspection, the final product would turn out to be of little use in practice. The book is confined to mechanical inspection which forms one of the several inspection methods today adopted in the manufacture of equipment.

It was Eli Whitney who presented the world in the mass production about the year 1798, but it was not untill 1913 that it was put to practical use. The greatest advance in mechanical tooling took place when after mass production, interchangeability of parts was fully recognised and engineering inspection took its place in this recognition. In simple language the author explains the manner and means of mechanical inspection and the procedures which contribute to quality control and efficiency. Beginning with such simple devices like the scale and calipers, the author passes on to micrometer gages, fillet and taper plug gages, block set-up, shoulder runout, and checking centre distance between holes.

These are followed by topics on Laying out a rough casting, surface shapes, adjustable limit snap gages, thread measuring, and care of gages. In the appendix the author gives a wide variety of information such as constants for finding pitch diameters and minor diameter for 60 degree screw threads; screw thread standards; basic thread dimensions; different standards for wire gages etc.

The number of illustrations and photographs render the text a valuable work for inspectors who wish to study the correct methods of engineering inspection.

S. K. G.

Several Indian Standards on Tar and Bitumen have been published. These cover crude and coal tar, straight bitumen cutbacks, etc. While preparing these specifications, the sectional committee found that the methods of tests to determine the same property varied in procedure and equipment from material to material. Such variations introduced new and additional equipments and made testing tedious on account of the variations in procedure. It was found desirable to simplify the test procedure and to prescribe the same standard equipment as far as possible. This standard compilation on methods of testing tar and bitumen has been prepared with this object in view.

These draft standards are in three parts. Part I includes Sampling, Part II covers Physical Tests such as Determination of Specific Gravity, Penetration, Softening Point, Viscosity, Ductility, etc. and Part III covers Chemical Tests and includes Distillation, Water Content, Solubility in Carbon Disulphide, Determination of Mineral Matter, Naphthalene and Volatile Matter Content, etc.

Comments are invited on these Standards by the Director, Indian Standards Institution, 19, University Road, Delhi 8 from whom copies of the Draft Standards can be procured on application.

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MUSCOVITE MICA

The Institution (ISI) has circulated the following three draft Indian Standards relating to Muscovite Mica for eliciting comments:

(1) Definitions of Mica Terms,

(2) Methods for Grading and Classification of Muscovite Mica Blocks, Thins and Condenser Films, and

(3) Methods for Grading and Classification of Muscovite Mica Splittings.

These draft standards are the draft revisions of the two Indian Standards published in 1949, namely IS: 13—1949 Tentative Indian Standard Methods for Grading Processed Mica and IS: 14—1949 Tentative Indian Standard Classification of Processed Muscovite Mica which have now been split up into three. The draft revisions incorporate several decisions of the International Committee on Mica of the International Organization for Standardization (ISO). The principal mica producing and consuming countries of the world are participating in the work of this International Mica Committee with India as the Secretariat with a view to establishing uniform specifications for international trade in mica.

The ISI is presently engaged in developing International Standards of Mica which is a major dollar earning mineral of India. The present export of this mineral is over Rs. 9 crores annually.

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LOW ALLOY HIGH TENSILE STRUCTURAL AND RIVET BARS

The Institution has circulated for eliciting comments, the draft Indian Standard Specifications for:

(i) Low Alloy High Tensile Structural Steel; and

(ii) Low Alloy High Tensile Rivet Bars for Structural Purposes.

The first of these drafts prescribes requirements for low alloy high tensile steel bars, plates and sections for use in structures. The materials covered include those for fabrication by methods other than fusion welding and also those where fusion welding is involved.

The second draft standard prescribes requirements for low alloy high tensile steel rivet bars.

In low alloy high tensile steels, enhanced mechanical properties and in most cases increased resistance to atmospheric corrosion, are obtained by the incorporation of low percentage proportions of one or more alloying elements besides carbon. These steels are generally intended for application where saving in weight can be effected by reason of their greater strength, and atmospheric corrosion resistance.

In view of the Government of India's decision to introduce in the country, uniform system of weights and measures based on the metric system, all values appearing in these standards are given in metric units. In order to help the industry to familiarize itself with the metric system, equivalents in inch system are also given.

In preparing these draft standards, the committees of the ISI have taken into consideration, the manufacturing and trade practices at present followed in the country. Consideration has also been given to the practices adopted in other countries.

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