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Shri R. L. Kirloskar (Extreme left), Managing Director, The Mysore Kirloskar Ltd., Harihar and Shri S. L. Kirloskar, (fourth from left) President, Indian Machine Tool Manufacturers' Association, seen with the U. S. Machine Tool Experts in Bombay.

JOURNAL OF INDUSTRIAL ENGINEERING

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PROCESS CONTROL AND INSTRUMENTATION

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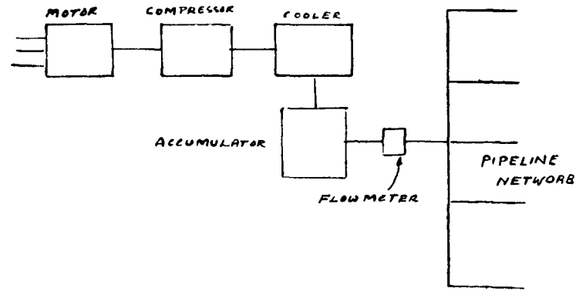
AN industry has two types of basic essential requirements—productive and non-productive, both of which need careful measurement and control to maintain a correct specification of its finished product. By productive requirement, we mean all the raw materials that go through various processes and operations to give rise to the final product ; e. g. coal, iron ore, lime stone, etc. for the iron and steel industries ; various steel sections, tubes, brass and copper mountings and accessories, bearings, wooden fixtures, bolts and rivettes etc. for a locomotive and automobile industry ; Soda ash, sand, lime etc. for a Glass works. Under the non-productive group, we can include items which do not directly constitute the ingredients of a finished product ; e. g. Electricity as a medium of Power and Heat, compressed Air for pneumatic grinders, breakers, drills and riveters, water for cooling and in hydraulics, fuels for Thermal operations.

For the measurement and control of productive requirements in an Industry, some attention is usually given. So far as the solid items are concerned, the measurement is simple, usually done on a Balance or a Weighbridge. In an Engineering Industry the calculation by numerical number, by linear and Area measurement is widely adopted. As the productive items directly affect the cost of production, usually sufficient care is taken to avoid any waste. But the consumption of non-productive items at random goes unchecked in many an Industry, inflating the cost of production unknowingly. The object of our endeavour is to furnish ways and means to ensure control and economy of costly and important services used in the form of non-productive requirements.

The measurement and control of consumption of Electricity has almost attained a perfection ; use of wide range of Kilowatt-Hour Meters, Voltmeters and Ammeters, Maximum Demand Meters and various protective Relays has become indispensable for the large and small industrial consumers.

Let us consider the supply and control of the compressed Air which is an essential service in an Engineering or Metallurgical Industry. The compression of Air and its distribution can be outlined as follows :

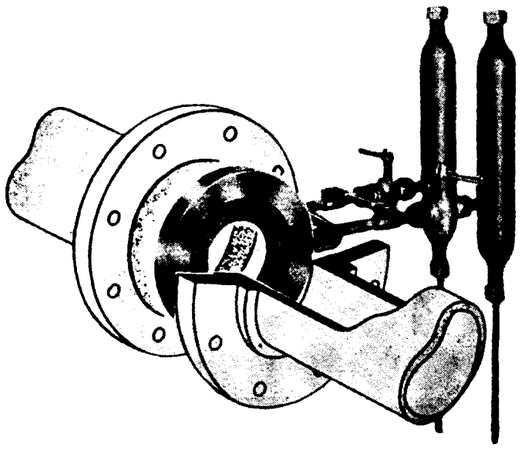


Schematic Diagram of Compressed Air Generation

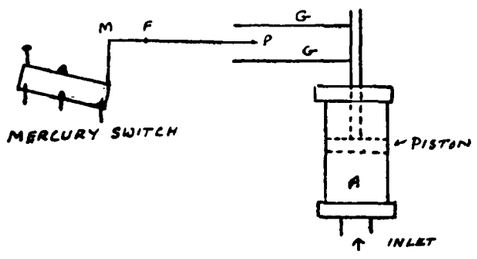
The primary requirement of such a plant is to supply compressed Air at a constant pressure. Usually, a Thermal or an Electrical energy is utilised for the compression of Atmospheric Air to a high pressure. To keep a check on the efficient working of the compressors, the interrelationship of measurement between the Energy Input and the quantity of Air compressed should be utilised. For the measurement of Energy Input to the compressor-motor a KWH Meter serves the purpose. To ascertain the air out-put at constant pressure from the compressor, an orifice or venturi type of Differential Pressure Flow Meter should be used after the Accumulator, before the compressed Air enters the pipeline net work. A differential-pressure Flow-meter has been illustrated below :

Apart from the measurement of quantity of Air, it is essential to incorporate some form of pressure modulator in the Plant in order to ensure a constant Air pressure with no loss of Input Energy. A very simple type of pressure cut-out is being described :

A small stream of Air from the compressor outlet is fed into a cylinder 'A' in which moves a Piston 'P'. On the piston rod, are fixed adjustable fingers 'G' which operate the end 'P' of a lever MFP. A 3-way mercury switch connected to the other end of the lever



An Orifice Meter.

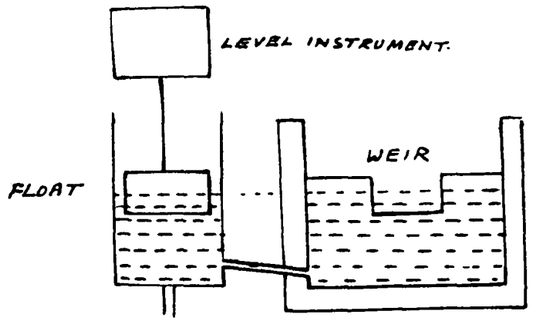


Pressure Cut-out.

MFP in turn energises a system of relays on the main control panel feeding the compressor motor.

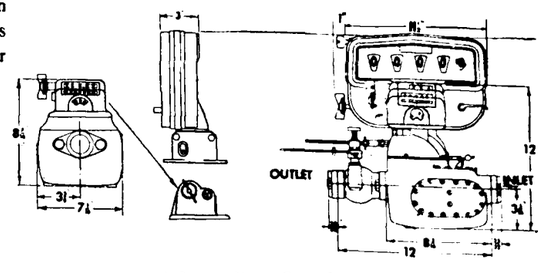
In many Industries, the use of water is not less important than the use of Electricity or Air. Apparently, the water seems to be of little cost. But wherever a filtered and softened water is consumed in huge quantity, it is essential to measure the consumption of water in the Plant or in the township. One of the most common forms of water meter used in the Filter-Plant for this purpose is an open channel Meter working on the Weir Principle as illustrated below :

If Q = the rate of flow
b = the width of notch
h = the head over weir crest
$Q = 2/3\ b\ 2\ \sqrt{gh^3}$
Taking C as the Coeff. of flow rate.
$Q' = 2/3\ cb\ \sqrt{2\ gh^3}$
h is measured by the device shown adjacent.



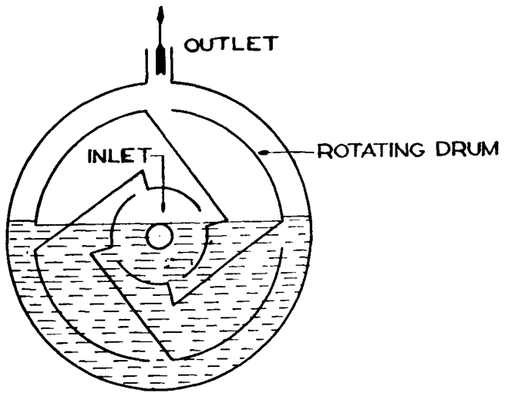
Of all indirect raw materials, Fuels constitute a very costly and important item in the Metallurgical, Engineering and Chemical Industries. The rising index of price of Fuel including electricity all over the world has already caused a lot of anxiety and the possible conservation of Fuel and Energy has been thought of from all angles. Instrumentation has been playing a big role in the combustion control, Fuel economy and quality control. Moreover, Maintenance of a correct and steady temperature is absolutely essential in the drying ovens, and furnaces for smelting, heat treatment, remelting, steam generation etc.

A control on the utilisation of fuel is achieved in two ways by having a check on the quantity of fuel-feed and by regulating proper combustion of the fuels in the furnaces. A similar control on the Electrical Furnaces is attained by restricting the input of energy at a desired temperature level. In case of solid fuels the quantity is directly weighed. The feed to a furnace is usually controlled by its volume, i. e., the depth of the fuel bed, as in a Mechanical chain grate stoker. The liquid and gaseous fuels need accurate metering for an economical and efficient furnace operation. A Rotary Piston type of Flowmeter can be very successfully used for the measurement of liquid fuels.



A Rotary Piston Type Oil-Meter.

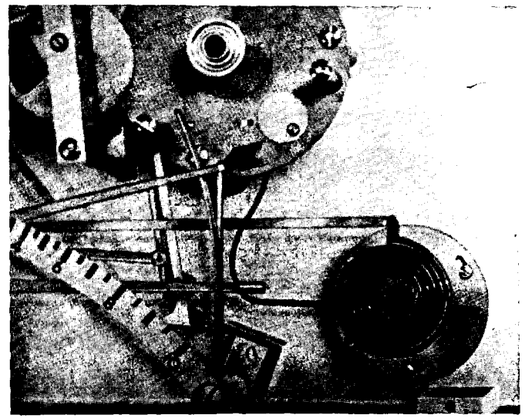
Similarly, a positive or rotary displacement meter is an useful equipment for the measurement of gases. It measures with extreme accuracy. In this meter, the water level is fixed just about the centre and gas enters through the hollow axis in the compartments of the drum, filling each compartment successively. The pressure of the gas causes the blades to revolve and operate the integrating mechanism.

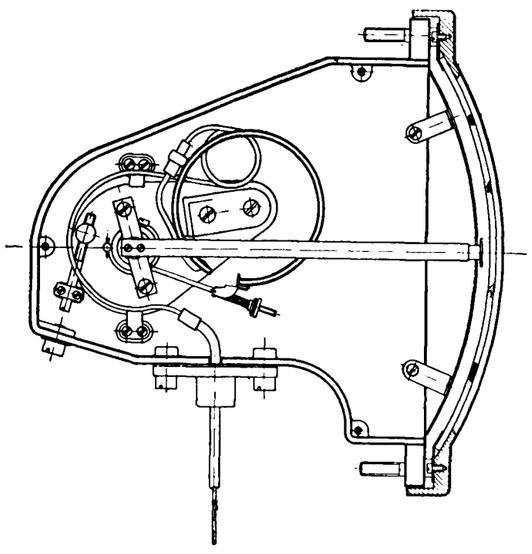


GAS FLOW MEASUREMENT

A large group of temperature indicating, controlling and recording instruments has been developed to suit various Industrial conditions. The essential principle of such a system consists of a detecting element, a transmitting system, a measuring device, a controlling relay and a recording mechanism. The detecting element might be either a Hot bulb filled with a thermosensitive material such as an inert gas or mercury, a resistance, or a thermocouple. The function of this element is to detect variations in the temperature by its change of pressure or electrical characteristics. The transmitting units consist of either a flexible capillary tube (hot bulb) or compensating leads (Resistance or Thermocouples) and their function is to transmit the fluctuations in the properties of the detecting element.

The construction of the measuring element depends on the nature of the detecting element. In the case of a hot bulb, it may comprise simply of a Spiral Tube or a sensitive bellow and a modulator cam, attached to a recording indicating mechanism. In the case of a Resistance Pyrometers, the resistance of the platinum wire disturb a bridge circuit giving rise to an unbalanced



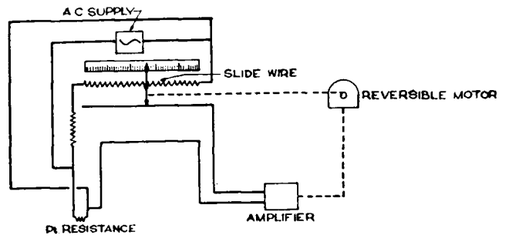


Mechanism in a Hot Bulb Pyrometer.

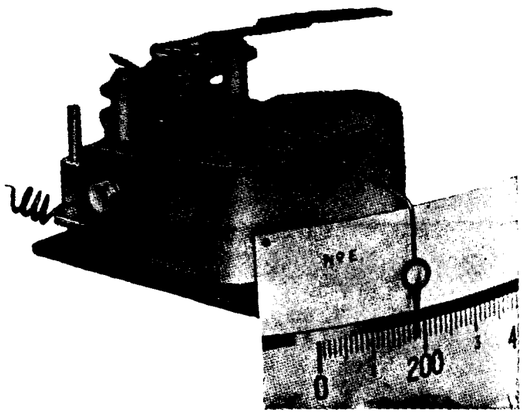
current which is directly measured in terms of temperature.

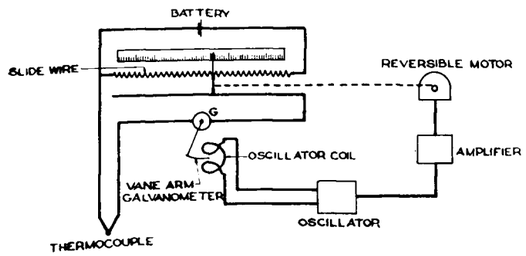
In a thermocouple type, an EMF is generated at the hot junction due to the rise in temperature and this EMF is either measured by a Millivoltmeter in terms of temperature, or is measured in Wheatstone Bridge principle. A Schematic diagram is given :

The idea of a controlling relay is to regulate the input of fuels to the furnace with the attainment of



ELECTRONIC RESISTANCE PYROMETER-CONTROL



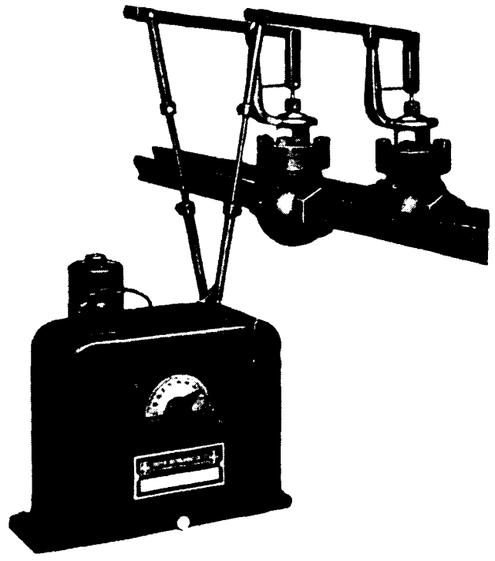


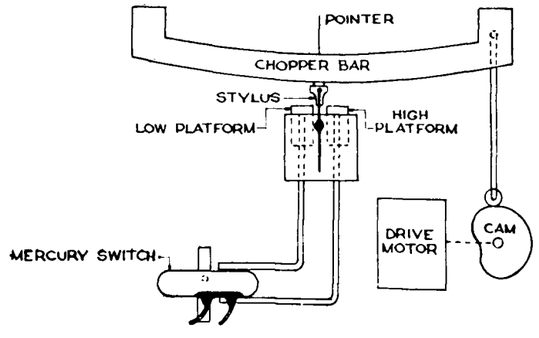
ELECTRONIC POTENTIOMETER CONTROL (THERMOCOUPLE)

required temperature. Obviously its functions are slightly complicated. A few modern controlling elements are discussed in details :

1. ON-OFF CONTROL

A Stylus is rigidly fixed to the indicating pointer on the moving coil system of a measuring element, as shown in the attached sketch. Low and High platforms are provided in the instrument which can tilt the mercury switch in either way. The controlling index is mounted on the frame of the platform assembly, and this can be set at the desired temperature on the scale. On top of the pointer a chopper bar operates an indicating pointer. As soon as the furnace temperature reaches the desired value, the indicating index will be just above the high platform and as the chopper bar drops, the stylus on the pointer presses the high platform tilting a mercury switch which cuts off the fuel input to the furnace. In the case of an electric resistance furnace, the mercury switch will de-energise a relay which will cut off the power supply. In an oil (or gas) fired furnace the switch will reverse the direction or rotation of a motor which operates the valves in the air pipeline and oil mains leading to the burners. A photograph of this unit is shown below :





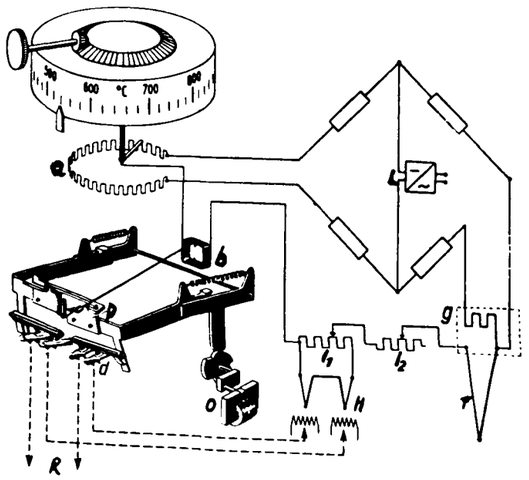
ON-OFF CONTROL

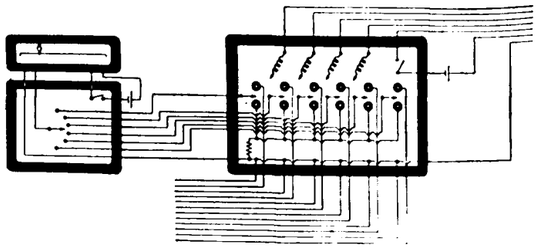
2. PROPORTIONAL CONTROL

On this system of control the E. M. F. Thermocouple opposes via a moving coil zero centre voltmeter, a D. C. Voltage corresponding to the desired (pre-set) temperature. The D. C. power is obtained from a bridge circuit supplied from the mains through an extremely sensitive voltage stabiliser and rectifier. A potentiometer circuit is incorporated in the unit mounted on a drum, precisely graduated and can be adjusted manually to the desired value. A Thermo-sensitive copper resistor balances the cold-junction errors of the thermocouple. The pointer of the zero-centre millivoltmeter indicates the direction and an extent of deviation of the actual temperature from the desired value. A power switch with two feeler-blades explores the position of the pointer periodically and operates one or more necessary switches depending on the position of the pointer. A small A. C. motor drives a cam which actuates the power switch. A pair of switches for each direction of control is incorporated in the unit, one of these controls the actuating motor and the other governs the thermal anticipation circuit. The period of engagement of these switches depends on the extent of deflection of the pointer.

A no-volt safety device is provided to set the necessary switches in the 'off' position in the event of a power failure. So that the valves etc. remain stationary in their existing position till the resumption of power. The Thermal Anticipation system is incorporated to correct the inertia of the equipment and prevent over regulation.

No doubt an elaborate instrumentation for the furnaces is a costly proposition, but all the same it is worthwhile spending the amount when compared to the Fuel-savings, control and ease of operation rendered by its use. Wherever there are a number of Furnaces working and automatic control not essential, six to eight furnaces can be conveniently connected to a single Multipoint instrument, which is definitely economical. A schematic wiring diagram for such a system is incorporated below :





The introduction of various measuring instruments represents perhaps one of the greatest economies and the only control of operation and processes in the industries. An idea as to the savings which has been provided by the instrumentation may be obtained from the example of the steam boilers in the end of the nineteenth century compared to those of to-day. Thermal efficiency in a Boiler plant in those days were never exceeding sixty per cent ; and with the advent of Instrumentation which brings to light many a neglected wastage and keeps the whole operation under control at every stage, the efficiency is as high as 85% in Modern Boiler Houses.

PRODUCTION STANDARD AND EQUIPMENT IN HINDUSTAN MACHINE TOOLS FACTORY PRAISED

The production standard and equipment in the Hindustan Machine Tools Factory of Bangalore were praised by Mr. George E. Merryweather, leader of the four-member Advisory Group of the U. S. Machine Tool Industry, after a visit to the Factory. The Group recently began its study of the Indian Machine Tools Industry on the invitation of the Union Ministry of Commerce and Industry. In its report to the Government of India, which is expected to be ready in August this year, the Group will include an assessment of the situation in the Machine Tools Industry both in the public and private sectors.

MASTABAR PATENT BELT FASTENERS

From A Technical Correspondent

POWER TRANSMISSION BELT FASTENERS

MASTABAR make a range of Fasteners to cover all normal types of belting found in industry. The principal advantage of a wire hook fastener is that they maintain an adequate hold upon the belt end, whilst at the same time the joint remains extremely flexible. The fasteners are easy to handle and with the equipment available can be fixed at the site of the breakdown. Mastabar is extremely economical in use and the great variety of sizes enables belt users to standardise on Mastabar.

The fasteners are made in seven different sizes and in three pitches to suit not only the Mastabar Lacing equipment, but all other types with any other make of tool.

The range of beltings covered by the Mastabar Fasteners are fully explained on each box of fasteners and range from beltings of 5/32" thick, or 4m/m, up to ½" thickness or 12.5 mm. The hooks are staggered and are held together by a transverse bar joining the hooks together. No two hook points enter the belt directly opposite each other, thus preventing the belt fibres being broken. When the fasteners are embedded into the belt surface the joining bar is embedded also, thereby joining all the hooks into one unit, thus providing the added strength of unity. Hooks lie flush.

The wire used in the manufacture of all Mastabar Fasteners is made from the finest quality alloy steel and rigidly held to specification. to withstand fatigue, tension and frictional wear.

Mastabar Fasteners run quietly and smoothly on the pulleys and the fastener does not tend to wander on the pulleys.

All the fasteners are made to rigid standards and to maintain an even quality, inspection is carried out after every operation during manufacture. Finally, the fasteners are subjected to Quality Control procedure as a final check that the fasteners are up to standard.

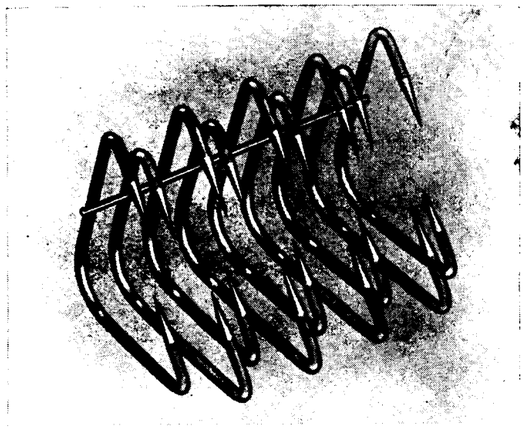
Each box of lacing contains 12—12" lengths and 6—12" lengths of equivalent Mastabar Rawhide Pins.

New Joint Closure System Container.

Lacing instructions are simple and full instructions for fixing will be found inside each box of Mastabar Fasteners.

Points to bear in mind for selecting the correct size of fastener is :—

(1) The size of hook recommended for the particular thickness of belt should be employed, certain beltings such as solid woven types and fabric beltings should have a size larger fastener than is usually used for leather and similar type beltings.



MM.12 Fasteners.

(2) The fastener should be inserted in the lacing tool with the bar on the bottom jaw and should be embedded into the outside surface of the belt, i. e. not in contact with the pulley face.

(3) Sufficient pressure should be exerted on the lacing tool to ensure the hooks being embedded flush with the surface of the belt in order to derive the full benefit of the Mastabar patent features. When the belt is particularly tough, as sometimes happens in cold climates, the fastener may not be compressed into the belt end with the first pressure, then, the belt end should be reversed in the tool and once again pressed, when it will be found that the hooks will enter flush with the surfaces of the belt end.

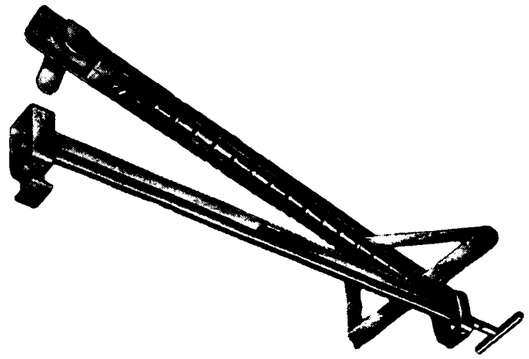
(4) When lacing rubber belting, best results are secured by wetting the ends of the belt and the length of fastener to be inserted.

(5) For lacing wide belts, measure the width of fastener required and cut into lengths as long as the capacity of the lacing tool. Insert short length first commencing from the left hand side. If there are two long lengths and one short length, insert the short length in the middle. Do not press hooks home completely until all the lengths are inserted and gripping.

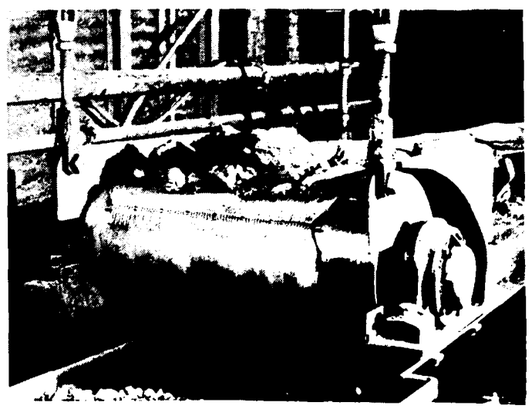
For moist o humid applications, Mastabar make a special moisture proof rawhide pin for these locations which are particularly suitable for damp and steamy atmospheres and where acid conditions prevail.

A wide range of lacing tools are available, the best of which is the Mastabar Patent Double Lever Speed Lacer which exerts a pressure of 12 tons between the jaws enabling the fastener to be properly embedded. A handy general purpose lacer—the Mastabar Mastiff Lacer—is a tool operated on the knock-down principle by use of a rawhide face hammer. Finally, there is a small tool—Mastabar Terrier Lacer—which is designed on similar lines to the larger Mastiff tool. This is only used with the smaller sizes of lacing and admirably suitable for the small works where belt lacing is not a frequent operation.

It is essential to have a square cut edge before a joint is made into a belt end and for this purpose



"Comet" Squarer.



"Comet" Application Photograph at Beckermet Mining Co.

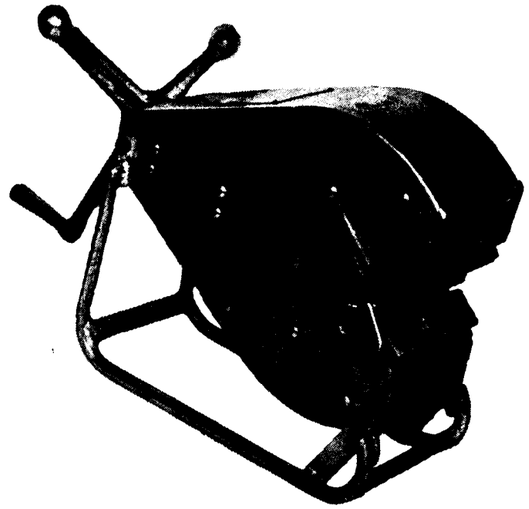
Mastabar offer a cutting tool which is portable, light and robust, and saves endless time and labour in preparing the belts for the fastener.

Some customers demand a portable lacing equipment outfit and for this purpose Mastabar offer a complete outfit which contains the Mastiff Lacer with a stoutwood base, Mastabar Rawhide Hammer, Mastabar Snippers, one packet of Mastabar Rawhide Pins, three boxes of Mastabar Fasteners suitable for the range of beltings required by the customer.

CONVEYOR BELT FASTENERS

Mastabar also make a range of fasteners specifically for joining conveyor belts and in particular those found underground in collieries. A range of fasteners, four in number, are made to cover the most usual thicknesses of belting used for conveying. For the insertion of these fasteners into the belt ends, a more robust lacing tool has been devised, and the whole system used for conveying is covered and sold under the trademark 'Comet'.

The 'Comet' Conveyor Joint Belt Lacing system covers the whole of the equipment necessary to make and rapair joints, whether they be on the surface or underground. The equipment covers a belt squaring device to enable a sound joint to be made at the end of the belt, suitable fasteners to cover all thicknesses of beltings up to $\frac{5}{8}$", a lacing tool that exerts 15 tons upon the fasteners and thereby guarantees that the fasteners are properly formed and clinched into the belt end for the heavy loads undertaken in conveying; and a joint sealing strip which, when passed into the loops of the completed belt ends, guarantees that no fine or small material passes through the joint when being used for



The Comet Offset Lacer.

this type of material. The hinge pins for conveying, being a different application altogether from driving belts, must have a very rigid and strong pin. For this purpose we offer in standard lengths, pins ready cut to size and bonded at the ends made from a very high tensile steel wire and in diameters of 3/16" and $\frac{1}{4}$", which cover along with the fasteners for all usual belt thicknesses employed in conveying.

Finally, planned maintenance, is the secret of good belt fastener performance. All joints should be examined frequently and regularly to maintain good joints, otherwise trouble-free service will not be obtained.

STEEL SUPPLIES FOR INDIAN RAILWAYS—MISSION TO GO TO EUROPE

The Railway Minister, Shri Jagjiwan Ram, announced in May, 1957, that it had been decided that the Ministry of Railways should take over the procurement of the specialised railway items of steel requirements, and a mission was being sent out to Europe and other countries to expedite the procurement of rails, sleepers, etc., the shortage of which was seriously hampering the implementation of the Railway Plan.

The procurement of wooden sleepers, he said, had been considerably promoted by exploiting the usage of a greater variety of new species with and without treatment, by the relaxation of the specifications, by increased supplies from the Andamans and by initiating measures for exploring the possibilities of import of timber sleepers from Burma, Australia, Thailand, Malaya, Indonesia and Brazil.

The Railway Minister said that inspite of these efforts, wooden sleepers could meet only about one third of our total requirement of sleepers and the railways had, therefore, been forced to use metal sleepers which also could not be procured in sufficient quantities. It was proposed now to use concrete sleepers also, in big yards to start with.

Standardisation of Aluminium Alloys

By B. N. Bose,

Tech. Superintendent, Indian Aluminium Co. Ltd., Calcutta.

THE development of Aluminium alloys during the past fifty years is a story of dramatic interest. An unusual combination of properties, the exigencies of two world wars and the fact that aluminium, unlike other common metals, entered the field when the science of metallurgy had already reached an advanced stage of development, explain the rapid progress in the technology of aluminium and its alloys. In India, until recently, the use of aluminium has mostly been confined to utensil manufacture. Gradually, however, the light metal is gaining ground in the engineering field and it is expected to contribute its due share in the industrial development of the country during the next few years.

An unfortunate result of the rapid progress in aluminium technology has been the inability of many engineers and designers to keep fully informed and take advantage of the latest developments of the new alloys. Moreover, the diversity of possible alloy composition and properties makes the task of producer very difficult if he has to cater to individual purchasing specifications. Standardisation helps in simplifying the situation, safeguarding the interests of both maker and consumer, and gives an agreed yardstick of quality requirements necessary and sufficient for any particular purpose.

The Indian Standards Institution, young as it is, has already issued a number of Standards for aluminium alloys and products, although the full ground is yet to be covered. In England and America standardisation has been more complete and from an almost endless possibility of alloy composition, a comparatively small number have been standardised to satisfy practically all normal requirements. A purchasing specification for a special alloy can usually be shown to be unnecessary since the requirement can almost certainly be met by one of the Standard alloys. And standardisation is based on extensive laboratory tests and practical experience and takes full advantage of the current knowledge of the subject, so that a product beyond the limits of specification can normally be proved to be inferior in quality.

In the preparation of National Standards, all possible care is taken to ensure full concensus of opinion among every section of industry that may be concerned directly or indirectly in the production or use of the alloy, product or process standardised. The final standard is thus a truly agreed standard based on free consent. The standards issued by the Indian Standards Institute do not, however, have any statutory authority, and producers and purchasers are free to use them only if they want to. The advantages of using the standards and the possible dangers of indiscriminate use of non-standard material will be seen from the following examples.

Utensil manufacture, as already mentioned, has been, and still is, the most important application of aluminium in this country. During and immediately after the war, large quantities of aero scrap were used in the manufacture of utensils. This resulted in complaints about the colour and flavour of food prepared in such utensils, and the utensils themselves underwent rather rapid pitting and corrosion; the aluminium utensil industry suffered appreciably. On the request of the Government of India, the Indian Standards Institute have issued two specifications, one for cast aluminium and the other for wrought aluminium for utensils, laying down maximum permissible contents of copper, iron, zinc, lead and other elements to ensure safety with food and reasonable life of the utensils. More recently, arrangements have been made for certification of utensils conforming to Indian standard specification; this is expected to further discourage use of non-specification material.

The above example, besides indicating the possible consequences of using non-standard material, points also to the most serious difficulty in the way of standardisation, namely, that, aluminium lends itself easily to small scale business which can be run by ignorant or unscrupulous people, not particularly concerned about their own reputation or the quality of products they turn out. Aluminium castings, in particular, may be made with very small establishment and capital outlay if one does not care of elaborate testing equipments or quality control measures. It is possible, for instance, to find an internal combustion engine piston, cast from an alloy that has no relation to Y-alloy or any other standard composition. The result of using such a piston can be well imagined.

An interesting example of a failure has recently been encountered in an aluminium-silicon alloy casting. Silicon, as is well known, improves the casting properties of aluminium, and aluminium silicon alloys are characterised by high corrosion resistance, low specific gravity and low thermal expansivity. Beyond about 11% silicon, however, both strength and ductility of normal aluminium-silicon alloys decrease rapidly. With the discovery of modification in about 1920, Silicon could be increased to 13% giving a composition with outstanding casting characteristics and better corrosion resistance than most other alloys. The failure under consideration concerned an alloy with 13% silicon. On investigation it was revealed that the composition conformed to specification but the ductility was too poor resulting from improper modification treatment. Apparently, neither the producer nor the purchaser had tested the material for requisite properties as laid down in the specification.

Ignorance or carelessness on the part of purchasers is responsible for many failures and militates against proper utilisation of the potentialities of aluminium alloys. It is not unusual to find an engineering drawing with the material specified merely as aluminium or aluminium alloy, as if the two are synonymous and one alloy is just as good as any other irrespective of the conditions of service. There are infact, many aluminium alloys which are particularly suitable for certain applications but not necessarily for others. A recent survey by the Aluminium Development Association on the failure of components in public service vehicles in England revealed that one of the principal causes of the unsatisfactory performance of aluminium castings was the choice of an alloy unsuitable for the particular part in question. The same survey also commented on the failure on the part of suppliers to comply with the requirements of specification and omission on the part of purchasers to specify or check the quality of the material. It is remarkable that most of the defective castings, examined during this survey, did not conform to any standard specification.

An historic example of a major failure is provided by "Defender", one of the first aluminium yachts built for the International Cup Races towards the end of the last century. There was rather rapid corrosion in certain parts which ultimately put the "Defender" on the junk pile and cost this light metal a quarter of a century before it could regain its position of importance in shipbuilding.

Many more examples of failure resulting from use of non-standard material could be cited. It is obvious that a few serious failures are enough to do irreparable damage to the industry as a whole. The more responsible producers, therefore, prefer to work to standard specifications in the interest of their own reputation and that of the industry. It is to be emphasised, however, that it is the user and purchaser who has the ultimate responsibility of ensuring that a high level of quality is maintained. In his own interest the purchaser should insist on buying against official standards and should satisfy himself either by his own inspection or by a declaration from the supplier that the material has actually been tested and proved to conform to every detail of the relevant specification.

ALUMINIUM

It is reported that the Tokyo Aluminium Co., producer of rolled aluminium in the country has started production of Aluminium paste for the first time in Japan at its plant at Tatta, in W. Japan. According to preliminary estimates, its initials output will be 3 tons per month which will be increased to 6 tons in August, 10 tons in September and subsequently to about 20 tons per month. It may be mentioned that so long Japan was importing about 10 tons of aluminium paste per annum from U. K. and W. Germany.

The Indian aluminium market continues to depict steady conditions. Demand for different categories of material reportedly ruled on the better side with prices remaining unchanged.

According to a Government notification, the steel covered and plain standard aluminium conductors manufactured by the Electrical Manufacturing Co. Ltd., of Calcutta shall henceforth carry the standard mark on them for which license has been granted by the Indian Standards Institution. It may be mentioned that aluminium conductors of the above type to be certified under this licence are being increasingly used in the rural electrification schemes.

The Indian Standards Institution has published IS: 735-1956 specification for wrought aluminium and aluminium alloys, forging stock which is one of a comprehensive series of Indian Standards for general engineering purposes. It covers requirements of forging stock made from eight aluminium alloys in various conditions.

It is reported that the 2-crore Umtru hydro-electric system near Gauhati which was recently inaugurated has been completed with Canadian assistance under the Colombo Plan. The project used Canadian electrical equipment to the value of $ 1 million. The local costs of $ 2.2 million came from money realized by sale of Canadian aluminium to the Indian Cable Industry supplied under the Colombo Plan.

Bird & Sons blend Roof Coatings with minimum of cleanout time in Sturtevant Rotary Batch Blender

MIXING dry materials with a liquid colloidal binding agent can be a time-consuming, profits-eating process when excessive cleanouts are involved.

Bird & Son, Inc. of East Walpole, Mass., manufacturers of asphalt roofing, floor coverings and other products, have learned through experience how to cut downtime to nothing although they blend ingredients that have doubled blending costs in other companies.

"We use a Sturtevant Blender to blend rock granules, pigments and a sodium silicate to produce a coating for roofing products," said Leonard W. Weaver, Assistant Chief Chemist. "The granules are first blended with pigments for a short time. Then the silicate liquid binding is continued until all ingredients are mixed thoroughly."

The wetted, coated granules are then dropped into a receiving hopper, transferred by bucket elevator to a rotary drying kiln, then to another kiln for cooling. Here, they emerge ready to be applied to roofing products.

In blending, the granules tend to stick to the 'flights' or scoops of the Blender's interior and cake. To partially control this, Bird & Son developed a mix that leaves the colored granules no wetter than damp sand, limiting their adhesiveness.

A second control is in rinsing out the Blender with water and uncoated granules at the end of each shift. The granules enter through the hopper, water through the pipe. "The abrasive action of the granules loosens most coated granules that accumulate," said Weaver. "In the minutes it takes, this prevents a serious down-time problem." This simple step is also taken when a different pigment is to be blended.

The interior design of the drum itself minimizes 'shelves' and 'ledges.' Self-discharging, it is entirely self-cleaning with ordinary dry materials.

Granules that aren't washed out in the above fashion are chipped out once a month or so, on a Saturday when the mill is inoperative. By removing the few bolts holding the manhole cover, a man can enter the rear of the drum in less than a minute. The entire process—removing the cover, chipping the interior, replacing the cover—takes about an hour.

Bird & Son's preventive controls completely answer the serious problem of cleaning that led one company, blending similar sticky ingredients, to purchase two blenders. One blended while the other was 'down' for cleaning. No rinsing or other initial cleanout control was used and the ingredients accumulated quickly inside the blender. Consequently, chipping had to be performed several times a week, a process that took one man nearly an entire shift.

In addition to its rapid mixing action, charging (and discharging) can be done into the Sturtevant Blender in less than half a minute apiece. However, the Bird & Son process uses a longer time for discharging to assure a smoother flow into the hopper below. As the blending action continues during discharging, reducing separation, prolonged discharge periods are possible. One user blends 450 cu. ft. at once and has a two hour discharge cycle, which gives the advantages of continuous mixing and also the critical ingredient and blending control possible only with batch mixing.

The Sturtevant Blender has one-gate charge and discharge, allowing a complete dust seal. Interior flights cascade material as the drum rotates, while design assures material flowing from the back to the front, overcoming a common blending problem in other types of blenders.

Bird & Son's Blender is being replaced by another Sturtevant, this a // 7 7-ft. diameter model to take care of needed increased capacity. The older machine was installed in 1940 and has been in operation three shifts a day since. Originally rated for 3 tons an hour, it had been blending at a considerably higher rate. During 16 years in operation, despite the extreme abrasiveness for the rock granules, its flights had been replaced only twice. The drum itself has not been affected by wear.

Fig. 1. Blender operator and color-mixer Richard Armour inspects interior of Blender drum, using manhole-hatch. Entering this hatch, he can chip entire interior in less than an hour.

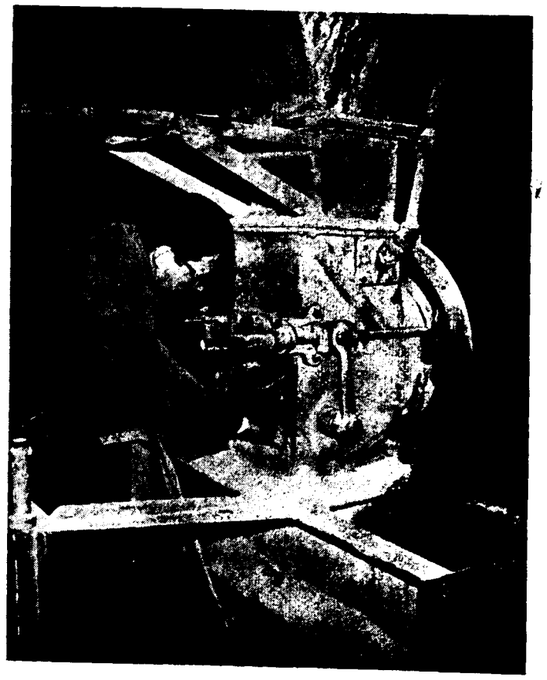


Fig. 2. Leonard W. Weaver, Assistant Chief Chemist at Bird & Son, Building Materials Division, takes a sampling of blended granules during discharge phase. Special stuffing box on Blender assures complete dust seal.

Receiving *Discharging*

Fig. 3.

Sturtevant Rotary Dry Blender

1. Intake and discharge are at same end of machine for operating simplicity.
2. Material can be charged and discharged during operation.
3. Four-way mixing action assures thorough blending:
   a) Series of revolving buckets carry materials to top of blending chamber, were they are cascaded and mixed.
   b) Revolving action of drum increases integration of material.
   c) Material is forced from *both* ends to the middle of the drum, a third mixing action.
   d) A swinging chute (or chutes) produces fourth mixing action—lateral
4. Open-door design permits easy accessibility for simple cleaning and maintenance.
5. Sturtevant Blenders are engineered and manufactured in sizes ranging from 500 lbs. per batch to 20,000 lbs. per batch.
6. Metals of construction vary with use of blender.

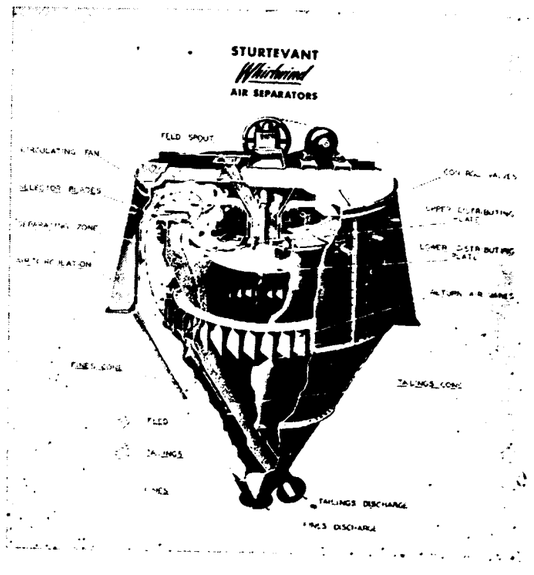


Fig. 4.

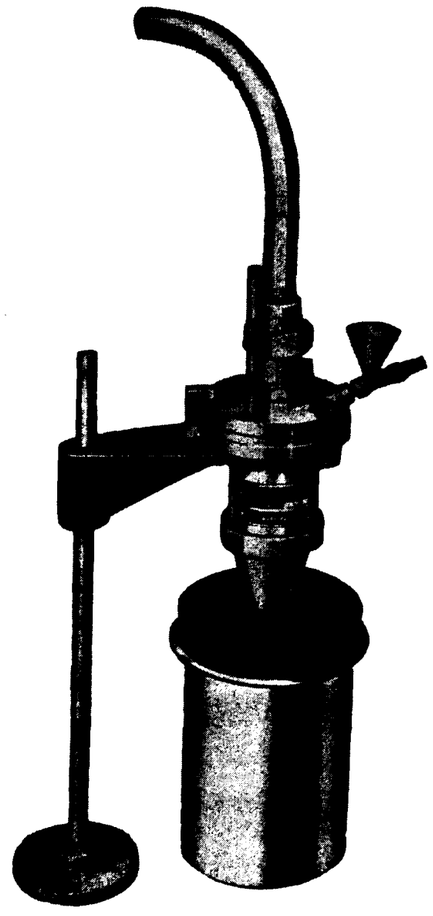


Fig. 5. Micronizer—Lab model.

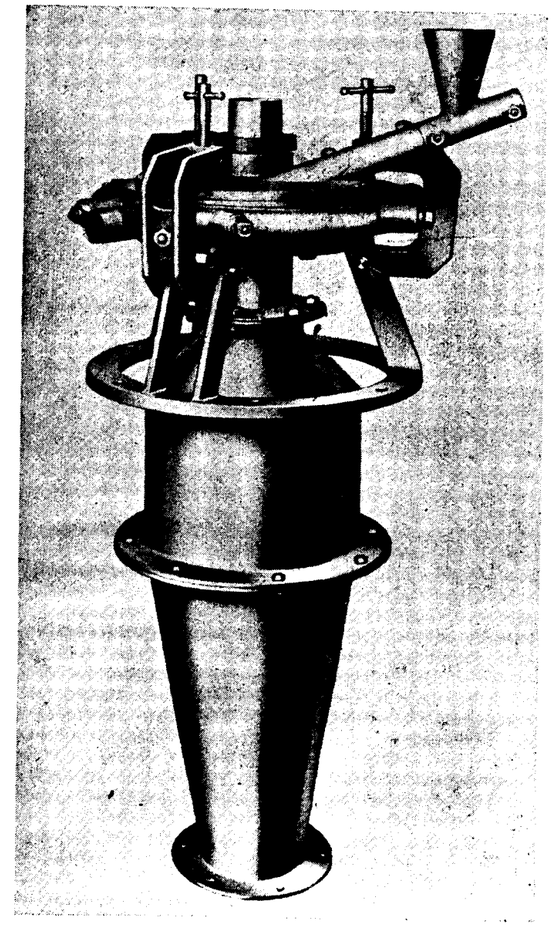


Fig. 6. Micronizer Production Model.

The unit, (Figs. 1, 2, 3.), fabricated of carbon steel by Sturtevant Mill Company of Boston, Massachusetts, U. S. A., is one of many manufactured by the company ranging in batch capacities from a few hundred pounds to ten tons. For extremely corrosive activity, the blenders can be fabricated of stainless steel or monel.

Besides rotary batch blenders, Sturtevant engineers and fabricates a complete line of Air Separators, (Fig. 4), designed for separating by centrifugal force, fines from tailings in a range from 40 to 400 mesh. Air Separators are built in sizes from three feet to 18 feet in diameter, with capacities from several hundred

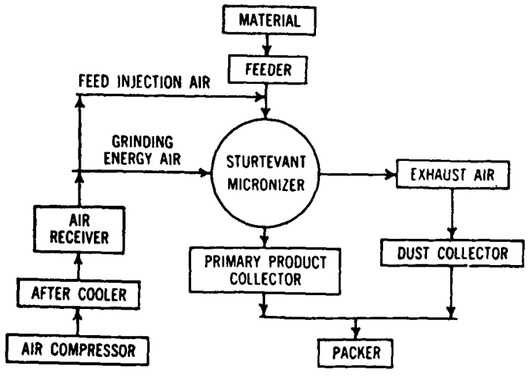


Fig. 7. Micronizer installation—schematic view.

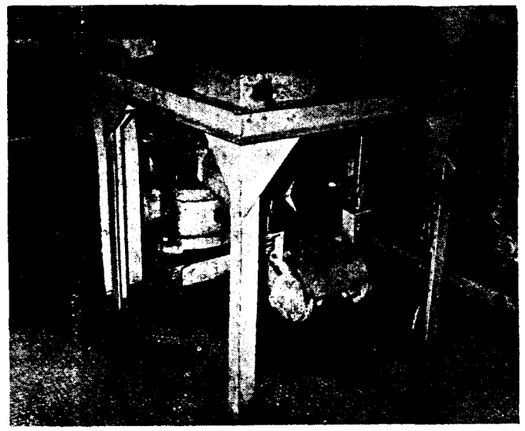


Fig. 8. **This Sturtevant jaw crusher is one of three units of dry** *processing equipment, manufactured by the Sturtevant Mill Company of Boston, Massachusetts, which has been operating in the Raw Materials Division of United States Steel Corporation's Monroeville (Pa.) Applied Research Laboratory since the experimental center began operations last May. The unit has a jaw opening of four inches by eight inches and a jaw setting range of a quarter inch to a half inch. With a quarter inch jaw setting, the crusher has a 1000 to 2000 pounds per hour capacity. At a half inch jaw setting, the unit can deliver up to 3000 pounds an hour.*

Other Sturtevant units in operation at the U. S. Steel lab are a roll crusher and a rotary dry blender.

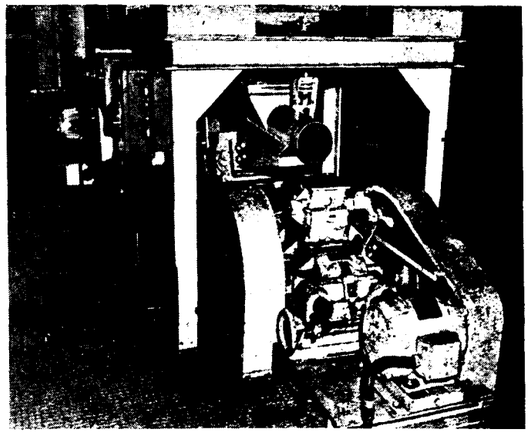


Fig. 9. **This Sturtevant roll crusher,** *capable of crushing a thousand pounds an hour of minus quarter inch feed to 0.065-inch product, is but one of three Sturtevant dry processing units now in operation at the Applied Research Laboratory of United States Steel Corporation in Monroeville, Pennsylvania. The unit is in action in the Raw Materials Division of the lab.*

The other material engineered and manufactured by the Sturtevant Mill Company of Boston, Massachusetts includes a jaw crusher and a rotary dry blender.

pounds to a hundred tons per hour. Micronizer fluid energy mills (Figs. 5, 6, 7) for fine grinding in micron ranges are also produced by Sturtevant Mill Company, as are full lines of jaw and rotary crushers, (Figs. 8 & 9) crushing rolls, hammer mills, rotary pulverizers, ring-roll mills, rock emery mills, swing sledge mills (Fig. 10), coal crushes and samplers, vibrating screens, dens and excavators. These units are available in laboratory or production models.

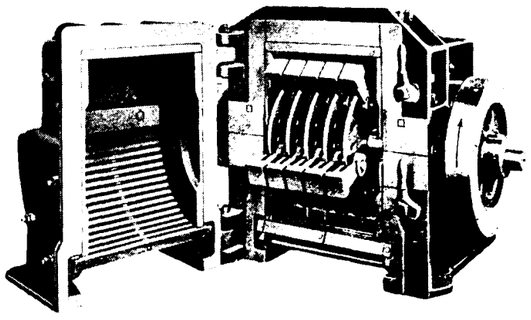


Fig. 10. Sturtevant Swing Sledge Mill.

BOILER PLANT NEAR DURGAPUR

Babcock & Wilcox Ltd., a leading British firm manufacturing land and marine-steam-raising plants, has maintained in India for over 50 years an organisation for the sale of its products and for their installation and servicing, both in the electric-supply undertakings of great centres of population and those indigenous industries which are of major importance to India's economy. They are now going to establish a centre for the manufacture of boiler and ancillary products in this country. As a result of negotiations begun last year, a new company is to be formed in partnership with Vickers Ltd., and Associated Cement Companies Ltd., of Bombay, to set up a large works in the Durgapur area of West Bengal for the construction of a variety of heavy-engineering products, including Babcock & Wilcox products of all kinds and cement-making machinery.

Capacities for Sugar Factories

By G. Ramchander, B.Sc.,
Fellow, Sugar Technologists Association,
Chief Chemist, Jeypore Sugar Co. Ltd., Rayagada.

WITH the need for increase in the production of sugar both for internal consumption as well as for export to earn the much needed foreign exchange a number of new factories are licensed especially in Bombay and South India. Licenses for substantial expansion of the existing units are also given.

Both in expanding the existing units and in the installation of new units sufficient attention is to be paid for balancing the various units.

In what follows is discussed the optimum requirements for various major units in a sugar factory.

MILLING STATION

From the point of view of the mill Engineer, cane is to be considered as a hollow cylinder; the total cane may be considered as containing juice and fibre. The cells of the cane have to be well ruptured and squeezed to get the maximum amount of juice containing the largest quantity of sugar.

The heavy rollers comprising the mills do squeeze and rupture the cells: but in this they are greatly aided by the preparatory devices before them. These cut the cane into small bits. The hard rind and the nodes are broken up and the soft pith that contains most of the juice can then be effectively treated by the following milling unit.

The cane knives are the preparatory devices. Generally one set of knives are used. More often two sets are used. One set forms a mere cutter and the other forms a cutter and a leveller. These knives rupture the cane cells with their impact or force of blow. A force of blow around 70 lbs. is considered good work. With well kept knives the capacity of the milling station could be raised by about 25% easily with advantage in extraction also.

The formula for the Force of Blow is :—

$$P\ blow = \frac{N \times 550 \times 60}{i \times n \times Rm}$$

where, P blow = Force of blow in lbs., for each blow.
N = Power input in H. P.
n = No. of Revolutions per minute.
Rm = Mean cutting radius in feet
i = No. of knives.

The power requirements of cane knives is taken as 2 H. P. per Ton Cane Hour.

MILLS

In capacity calculations for the mills, as the fibre is the one that gives the main opposition in crushing, the proper basis for all calculations in milling is the weight of the fibre and not the weight of cane as such.

Out of the number of formulæ that have been developed in arriving at the capacity of the milling tandems, the one that takes into account the preparation that is given to the cane also is the so-called Birkett's Formula given below :—

$$N_c = \underbrace{C\,L\,D^2N}_{\text{Mills}} + \underbrace{C_1\,K}_{\text{Knives}} + \underbrace{C_2Sh}_{\text{Shredder.}}$$

where N_c = Normal capacity of the milling tandem
C = Constant equal to 0.000024
L = Length of roller in inches.
N = No. of rollers in tandem.
C_1 = Constant 0.01
K = H. P. of Knife Engine as installed.
C2 = Constant 0.005
Sh = H. P. of the Shredder.

It will thus be seen that the determination of the fibre percent cane periodically if not daily will give us a good insight into crushing capacity of the milling unit.

There is another rough and ready method for determining the capacity of a milling unit.

Capacity in Tons per hour = 1/11 ton cane per sq. foot of total roller surface.

JUICE WEIGHING SCALES

Usually two scales of 2 Tons capacity each is to be installed so that while one is filling the other is discharging.

JUICE HEATERS

The capacity at this station should be such that 40 sq. ft. of heating surface is available per ton cane ground per hour.

SULPHUR FURNACE

The consumption of sulphur on cane may be aimed at around 0.06%. On this basis the sulphur furnace capacity should be calculated taking into account that 2 sq. ft. tray area is required for burning 1 lb. of sulphur.

It is usual to fabricate a furnace of about 6 sq. ft. tray area. The total capacity should be divided into a number of furnaces so that it will be possible to switch over to an alternate one while charging sulphur or if one goes out of order.

AIR REQUIRED FOR BURNING SULPHUR : COMPRESSOR CAPACITY

Though one lb. of sulphur requires 60 C. Ft. of air at 85° F. for complete combustion, an excess of air is provided and a figure of 100 C. ft. of air per lb. of sulphur burnt per hour is taken and the Compressor capacity is arrived at as so many C. ft. of air per minute.

AIR DRYING CHAMBER

It is very essential that the air supplied for burning sulphur should be completely dry. Other wise sulphur trioxide formation takes place. On bubbling through juice this forms Sulphuric acid resulting in inversion.

For drying 100 C. ft. of air 1 lb. of quick lime is required. But due to the dampness of sugar factories 2 lbs. of quicklime is consumed. The chamber should be so constructed as to take in a day's supply of quicklime on the trays. It should also be easy to open and change the quicklime quickly.

LIMING AND SULPHITATION TANKS

Usually three to four tanks of about 1500 gallon capacity with conical bottoms are required for an 800 Ton factory. We have recently the continuous liming and sulphitation tank on the market where one tank of ample capacity is used.

SETTLING

Where settling tanks are used the settling volume should be 2½ supply of juice.

The total volume is divided usually into 10 tanks so that when one is filling and other discharging, the remaining tanks will be in various stages of settling and continuity of operations is ensured.

But the modern trend is for the installation of continuous clarifiers where heat is conserved better and the resulting mud is more concentrated and compact. But in dealing with the continuous clarifier the initial juice treatment should be very carefully and properly done; otherwise the whole of the clarifier juice will be spoilt.

The continuous clarifier capacity required is 65 to 85 C. ft. per ton cane hour.

SCUM TANKS

They should be 1/5th. of the volume of the settling tanks.

FILTER PRESSES

With the plate and frame type filter presses 125 Sq. ft. of filtering area is required per ton of cane ground per hour. If a vacuum rotary filter is used only 6 to 8 sq.ft. of filtering area is required per ton cane hour.

EVAPORATORS

The heating surface required per ton cane hour is 260 Sq. ft.

VACUUM PANS

Capacity required at this station is 40 C. ft. of massecuite per Ton cane hour.

CRYSTALLISERS

Capacity required per ton cane hour is 150 C. ft.

CENTRIFUGALS

In one method it is usual to take one 18" × 30" machine per ton cane hour. In another method, the screen area method, it is assumed that 10 Sq. ft. of cane area is required per ton cane hour. Whichever method is used it is preferable to have a little over-capacity at this station. Though initial investment is there, it will help bagging as much of the final product as possible within a short time. Secondly with the overemphasis on increase crushing rates it is possible that always the boiling will not be upto the mark. Therefore a little extra capacity at this station will not allow jamming conditions at the crystallisers and pans. Besides with the longer crushing seasons, sugar factories have to crush not fully mature canes at the beginning of the season and overripe and stale canes at the end of the season resulting in improperly boiled massecuites which give a lot of difficulty in spinning. With these considerations in view it is better to have a little more capacity at this station. The latest make of automatic electrical centrifugals like the BMA machines will certainly add to the capacity and efficiency at this station ; but the old belt driven and water driven machines are not upto the mark in performance due to lower speeds in the course of service and this is another added reason for a little overcapacity at this station.

BOILER PLANT

With efficient working a Heating surface of 350 Sq. ft. per ton cane hour is required for a sulohitation sugar factory and 400 sq. ft. per ton cane hour for a carbonatation sugar factory.

GRATE AREA

50 Sq. ft. H. S. requires 1 Sq. ft. Grate Area

1 Sq. ft. grate area consumes about 25 to 28 lbs. of coal or about 85 lbs. of bagasse taking 1 lb. of bagasse as equivalent to 1/3 lb. of coal.

CHIMNEY DIAMETER

The following formula gives the method of working to obtain the chimney diameter:—

$$E = \frac{0.06\ W}{H}\ ;\quad \text{and } D\ 13.54\ E + 4.$$

where

E = Effective Area in Sq. inches.

W = Weight of coal burnt in lbs. per hour.

D = Diameter of the Chimney in inches.

H = Height of the chimney.

FLUE AREA

This is usually 20 to 40% greater than the chimney area.

REFERRENCES

1. L. A. Tromp. Machinery & Equipment of the Cane Sugar Factory.

2. The Engineer's Year Book 1948.

NEW ZEISS EQUIPMENT FROM JENA FOR NUCLEAR RESEARCH AND ENGINEERING

A team of scientists of VEB Carl Zeiss Jena have designed a number of new apparatuses for nuclear research and nuclear engineering. The work was directed by the chief scientific adviser of VEB Carl Zeiss Jena, holder of the GDR National Award, Professor Paul Goerlich who, twenty years ago, invented the Sb-Cs photographic cathode.

The principal item is a secondary electron multiplier phototube, the m 12 fs, incorporated in a scintillation counter. It has a 26-square-centimeter inlet window on which a scintillator is placed. This scintillator converts the energy of radioactive brighter the greater the energy of the absorbed radioactive radiation. The impulses can then be measured and counted with an electronic aid to determine the exact energy developed by the radioactive rays. This is a decisive improvement on the conventional geiger counter. Furthermore, with the help of a scintillation counter it is possible to determine the particular element responsible for the radiation. The new measuring technique will find application in the fields of medicine, chemistry, biology, geology, in the design of labour safety devices and in nuclear research.

Carbon's Unique Properties

By A Plant Engineer

TO say that carbon is a widely occurring element of great industrial importance is to state the obvious. Its large-scale exploitation in the form of coal or coke, or in combination with hydrogen as in fuel oils, or with other elements in chemical industry, is generally familiar and yet, in manufacturing processes such as steel making, relatively minute proportions of the element critically determine the quality of the product.

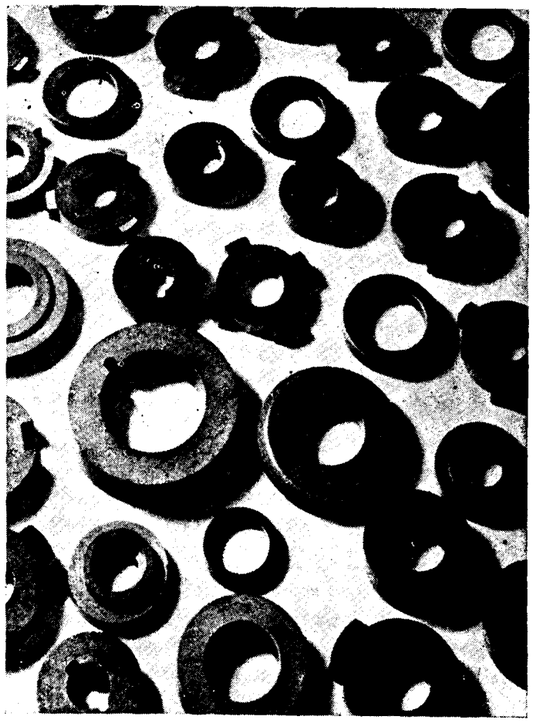
Less well known, but often of vital importance, is the use made of the unique properties of carbon in many manufactured products employed in mechanical electrical and chemical engineering which have contributed significantly to the advances largely credited, in modern technology, to the availability of improved materials.

Practically all the varied properties of carbon are of interest to the engineer. No oil or other lubricant is required for sliding mechanical parts made of carbon. Its compressive strength is adequate for many applications such as bearings where the resistance of the material to heat and to attach by chemicals is important. It is also lighter than aluminium, and of course cannot rust. Shapes can be moulded, or where necessary intricately machined, to a high degree of accuracy.

When air is excluded, as in certain industrial furnaces, carbon withstands temperatures far above the melting point of metals. Its electrical conductivity further widens its scope of use. It should be noted that because of its immunity to chemical attach and the fact that its oxides are gaseous, no interfering film is formed on carbon surfaces which are required to pass an electrical current. The black surface is an advantage for heat radiation.

The table reproduced here, whilst not comprehensive or fully indicative of the field of use of carbon, gives some interesting comparisons of physical and mechanical properties.

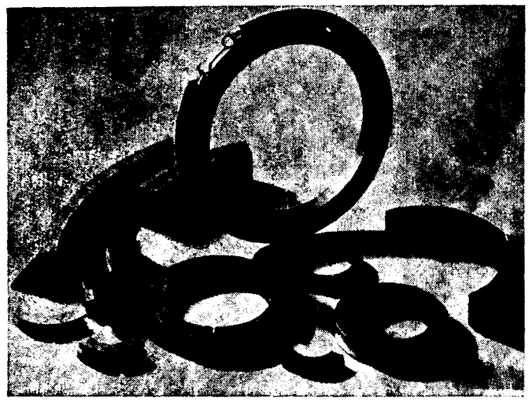
The variety of carbon used and to some extent the process of manufacture adopted depend largely on the purpose for which the product is required. The element remains solid at all temperatures from below



A varied selection of Morganite carbon seals.

freezing to above 3,000 deg. C. It passes directly from the solid to a vapour at extremely high temperatures as in the electric arc, and as it has no liquid phase it cannot be melted and cast like metals. Hence carbon articles have to be fabricated by grinding the raw materials to a fine powder and re-agglomerating with a suitable binder. The selected forms of carbon are blended together, and pitch, tar or other hydro-carbon binders, and sometimes other substances such as synthetic resins or powdered metals, are added.

The powdered mixture is then compressed under high pressure in a die or mould to the required shape and size; some carbon mixings are made suitable for extruding into lengths. This process is the so-called "green" stage of the product, which is then heat



A selection of Morganite carbon gland rings for steam and water turbines.

treated by raising it slowly to a high temperature in a protective atmosphere. The binding agent is decomposed and the residue of carbon is deposited between the particles of the original mixture, the whole mass being thus agglomerated together into a uniform solid article.

For some purposes articles made from different grades of amorphous carbon in this way are subjected to a second treatment at a still higher temperature, exceeding 2,000 deg. C., in special electric furnaces. This refinement produces greater purity and conductivity, and the product is known as electro-graphite.

The probable explanation of the lubricant properties of carbon or graphite is of particular interest to the mechanical engineer. In the structure, as revealed by X-ray diffraction, the crystals can be imagined as built up by the location of the atoms at the corners of contiguously extending hexagonal plates of which there are many layers. The cohesive forces between adjacent atoms of different layers are much less than the forces between adjacent atoms of the same layer. Hence the layers can readily split apart and slide easily on each other.

A carbon bearing quickly develops a graphite polish on its shaft, and in effect the great practical advantage of being able to do without oil or other lubricant is provided by the ability of the graphite surface of the bearing to slip easily and not seize on the graphite surface it has itself produced on the shaft. The coefficient of friction of carbon on steel is about 0.12. This value, of course, is higher than that obtaining on oil-lubricated surfaces and, as is to be expected, carbon bearings are generally limited to the field where oil lubrication is impossible or undesirable.

There are many applications, for instance, where bearings are required to work in hot surroundings at temperatures too high for oil, or where chemical conditions preclude the use of oil, whereas carbon, because of the remarkable chemical inertness, is unaffected. Carbon does not contaminate food and so finds various uses in the food industry.

Numerous examples could be given to illustrate the extensive development of carbon bearings in recent years. Perhaps of special interest, indicating the robust nature of the grades specially developed for mechanical applications are the Morganite Carbon bearings. These bearings are made by The Morgan Crucible Company Limited of Battersea, London, England who are represented in India by: Greaves Cotton & Crompton Parkinson, Ltd., P. O. Box 91, Bombay, Balmer Lawrie & Co. Ltd., M/A for The British India Electric Construction Co. Ltd., 21, Netaji Subhas Rd., Calcutta, The Crompton Engineering Co. (Madras) Private Ltd., P. O. Box 205, Second Line Beach, Madras 1, South India.

These "Morganite" bearings comprise several carbon bushes, usually of 200 mm. bore, and have largely replaced plain cast iron bearings. Because of high temperature and the presence of fine ash and dust, cast iron bearings could not be satisfactorily lubricated; their rate of wear was rapid and maintenance costly. A year ago the wear on a certain carbon stoker bearing was

Morganite Carbon bearings

measured and found to be only 0.2 mm. for about 9,000 steaming hours. After a further full year's run measurements were recently taken again and wear had increased by only 0.25 mm. By contrast the wear on cast iron was 8 mm. in 3,000 hours.

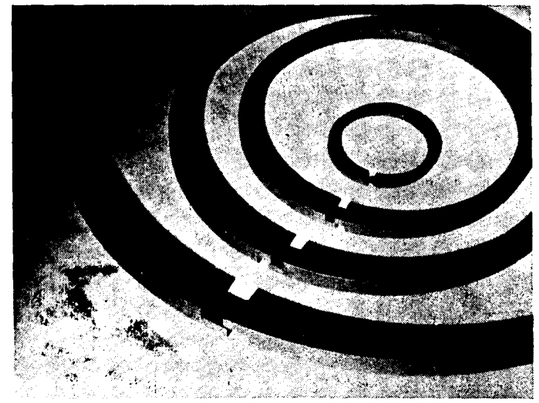
There is a growing demand for Morganite Carbon Bearings for conveyors and where a succession of several and widely different atmospheric conditions including those involving intense heat and chemical fumes to which the work may be subjected, prohibits the use of normal methods of lubrication. The continuous processes for the enamelling and "bonderising" of steel parts, for example, use conveyors fitted with carbon bearings which have given satisfactory results for many years, although they pass in cycles from one severe atmosphere to another as in the degreasing, stoving, cooling, hot water spray, chromatic rinsing and final drying at 320 deg. C.

The self-lubricating property of Morganite Carbon is also important in its use of rotary shaft seals. Much ingenuity has been expended in developing various designs incorporating carbon rings as the sealing member. Some designs employ a rubber member which is a tight fit on the shaft while leakage radially outward is prevented by the radial face of the carbon ring which rubs against the pump housing or a collar on the shaft.

In the latest design the Morganite Unit seal, particularly developed for circulating water pumps in motor-cars, a specially shaped compressible rubber cap is bonded to the carbon ring thus forming a simple unit which can be fitted by pushing into the glad opening in the pump housing.

Morganite Carbon ring glands for preventing leakage from steam turbines were first introduced nearly 40 years ago, and the principle is one of the methods most widely used today. For some time this system of shaft sealing has also been adopted for water turbines. Two principal factors affected the design of the glands in these machines. First there is the necessity to make the carbon rings in segments, so that they can be readily mounted and replaced without moving the shaft or bearings. Secondly, because of the high rubbing speeds, the design must be such that excessively high pressures are not exerted on the shafts.

Where carbon rings are used in modern turbines they are usually made up of segments, having simple straight radial joints, and kept together by an encircling garter spring. Allowing for the difference in the



Morganite carbon piston rings for a compressor giving oil-free delivery.

expansions of steel and carbon, the rings are arranged to have a slight clearance at the joints at working temperatures when newly mounted on the shafts. After a short running time and under the pressure of the steam the bore of the segments wears until the joints butt together. Thereafter the segments exert practically no pressure on the shaft although making the closest possible running fit with it. This condition makes a much tighter shaft seal that is possible with a labyrinth gland and so the important advantages of shorter axial gland length is secured.

Where the running speed permits, for example on water turbines, the segments are provided with overlapping joints with a clearance between them. Under the fluid pressure they can press continuously on the shaft and make a tighter seal. The overlapping joints are usually of special design to prevent leakage through the clearance. In the latest design the ring is made of simple unequal segments which by a wedge action permit any desired sealing pressure to be exerted on the shaft according to requirements. Radial leakage outwards is restricted in all these examples because of the side surface of the ring mates against the side surface of its housing.

It is also possible to use Morganite Carbon in the design of labyrinth glands to reduce to some extent the amount of leakage to which they are generally subject. The gland housing in the stator is provided with grooves in which the carbon rings are fitted. The housing closely surrounds the carbon, which is of a suitable section to be securely held without the need of an encircling spring. The edges of the fin-like annular

metal labyrinth projections on the shaft lie opposite the bore of the rings. Leakage is thus reduced, as a much lower clearance is permissible between the fins and the stator, because when the fins rub on the carbon, as can happen when the shaft passes through its critical speed they can readily wear a fine groove in the carbon, whereas in rubbing metal against metal severe damage could ensure. This application forms another example of the development of a special grade of Morganite Carbon to meet a demand. It must be soft enough not to resist the cutting action of the fins, yet sufficiently dense to withstand the action of super-heated steam at high pressures.

Piston rings and shaft seals on reciprocating pumps and compressors often present difficulties in some operating conditions and suitable grades of carbon have been highly successful in this field. In air compressors the use of carbon piston rings ensures an oil free supply. This same advantage is obtained in reciprocating steam engines when clean process steam is required, as in laundries. Carbon is also used in compressors for various chemical liquids and gases where the use of oil lubrication may be prohibited. The piston rings are usually made up of overlapping segments, with an expanding internal circular springs pressing them outwards against the cylinder walls, although they may sometimes be in one piece and slit. The reciprocating shaft seals usually comprise carbon rings of patented design consisting of simple unequal segments giving a wedge action to limit the pressure they can exert on the shaft.

In this bried account of the uses of Morganite Carbon in one branch of the engineering only, reference should also be made to the large variety of components used as rotary or sliding valves. Petrol pumps for direct metering employ a rotary valve made of a particular grade of carbon, moulded in a comparatively complicated shape but with the rubbing sealing face machined practically to optical flatness. Meters for hot water and chemical fluids use carbon "pistons", specially shaped cylinders, eccentrically mounted in the circular chamber of the meter, which sweep out a given volume of the fluid for each revolution. In such applications, among its other properties, carbon offers the advantage over other non-metallic materials of dimensional stability and the capacity to withstand an extraordinary variety of difficult operating conditions.

TABLE OF PHYSICAL AND MECHANICAL PROPERTIES OF "MORGANITE" CARBONS

Property	*Carbon*	*Comparisons*	
Density	1.4–1.95	Aluminium	2.6
Specific heat	0.20	Copper	0.092
		Iron	0.11
Heat Conductivity (c. g. s. units)	0.3–0.03	Silver	1.0
		Steel	0.11
Melting point	3,500°C–4,200°C	Copper	1,083°C
		Iron	1,500°C
		Tungsten	3,400°C
Radiation constant 700°C	94 per cent of black boxy	Molybdenum	9 per cent
Linear Cœfficient of thermal expansion	1.8–3.8 × 10–6 per°C	Steel	11.4 × 10–6
		Copper	16 × 10–6
Ultimate tensile strength	1,000–4,000 lb./sq. in.	Carbon steel	60,000 lb. sq. in.
Ultimate compressive strength	3,000–20,000 ,,	Cast iron	100,000 ,,
Modulus of elasticity	0.45–1.4 × 10–6	Steel	30 × 10–6
Electrical resistivity	750–7,500	Copper	1.6

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

PART-II STRESS IN RAILWAY MATERIALS

(Continued from Vol. I, No. 4—June, '57, Edition)

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FISH PLATES

EARLY fish plates were merely straps of iron bolted against the webs of adjoining rails to hold them in correct end-to-end alignment. It is now known that they must preserve as far as possible the continuity of the rail by providing approximately the same strength, stiffness, flexibility as the rail itself. Subsequent designs therefore gave greater stiffness by contacting the fishing spaces and base of the rail but not the web. Strength was at the expense of symmetry by adding more metal at the base in the form of a toe. As symmetrical sections have greater resistance to flexure and lateral deflection from vertical loads, the recent trend is to have approximate symmetry (with in 10 per cent) about both horizontal and vertical axes.

It has been shown that the negative bending moment of fish plates (when the carriage wheels lie outside the ends of the fish plate) is greater than the positive one (when a wheel passes the gap between rails). The resultant stress will be high enough to cause fatigue cracks at centre of top of plates. When, however, girder type fish plates are used, the load on fishing surface is stated to be only 1/6th of that with the standard joint with the result that over stressing can be reduced. Such joints were under test for more than six years in the Ex. L. M. S. Railway and have been stated to be satisfactory.

It has been the practice so far to make the fish plate steel softer than the rail steel, so that wear at the joint would occur on the cheaper replacement item, i. e. the fish plate rather than the rail. Whereas a medium manganese rail steel requires 0.45 to 0.55% carbon and 1.1 to 1.4% manganese for all sections, and a basic O. H. carbon rail (90—115 lb.) requires 0.58—0.68% carbon and 0.65—0.9% manganese, the fish plate steel requires only 0.3 to 0.42% carbon and a maximum of 0.8% manganese. The yield point of this fish plate steel is expected to be about 19.5 tons assuming it to be about 50% of the tensile strength. It is now known that fish plates may ordinarily be subjected to pulsating loads of 22 tons per sq. inch. Calculations show that with a coupled axle load of 21½ tons moving at 60 mph., such fish plates used with 90 R rails could be stressed to about 25 tons/sq. in. Stress-recorder observations show that very high stresses occur in practice.

In view of this and the incidence of a large number of failures, a higher quality steel would appear to be necessary. The modulus of section of two fish plates is about half that of the rail section. Hence, the stress in the fish plate should theoretically be almost double that in the rail. In practice, other factors also come in the picture which reduce the stresses. It has therefore been stated that a fish plate steel should have a tensile strength equivalent to that of rail steel, with a yield point preferably in the range 35 to 40 tons/sq. in. In American specifications, there is provision of a superior quality of steel. Besides a high carbon steel with a minimum of 0.45% carbon there is provision for a quenched carbon steel variety having 0.35 to 0.6% carbon with a minimum yield point of 31.25 tons/sq. in. The continental specifications while requiring a tensile strength of 36.2 to 41.3 t. s. i. for fish plates in the 'as rolled' condition specify a minimum tensile strength of 70 Kg./m² for heat-treated fish plates.

AXLES

From the earliest days of railway operation, the closest attention has been paid to broken axles since these generally result in a derailment and this endangers not only the vehicle concerned but also the entire train. A statistical analysis of axle failures shows that the defect of material forms only a small fraction of the total number of broken axles. It has been found that even relatively large defects are not dangerous provided they occur in a favourable position

such as the centre of the cross section of the axle. Since the fracture of these commence from the outside, even pipes which were discovered at the centre gave no trouble.

Axles rarely break in the centre. On outside journal axles, where the journals are outside the wheels, the fracture commences within the wheel fit at a short distance from the inside wheel hub face. In these cases, one would expect failure in the considerably smaller journal and not at the inside of the boss where the section is much longer. It is peculiar that the same kind of fracture occurs in journals fitted with roller bearing axle boxes. The failures are generally within the pressfit near the inside hub face. On inside journal axles where the journals are between the wheels, the failures are generally found between the pressfit near the inside hub face of the wheel and also near the bearing seat. These failures have been attributed to the abnormal stress due to the pressure of the shrunk-on wheel centre or of the taper clamping sleeve and the notch effect of the change of section from the wheel seats to the journal and to the axle.

While it is known that a square cornered fillet is bad, it is however not remembered that quite the same effect is produced when a shaft has an integral collar, when a collar is clamped on a shaft or when a press-fit is made without any effort at distributing the local stress. In 1937, Lea found that a smooth shaft without a collar had and endurance limit of 88000 lbs. sq. in. which was reduced to 45,000 when a collar was clamped on it and to 43,000 when it was made integral. Press-fits exert a similar clamping effect. This is particularly serious in Railway Axles since the crack starts just back within the press-fit and cannot be seen on inspection.

The design of axles presented 2 difficulties—(1) The forces acting on axles under service conditions are not known. It is, therefore, impossible to calculate the stresses present. (2) The fatigue strength of steel in large sections were not known. Fatigue strength has been found to decrease with increasing size of the test piece, the reduction being greater in material of high tensile. This is probably because the larger the specimen, the more is the chance that a tiny weak spot will be present. Herger and Neifert found that the endurance limit of a 0.3 in. diameter axle is 33,000 lbs. as against 28,000 for 1.5 in. diameter and 17,500 for 6.5 in. diameter. As such, data from fatigue tests usually made on 0.3" diameter could not be applied to larger diameter. In the past, empirical formulae were used based on the results of successful performance over a long period of years. The advent of higher speeds has however increased the working stresses so that application of this empirical design formula to axle design could not guarantee freedom from failure.

HAMMER-BLOW

In order that an engine may run smoothly, it was necessary to provide counter weights for the driving wheels opposite the crank pin with the object of balancing the weight of the rotating parts. Such static balancing was however found not enough since a loco driving wheel is usually moving. As the different rotating weights carried by crank pin and counter balance are not acting in the same plane, couples are set up which prevent smooth running. To prevent swaying, a secondary weight was found necessary in the opposite wheel for dynamic balancing. Further, the alternate back and forth thrusts of reciprocating masses like piston, and connecting rods set up an unbalanced force acting on the engine frame and stressing it as well as the axle in a horizontal direction. This was minimised by adding an additional counter weight on the driving wheels opposite the pins where the crank and side rods are connected; which by its unbalanced centrifugal force tended to llft the wheel or press it down alternatively. The effect of this additional weight was to transfer the forces acting on the engine from a horizontal direction to the vertical so that the rails felt the effect instead of the train. As this was detrimental to track a compromise was reached between balancing for the vertical and horizontal forces. In practice only 2/3 of reciprocating masses are balanced so that there is an unbalanced horizontal force arising from 1/3 of reciprocating masses and a vertical force from 2/3 which produces what is known as hammer blow on rails. This increases with the square of speed so that it is doubled when the speed increases from 70 to 100 m. p. h. Photographs have shown old wheels rising as much as $2\frac{3}{4}$ in. from the rail at speeds of 100-115 m. p. h. The downward blow is sufficient to bend and kink the rail in many places.

Modern research has shown that the bending stresses are much greater than those normally calculated due to abrupt changes in section from axle to hub. It has been found that the mere press-fit of a member on an axle submitted to alternating stresses reduces the fatigue strength to between 1/2 to 1/3 as though the axles are notched. This is because, a press-fitted assembly presents a shape similar to an axle with an integrally machined hub having a small fillet radius, which introduces a concentration of stresses near the change of section. The press-fit pressure between the two members also reaches a peak value at the end faces of

the hub due to the end restraint of the protruding axle. Further, as the axle rotates under bending stresses and flange forces, the minute sliding action of the end face of the hub on the axle surface due to alternate elongation and contraction of axle fibres produces rubbing corrosion and rust near the end faces of hub, thus resulting in weakening due to corrosion fatigue.

The greatest bending moment and consequently stresses are encountered at the junction between axle and inner hub edge. It is here that the peak press-fit stresses are also imposed. This results in dangerously high stresses, the adverse effect of which is accentuated by corrosion within the hub caused by fretting of the axle. Any damage to surface or notch effect is more dangerous than calculation show. This is because stresses affect only the outer fibres and must be taken in relation to a surface layer 0.1 mm. thick which has to carry the maximum load and not the whole section. With a rapid alternation of load, the inner zones of cross section cannot participate in the load.

Other factors that reduce endurance strength are—(1) excessive pressure in pressing wheels into axles, and (2) loss of camber of springs of overloaded goods wagons etc. resulting in additional load on axles when running over rail joints. Fretting corrosion due to flange forces near the end face of the hub can be minimised if the axle between the wheels is elastic. In such a case, the energy arising from any impact between wheel and rail can also be absorbed in the unsprung weight system. since most of this energy would be expended in deflecting the axle. It is therefore the practice to taper the portion of axle between wheels (for e. g. from 12 in. to 9½ in. at centre) so that it can deflect and thus reduce not only axle impact stresses and fretting corrosion due to flange forces but also result in weight reduction.

In the old-fashioned method of pressing wheel on to axle, it was not possible to check whether the hub contacted the wheel seat through out its entire length. As a rule, this was not the case and the contact was usually unsatisfactory just against the inside. This results in a streak of corrosion forming round the wheel seat, which sooner or later led to failure. The method now adopted by the Swedish State Railways is to grind in special machines the wheel seat as well as bore of hub. For mounting, the wheel centre is heated to 150°C when it can easily be fitted into the right position on wheel seat. After cooling, a tight interference fit is obtained.

Increased strength of press-fitted assemblies has been obtained by (a) providing relief grooves in end faces of pressed-on members, (b) raised seats on the axle at the press-fitted portion and (c) cold working of wheel seat. The first relieves peak press-fit stresses near end face of hub due to the flexibility of the lip on the hub which prevents building up of high stresses at this point. The second gives a more gradual change in section between wheel hub and axle. It also reduces the peak pressure at end face of wheel hub due to decrease in lateral restraint of protruding axle. The bending stresses near end of pad are also reduced at the point where the press-fit stresses are maximum. These methods have given a maximum of about 30% increased strength. The third method, namely, surface rolling, better known as 'burnishing' in shops gives an increase in the fatigue strength of press-fit assemblies amounting to 2—1/3 times. This is primarily due to strain-hardening of cold worked axle surface, though residual compressive stresses in the surface layers of axle may also help. It is understood that Timken has adopted a combination of (a) stress relief groove on the inside face of wheel hub (b) raised seat for press-fit of wheel hub and (c) cold working of wheel seat.

The best groove shape is found to have 20° angle tangent to groove radius. Improvement can also be obtained at slight expense by providing an extended hub or reduced diameter corresponding with the 20° lip on relief groove. A hub conically shaped so as to give a thin wheel bore will also reduce the stresses at edges and thereby reduce axle stresses.

Many axle failures have been traced to operating conditions such as hot running. According to the results obtained by J. J. Laudig, research engineer, Lackawanna and Western Railroad Co., U. S. A., the cause of journal failure due to a hot box is not due to the intense heat produced when lubrication fails as is commonly believed. It has been demonstrated that when a 3/8 inch steel rod bent or held under stress is heated and any copper-base metal is rubbed on the bent surface, a brittle fracture is obtained due to the weakening caused by penetration of copper into the grain boundaries of steel. Since atoms at the inter granular boundary cannot be in perfect alignment with crystals on either side they are loose and hence easily attacked compared to those in the interior of the crystal. Low melting alloys have, therefore, a tendency to alloy with these. Stresses favour such intergranular attack by keeping such areas open.

In actual journal failures due to hot box, analysis showed a notable amount of copper at and below the surface. Microscopic examination of the surface metal

and the area directly below revealed copper between the grains. It is evident that frictional heat, bending stresses and contact between steel and bronze have brought about migration of copper from the bronze shell to the steel journal surface along the grain boundaries. When bearings made of Meehanite B high strength cast iron lined with white metal and without lubrication were placed on one end of an axle, the expected hot box developed but the journal remained intact though red hot. With a bronze shell under similar circumstances the journal broke. As a result of these tests, the A. A. R. at its annual meeting in 1952 approved this kind of iron bearing as an alternative standard.

During 1951—56, in Indian Railways there have been several failures of W. P. and W. G. loco. axles. Many of these premature failures were traced to copper penetration. The fractured part when examined under high magnification showed intercrystalline cracks with copper-coloured material, and the areas just below the fine cracks showed the presence of copper-coloured constituent along the grain boundaries without any actual formation of cracks. To prevent such failures, revised designs for lubrication of wheel hub linear and axle box side linear, improved wedge adjustment and rigorous inspection at the shops have been initiated. On new W. P. locomotives, roller bearing axle boxes are to be fitted on the coupled axles.

COUPLED AXLE BOXES

Heated bearings, popularly known as 'hot boxes' which lead to axle breakage are not only caused by poor quality lubricants but are also due to breakage of axle box and failure of lubrication arising from improper design. For instance, a statistical analysis of failures of solid leaded bronze axle boxes of WP class of engines up to 1953 showed that about 150 boxes had failed. In the majority of cases the pattern of failure was similar. Cracks originated from the sharp machined horizontal grease grooves. The same was the case with the 110 XD class locomotives supplied soon after the war. The sharp corners resulted in stress concentrations. While in the case of carrying wheel bearings, the pressure/sq." due to the static weight of vehicle is the measure of journal loading, in coupled axle boxes, the maximum pressure is increased and altered in point of application by the loading due to piston thrust when steam is on. The whole of piston load is transmitted through driving boxes and the piston thrust effect can produce and sustain for long periods a resultant load on the bearing several times that due to vertical dead loads. The stresses will be much greater about 40° on each side above the horizontal central line of a coupled bearing. It is in this region that the bearing surface should be continuous to avoid any break in the lubricant film. The existence of long horizontal grooves is therefore not desirable. This is specially so when they are located in the thickest section which is more prone to porosity and coarse structure as a result of the longer time required for solidification and cooling. As such, it was recommended that boxes with horizontal grooves should be replaced by boxes with rounded shallow vertical grooves at the first loco. periodic overhaul. The grease grooves instead of being made by machining should be cast-in with increased radii for the corners. As failure in lubrication may result in excessive temperatures and thus affect the strength of leaded bronze, the present trend is to replace solid bronze axle boxes by steel ones having a 'cast-in' bronze bearing.

TYRES

Just like axles, the wheel is of vital importance in the make-up of a locomotive since any failure here can be attended by the most serious results. Wheel centres are very rarely the cause of failures in service. The fracture of tyres is however more common and is one of the most worrying problems to the railway engineer. Most of these show a small fatigue flaw spreading into the tyre from the machined surface of bore close to flange face. Originally, tyres were thought to be better for being turned very roughly. It was thought that the rough material enabled the tyre to grip the centre more securely. It is now known that rough machining of the bore with H. S. steel gives rise to stress concentrations. As machining has also the effect of cold working and hardening cracks are produced. Further, with a roughly bored tyre, corrosion occurs resulting in loose tyres. With polished surfaces free from tool marks got by using carbide tools for boring, there is contact between wheel centre and tyre over a greater area. Ingress of moisture and consequent corrosion can therefore be prevented.

The flaws in driving wheels were generally found to develop at the ends of the balance weight. As this was traced to uneven cooling caused by the large mass of the cost in balance weight which hastened the cooling of that portion of the heated tyre adjacent to it and thus caused an unequal distribution of shrinkage stresses, built up balance weights were introdced. This led to a reduction in fatigue flaws. As a result of severe or prolonged braking at high speeds the tread metal often develops thermal cracks which will lead to failure unless eliminated by turning before

they become dangerous. At high speeds, due to friction by brake blocks heat develops on the surface of the tread more rapidly than it can flow into the rim, and the tread metal rises to temperatures of 1400°F and over, at which temperature the strength of the steel is reduced more than one half. On emerging from beneath the brake shoe, the tread metal is cooled rapidly due to air currents and atmospheric moisture. This alternate rapid heating and cooling of the tread metal while the body of the rim remains at a moderate temperature, leads to the development of thermal cracks in the tread metal.

If brake shoes are allowed to overhang the edge of the tread or to ride the flanges of wheels, concentrated heat effects are produced at those locations. Similarly, when brakes on the various cars comprising a single train are not equalised, resulting, in certain cars doing much more than the average amount of braking, the results can be extremely destructive to the wheels.

In the operation of a wheel, the stress at any point in the tread rises from zero to a maximum value, and falls again to zero once in each revolution. A 36" diameter wheel makes one million revolutions in about 1,800 miles. In the regular course of service, therefore, all of the conditions required for fatigue failure are present. Consequently, if the wheel is overloaded so that the maximum stress exceeds the fatigue limit of the steel, fatigue failure from shear stresses in the tread metal known as 'shelling' may be expected. Many cases of shelling of hind truck wheel tyres have been reported by Indian Railways. The fact that there were no such complaints about tender wheel and driving wheel tyres has been explained by the fact that the hind truck wheel tyres are more heavily loaded per foot of diameter of wheel. A suitable remedy would therefore be to reduce the loading on hind truck axle.

In estimating the carrying capacity of a wheel, its diameter as well as the load is considered. The larger the diameter, the greater is the area of contact between wheel and rail and the lower the stress for a given wheel load.

An increase in speed increases the impact force with which the wheel strikes rail ends, cross-overs, switches, and other irregularities in the rails. The impact forces add to the stresses due to static loading and increase the tendency to failure by shelling.

Resistance to shelling is provided by increasing the strength of the tread metal. The wearing qualities are improved by using harder steels. The usual method of increasing hardness and strength is by increasing the carbon content though this reduces its ductility. On the other hand, thermal checking is minimised by lowering the carbon content. Thus, the two causes of failure, thermal checking and shelling, call for remedies which are the opposites of each other. Hence, a balance must be struck between a soft tyre which wears quickly and a hard tyre with the danger of thermal cracking necessitating early replacement. In view of the flexing to which the material of the tyre is subject, good ductility is essential. By quenching in oil and tempering, steels with higher tensile strengths can be obtained which also give very good elongation. For instance, a tender tyre 'as rolled' having 0.7% carbon and 0.68% manganese was found to give a tensile strength of 53.95 t. s. i., an elongation of 13.5% and R. A. of 20%. The same tensile strength with increased elongation (17%) and improved R. A. (29.2%) was obtained with a tender tyre having a lower carbon (0.56%) and similar manganese content when quenched in oil for 45 seconds from 815-830°C, tempered at 560-580°C and cooled in still air.

With the introduction of high speeds and the necessity of rapid braking to enable a train to come to a stop within a short distance, rapid heating of tyres to critical temperatures followed by cooling has become more common. Consequently, all tyres of these fast services developed cracks and required machining resulting in loss in service life of tyres. When, instead of high carbon steels, softer tyres with lower carbon are used there is slackening of tyres on wheel centres. The tyre gets cold rolled between the rail and the wheel centre in portions round its vertical central line, thereby developing a concavity in the centre of as much as 1 m. m. Consequently, it is only at the extremities that the tyre grips the wheel centre. Water finds its way in the concavity causing rust and slackening of tyres. Alloy steels have therefore been used which give the necessary tensile strength without sacrificing ductility and thus inhibiting cracks. The tendency to cold rolling and consequent slackening of tyres is also diminished. It is understood that the Italian State Railways use 1% nickel steels with lower carbon for their high speed electric multiple trains.

As regards fastening of tyres, theoretically speaking, the shrinkage should be sufficient to hold the tyre securely on the wheel. However, when a tyre is heated by a prolonged brake application, it expands and without effective means of securing might move sideways before it cooled off and gripped the wheel again. This happened during the war in certain American engines turned out without any fastening.

In the event of a tyre breakage, the fastening is also helpful in holding as much of the tyre in position as possible until the engine can be brought to rest.

In the beginning tyres were fastened to wheels with studs. Fatigue cracks were often found to originate from the bottom of one of the threads in threaded stud-holes which existed on the inside for fastening tyres to wheels with studs. For instance, the investigation by the Metallurgical Inspectorate, Tatanagar, of several cases of tyre failure reported by the ex. G. I. P. during 1926—1938 showed that the crack in each case was located in the plane of the major transverse axis of the stud hole. The latter caused a concentration of the normal stress at the surface of the hole which in simple tension was stated to amount to 3.9 times the normal. In addition, there was the 'notch effect' due to screw threads. As a result of these findings, the stud type of fastening tyres was abandoned. Though rivet fixing is better in this respect, there is the possibility that the side riveting holes on the wheel centre would also have the effect of notches, though to a less severe degree. Fastening with the Gibson ring type has the advantage of calling for no drilling at all and hence eliminated one source of possible failure. The ring was fastened in position by a machine which rolled over the lip as the wheel was slowly rotated. A pressure of about 15 tons on the roller was gradually applied. The use of rings however involved corners in the design of tyres, which when sharp, gave rise to a number of fatigue failures. In the AWE and MAWD locomotives built in America, Mc—cormick tyre retaining clips were used for fastening. Though effective in retaining the tyre in position laterally, they do not prevent circumferential movement of slack tyres.

Many tyre fractures, excepting those due to stud holes have been found to originate from fatigue flaws developed from the inner surface adjacent to the wheel centre. Cracks in the tread are however of no importance since this part is in compression. As cracks on the inside of bore tend to open, stresses have to be prevented. One method is by making the wheel rim stronger. A weak rim section which does not give rigid support to the tyre allows it continually to flex between adjacent spokes. When so flexed, the inner surface will be in tension while the outer will be in compression. As such cracks on the inside of the bore tend to open and are dangerous. The remedy is to make the wheel rim as strong as possible. The recent trend is therefore to have a triangular-shaped rim which gives better resistance to flexing between wheel spokes due to impacts when an engine passes over rail joints, points and crossings, etc.

It has also been found that in the case of roughly bored tyres, tool-marks help in the ingress of moisture. Corrosion arising from this is a possible starting point for minute flaws and is therefore undesirable. As rough machining also gives rise to stress-concentrations, a perfectly polished surface of tyre bore and wheel centre is desirable.

CONNECTING AND COUPLING RODS

Like loco. axles, these have to be designed uneconomically from an academic stand point to take care of stresses not susceptible to precise service analysis. Stresses arising under service conditions include eccentric loading due to s de play of the leading coupled axle in relation to the driving axle or frame under nosing movements of the engine, concentration of stresses due to rough machining, overloads set up by suddenly arrested slipping and simultaneous action of thrust, inertia forces and torque. It has been found that the rupture of coupling rods either starts from flanges due to transverse flexure or web due to torsion. Static tests on connecting and coupling rods in longitudinal compression showed that compressive loads produced a lateral deflection roughly proportional to the load applied. This has been explained on the assumption that the loading is never applied exactly along the central axis of the rod. In the design of coupling rods, the most critical factor to cover is bending in the horizontal plane since rods do not generally bend upward but always outward. The remedy is therefore to increase the lateral strength of the member against bending by making the section rectangular.

Round about 1938, the number of failures both in the body and in eyes of coupling and connecting rods reached alarming proportions. The existing XB, XC, XE rods were found to be weak against buckling at low speeds. Within a short time, fracture occurred at low speeds in leading coupling rods at a point about 9 inches from centre of driving crank pin where the normal section or rod commences to be enlarged to form the eye end. Under all ordinarily computed stresses, this is not a position of maximum stress since the bending moment is zero at this point at low speed. A mathematical analysis of the working stresses by the consulting engineers, M s. Rendel, Palmer and Tritton in what is now familiarly known as the £ 1000 report showed that the epidemic fracture of coupling rods was due to incorrect design based on stresses computed by traditional methods resulting in stresses exceeding the capacity of the material In practice, the mechanisms are actuated by dynamic

forces changing in sign and therefore varying in amount and by incidental and accidental influences. The original fluted design of the I type had a variable thickness of web and width of flange. Cross sections with large differences in moments of inertia about the 2 principal axes will be weak in torsion. The torsional rigidity will be less than either and twisting will occur due to torsional stresses under simultaneous flexure from compressive load and lateral bending. Fractures from such stresses would occur at a point where the transverse section is least. For all scetions other than circular, the surface would warp. The ideal strut would be one which tapers elliptically from centre of length towards ends and which has every where an elliptical cross section. As such a section is impracticable due to difficulty in machining the profile, a rectangular section which approaches the elliptical was chosen as the best compromise. It has torsional and fatigue values much in excess of I sections. Though the latter is more economical in material, the rectangular section being more flexible for lateral bending could deflect more without the maximum permissible stress being reached, thus giving increased resistance to lateral bending or torsion.

The value of the recommendation was however largely nullified by their overlooking the serious stress raising effect of external corners under repeated bending. In their new design, only a radius of 1/8" was specified though many failures of connecting rods did start from an external square corner. On this the comments of the Metallurgical Inspectorate were as follows :—

> "While most of the designers are aware of Wohler's work, very little practical use has been made of it.... It does not seem to come easily to mind that while say 99.9 per cent of the area of a section may be stressed within reasonable limits, yet owing to the stress raising effect on the contour of the remaining 0.1 per cent, the whole of the section is doomed to inevitable failure.... R. P. & T have not realised that an external corner is just as dangerous as a discontinuity under repeated lateral flexures and repeated torsion. Actually the rod has fractured from an external corner. To change from a girder section to rectangular section of larger area without rounding the four external corners, is not removing the cause of trouble".

As a result of these remarks, the radius given for the four corners of the proposed new design of coupling rods was increased from 1/8" to 3/16". This was also done for all the corners of the I section of connecting rods.

It would thus appear that the recommendations of the consulting engineers based on the mathematical analysis of working stresses should be experimentally verified by metallurgical examination of broken parts including a statistical analysis. A broken rod is nothing more than a test piece broken on a testing machine and a fatigue fracture may be considered as the autographic record of what has been happening in service. Since the value of a mathematical analysis of stresses is largely nullified by the wide assumptions necessary and undetermined factors arising from dynamic augment, harmonic or unharmonic vibration etc., a good deal of co-operation between the metallurgist and the design engineer is necessary in solving problems of failures of stressed components.

LOCO. FRAMES

In addition to supporting most of the weight of the locomotive, a loco. frame has to stand up to an enormous number of stresses-bending, tensile and compression including the reciprocating stresses between the piston and crank. It was once considered that the loco. frame should be of riveted construction so as to be flexible enough to accommodate itself to the track. The strength and security of bolted and riveted joints is however based on the assumption that every bolt and every rivet is perfectly tight. Under the severe conditions of loco. service involving stresses of all kinds, some measurable and some unknown there is always slackening of bolts and rivets. The basic assumption does not therefore hold good. The present day practice is to design a rigid frame structure. To provide the required rigidity, the frame plate must have a certain thickness in addition to tensile strength. The steel must also be weldable as many frame repairs are executed by cutting out the faulty section and welding a new section of plate in its plate. Though mild steel is generally used, where weight must be reduced owing to loading limitations, a low alloy manganese-copper-chromium steel has enabled the plate thickness to be reduced without loss of strength but with increased corrosion resistance. A rigid welded structure has also been advocated since this has the advantage of maintaining correct alignment of moving parts and increasing the life of bearings.

As a result of experience, electric arc welding which had for many years been used for minor and unstressed parts is now being used for making reliable joints for stress carrying members. Much attention has been

given of late years to the question of residual stresses in welded structures and methods of stress relief. Experience has shown that when every weld is laid in short runs and peened before the deposited metal has had time for considerable cooling, all the stress relief needed is obtained. The fact that extensive arc welded repairs depending entirely on welds have been in service for years without any sign of failure has given complete confidence in the fully welded frame. There is here no possibility of corrosion as in pockets between the spacing of rivets. Complicated shapes could be fabricated from rolled sections which result in saving in weight due to elimination of angle knees and reduction of gussets. There is also no noise from power riveting hammers.

It will be seen from the above that the permanent way and the mechanical department of railways are interdependent. The strength of the track and bridges are to a large extent controlled by the design of the Loco. and vice versa. For instance, in view of the conflicting requirements of the Loco. and Civil departments, the amount of counter-balance should be regulated between an upper limit to prevent excessive hammer blow on track and bridges (which alternately increases and decreases the static load) and a lower limit to guard against undue vibration of the loco. during running. As a good deal of compromise is necessary in many instances, it is necessary to base design on a combination of scientific principles of the metallurgist, the intelligent anticipation of the designer and experience derived from a study of service failures under prevailing local conditions. Recognising this long age, the Railway Board took the initiative in establishing the Metallurgical Inspectorate during 1909 to 1912 and the Central Standards Office for railways in 1925, who by their co-ordination have been responsible for some of the major investigations in the field of tyres, rails, motion rods, etc. Recommendations based on such experience have formed the basis for the drafting and revision of material specifications in I. R. S. R-32 for Steam Locomotives.

As track and loco. components are subjected in service to so many variables like chemical composition, the frequency of traffic, type of rolling stock, its weight, speed and state of repair, condition of road bed etc., the actual stresses involved are complex which neither the metallurgist nor the design engineer can anticipate from purely theoretical consideration. A glaring example of this is the recent discovery by the Association of American Railroads (A. A. R.) that fatigue due to shear till now thought to be the cause of rail shelling, is not the culprit but rather the reversal between compressive and tensile stresses. Since shelled spots were frequently observed to start on the underside of small fins formed on the gauge side of the rail, it was believed till recently that the fin acted as a notch or stress raiser in causing a shell crack at its underside. The formation of fin was considered to indicate a shear mechanism where the top surface was attempting to slide past the metal below. Recent work by the A. A. R. however showed that rails which were ground to remove fins shelled just as readily as the unground rails. Further, the values of shear actually observed in experiments concerning the effect of wheel diameter and wheel load on rail damage, were found to be far too low to cause progressive failure by shear stress alone. On the other hand, strain gauge measurements of residual stresses in rail heads subjected to track conditions showed a reversal between compressive and tensile stresses. While residual compressive stresses of 20,000 p. s. i. were observed at the gauge corner, by removing successive layers of metal the residual stresses were found to be gradually reduced until at a depth of about 1/8", a stress of 20,000 p. s. i. tension was found. Such a rapid reversal between high compressive stresses and tensile stresses is now considered as the fatigue producing agent in failures due to shelling.

Messrs. Gelson and Blackwood during their investigations on stresses on Indian track as early as 1939 had recorded 12 tons/sq. in. tension in the head on the outer face of the outer rail. They expected that the corresponding compressive stresses on the gauge face of the rail would approach the upper limit of fatigue when high lateral loads were caused by locomotives. Such tensile stresses have now been attributed to secondary deflection of the rail head due to elastic compression of the web by vertical loads or lateral flange forces on straight track or eccentric vertical loads on sharp curves.

A study of rail end failures by the A. A. R. has shown that a large number of these begin by concentration of stress at the rough spots or right-angled corners left by the saws at the rail ends or by the drills at the bolt-holes. The gouges and burrs around the edges of bolt holes also function as stress-raisers. Such failures could be reduced by rounding off the corners. According to the experience of the French Railways, countersinking the edges after drilling, by a special milling drill, also considerably reduced the incidence of bolt hole cracking. Grinding rail end is also desirable. They also found that the number of bendings required to give cracks increased as the bolt hole diameter decreased. As such, the diameter of the bolt hole was brought down from 35 m. m. to 23 m. m. The frequency of web failures within the joint bar area and especially though the over-stressed bolt hole nearest the rail end led to a study of the effects of bolt hole spacing on rail web stresses in the University of Illinois Engineering Experiments Station These tests showed that high tensile stresses in a vertical direction are produced under load at the bolt holes and in the upper and lower fillets at the rail end when the track bolts are tightened to much. The max. tensile stress and possibility of fatigue failure is decreased in all web areas when the distance between the rail end and the first bolt hole is increased. As a result of these tests, the standard spacing for 4 hole fish plates was changed from $2\frac{1}{2}$"—6" to $3\frac{1}{2}$"—6".

Another important experimental finding by the A. A. R. relates to the endurance limit of a fill sized carriage axle (6—7 in. dia.) at the section where wheel is pressed. This is only 17500 p. s. i. as compared 33,000 p. s. i. for that of the usual 0.3 in dia. specimens machined from surface of full sized axles. The designer has to take cognisance of this reduction noticed in tests with full size materials.

(*To be Continued*)

STEEL IN INDIA

Though India is second only to Brazil in the possession of the world's largest reserves of high-grade iron ore, her output constitutes only 2 per cent of the total world production—compared to U.S.A.'s 43 per cent and U S.S.R.'s 18 per cent. India's annual output of steel is a little less than 1.5 million tons compared to 17 million tons in the U. K. and over 100 million tons in the United States. India consumes only 11 lbs. of steel ingots per head in comparison with U.S.A.'s 1,237 lbs., U.K's 628 lbs., Australia's 540 lbs. and Italy's 137 lbs.

The First Five-Year Plan accorded high priority to the expansion of the steel industry and laid down a target capacity of 1.65 million tons of steel (as against 1.01 million tons in 1950–51) to be attained by 1957–58. By the end of the First Plan, the Government of India decided to set up three steel plants of 1.0 million ton ingot capacity each in the public sector, located at Rourkela (Orissa), Bhilai (Madhya Pradesh) and Durgapur (West Bengal).

TEXTILES SECTION

Far-Infrared for Textile Finishing

By W. L. Thomson

Manager, Radiant Heater Div
The Edwin L Wiegand Company, Pittsburgh, Pa.

INTRODUCTION

BEFORE discussing electric far-infrared uses for textile finishing, I would like to tell you something, which, I am sure, is of interest to everyone, whether in the textile finishing business or not; something of general interest, about the increasing use of electricity in United States industry of today.

In 1947, use of electricity was about 5 kilowatt hours per man-hour of labor. Today, 10 kilowatt hours per man-hour are used. Since one horsepower is equal to 746 watts, or three-quarters of a kilowatt, each industry employee now has helping him about 13 horsepower in electrical equivalent.

Now, a large, well-trained man can deliver one-eighth horsepower but only for short periods of time; so, if men were used to replace this 13 electrical horsepower, it would require at least 106 men working at maximum effort to deliver only intermittently the power which is being supplied per man-hour by the American electrical industry today.

At current average industrial electric power rates, less than 2½ cents per kilowatt hour, the electrical equivalent of 106 man-hours can be had continuously, three shifts a day and seven days a week for under 25 cents per hour or about $.0024 per equivalent electrical man-hour.

This low cost bears no taxes or fringe benefits. The power it represents is available day in and day out and is one of the predominant reasons for our industrial and economic success.

It is predicted that our overall use of electric power will more than double each 10 years and at decreasing relative costs.

In order to assist people in industry to better realize the values to be obtained by increased use of electricity, the Industrial Electrification Council was recently formed, choosing as its first mission to industry the formulation of an educational course in the uses and applications of metal sheath electric heaters to a wide variety of industrial process problems. The Metal Sheath Heater Course has now been given by 32 electric utilities to more than 6,000 industrial power user personnel; plant engineers, process engineers, maintenance men and others interested in process and comfort heating problems in their various industries.

To show how important this can be to you, it is interesting that one utility has given the course six times in the same area. For the first session, the class consisted of 30 people. Each session grew progressively larger until at the sixth session 82 people showed up, most of them from plants that had already sent others of their personnel to take the course. So, if your local utility company has not as yet offered the course in Metal Sheath Heaters sponsored by Edison Electric Institute, ask your electric utility power salesman when the course will be given. It will do wonderful things for your business in promoting economy, automation and above all, profit.

FAR-INFRARED RADIANT HEATING

Radiant heating is probably as misunderstood as any subject could be, for the simple reason that people usually attack it with what is sometimes called "the concrete mind"—one which is thoroughly mixed up and permanently set.

Actually, radiant heating principles are very simple and its uses date back to the time of the ancients who used it to evaporate water for making salt, for drying fish, etc. There is no reason today why we could not continue to use solar radiation in industry except that it is not continuously available as at night or on rainy days and is not easily subject to control.

Radiation cannot be stored as such, so, of necessity, if radiation is to be useful in industry a source must be found which is available where needed, economical to apply and use, and subject to easy control in a wide variety of industrial processes. Very largely, radiant heating in industry is dependent upon electric power as a source, and fortunately this is now almost universally available.

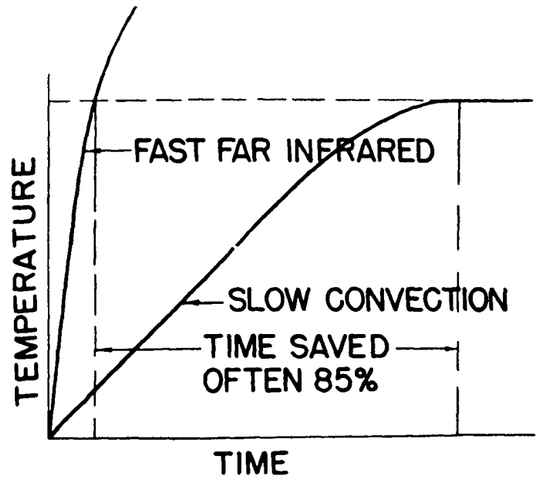

Fig. 1

The reason radiation is valuable, and this applies to all kinds of radiation, is because it travels from source to the point at which it works with the speed of light. It also travels through most gases without any loss, and for that reason all of the radiation which is accepted by a given piece of work is turned into heat, that which is rejected or reflected can be returned to the work with a reflector.

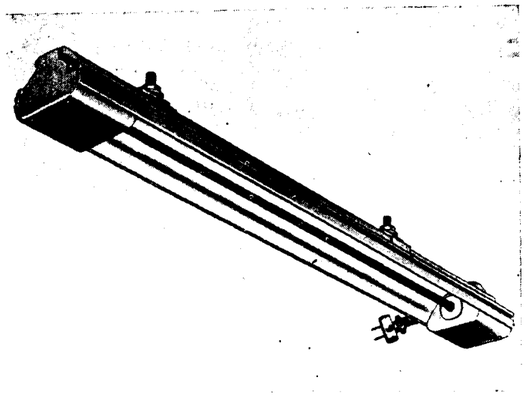

Fig. 2

Radiation which is industrially valuable for heating purposes comes from the infrared wave lengths of the spectrum. This infrared portion of the spectrum is customarily divided into two portions, "near-infrared" with wave lengths upto 0.7 micron and far-infrared with wave lengths ranging from 0.7 micron to 1,000 microns. Near-infrared comes from high temperature sources, such as the glass-enclosed infrared bulbs used by Ford Motor Company 20 years ago for paint drying.

Far-infrared comes from lower temperature sources, such as metal sheath heaters, and this radiation is characterized by the interesting quality of "color blindness." This means that all colors from black to white "see" far-infrared radiation as varying shades of gray, and, therefore, work materials of all colors can be heated at practically the same speed. This can be very important in any business where wide variety of colors must be handled.

Another advantage of far-infrared is that, because it comes from low temperature radiant sources, these sources cannot be a source of undesirable glare.

In industrial fields the metal sheath heater as a source of far-infrared can take many forms and has many advantages. Being encased in a metal sheath, all electrical parts are enclosed for safety and long life. The device is splashproof and shockproof and is easily subject to control. The metal sheath heater can be made in a variety of volt and watt ratings, and radiation from it can be spread out over the widest widths with perfect uniformity.

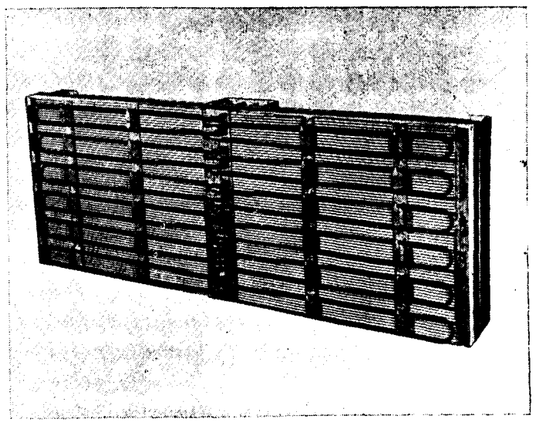

Fig. 3

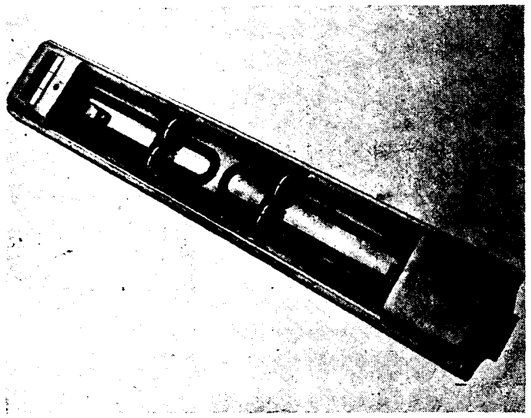

Fig. 4

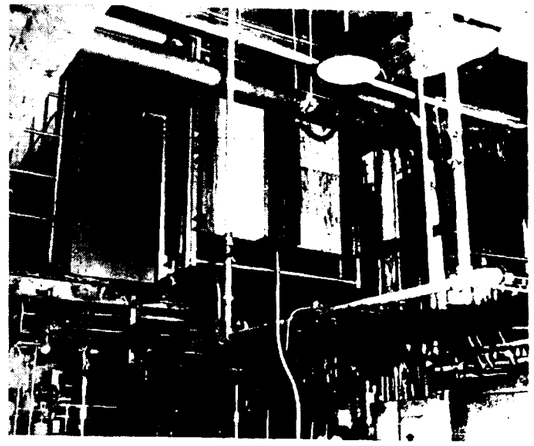

Fig. 6

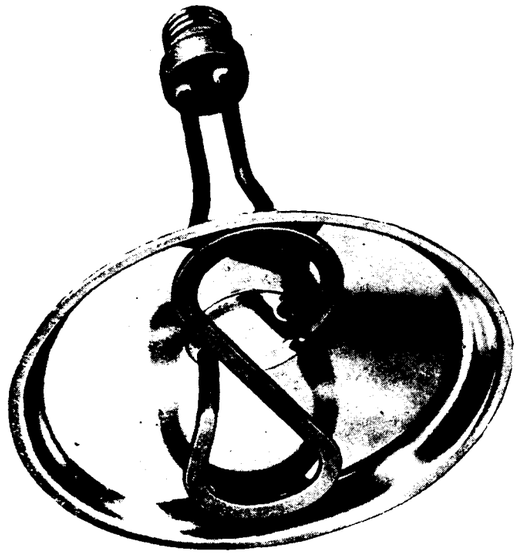

Fig. 5

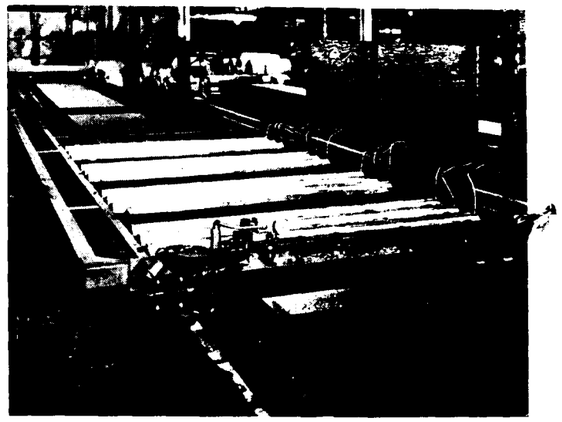

Fig. 7

Uniformity becomes highly important in such operations as resin finishing where maximum cure without degradation is essential to maximum user satisfaction with minimum use of resin all perfectly cured.

Numerous requests make it seem desirable that the subject of resin finishing be reduced to more of a science than at present.

Several years ago investigations were started in the use of far-infrared metal sheath heaters for curing paper-resin combinations. To date many interesting and valuable results have been obtained on a laboratory basis. Since the paper and textile industries are not entirely unlike in that they both deal with fibrous materials, it is felt that some contribution could be made in the resin finishing field if a comprehensive program of development could be evolved. Results of our investigation in the paper industry are gladly made available to all who are interested.

Far-infrared can be valuable in prevention of migration of dyes and resins which result from liquid flow from one place to another in fibrous materials.

Migration will invariably be caused by lack of symmetry in any of the forces which may cause liquid flow. Among these forces are gravity and evaporation. Counteracting evaporation from one side of a piece of goods by inducing evaporation from the other may be a means by which equality of liquid flow is restored. In general, it seems that the application of far-infrared to the side of goods toward which migration is desired has a corrective influence. Here again is another of the many problems which needs evaluation from a laboratory standpoint.

In order to give you a better idea of what equipment is available, how it is applied and how it works and why, here are a number of illustrations.

Fig. 1 illustrates the fast heating quality of far-infrared as compared with slow convection. The frequent time saving of 85 percent is due to the fact that infrared penetrates the boundary film of air which surrounds and adheres to the surface of each fibre in a piece of goods, yarn or thread. Travelling with the speed of light, radiation penetrates the boundary film and causes fast heating of the fibre without the necessity of heating the air around it. This mechanism is the universal attribute of far-infrared and accounts for its popularity in the many industries where it is used.

In Fig. 2 is shown the type RAD radiant heater consisting of a metal sheath electric heating element mounted in an aluminium extrusion bearing a parabolic polished aluminium reflector. This is one of the earliest forms of metal sheath far-infrared heating devices built and although it has been supplemented by others, it is

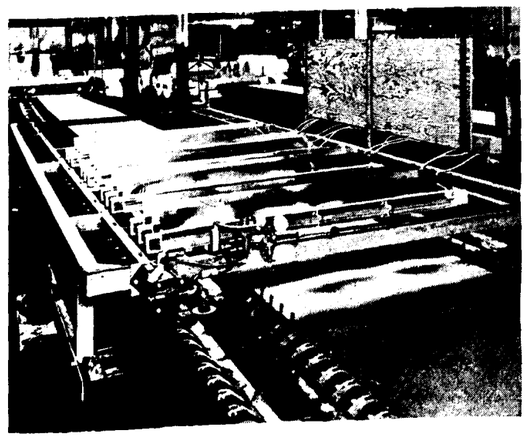

Fig. 8

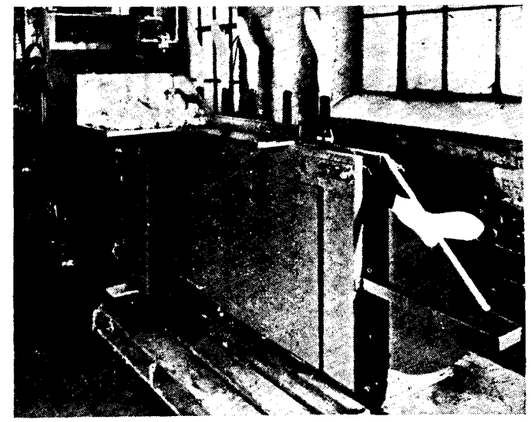

Fig. 9

the device used in heating on tenter frames because it can be rotating in the event of work stoppage and as supplemental heat in hot flue dryers where high ambient temperatures do not affect its all metal construction. Available in a wide variety of lengths, volt and watt ratings, the type RAD radiant heater is adaptable to a wide variety of high- and low-intensity heating applications.

In Fig. 3 is shown the type RP radiant panel designed to furnish high intensity far-infrared over large areas. Use of this construction minimizes electrical and mechanical connections to be made when covering large areas with radiation. Composed of metal sheath heaters mounted on an insulated frame with reflector and bus bar connections, this construction represents the ult mate in economy and ease of application where areas of radiation are needed.

In Fig. 4 is shown the type U-RAD radiant heater, an adaptation of the construction shown in Fig. 2, and designed to give variable areas of high-intensity radiation. Each of the two elements shown is available in a variety of physical lengths, volt and watt ratings, and combinations of any two of six different physical lengths may be combined in the extruded aluminium housing to produce twenty-seven different heated lengths. They may be used singly or in pairs as shown. This device has very considerable economic value where webs of different widths must be handled at different times. Extreme economy in the use of wattage is thus made available for pre-heating, drying and resin finishing.

In Fig. 5 is shown one of the seven models of the style FR glass lamp replacement element designed to

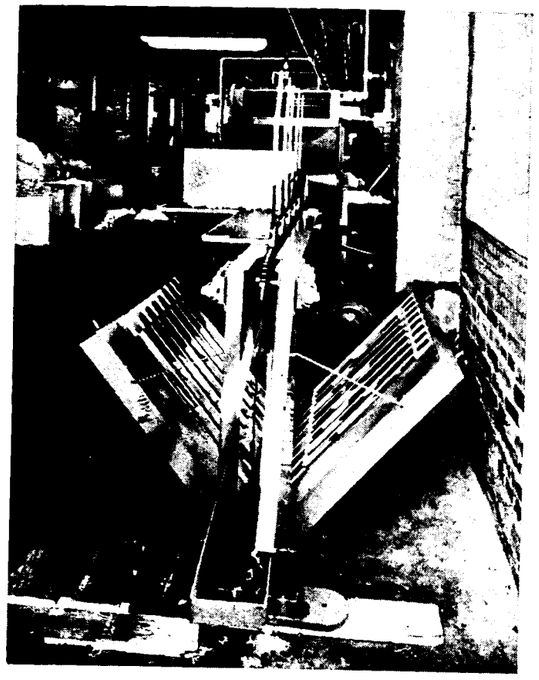

Fig. 10

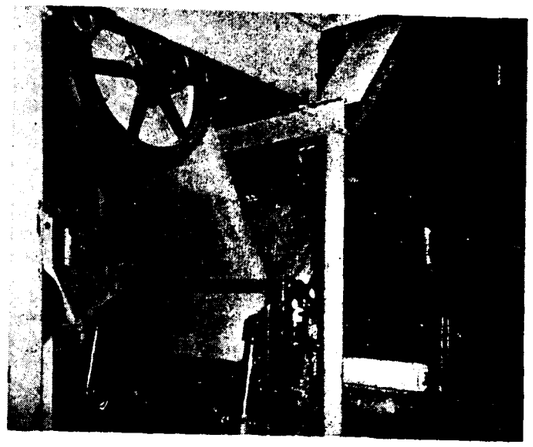

Fig. 11

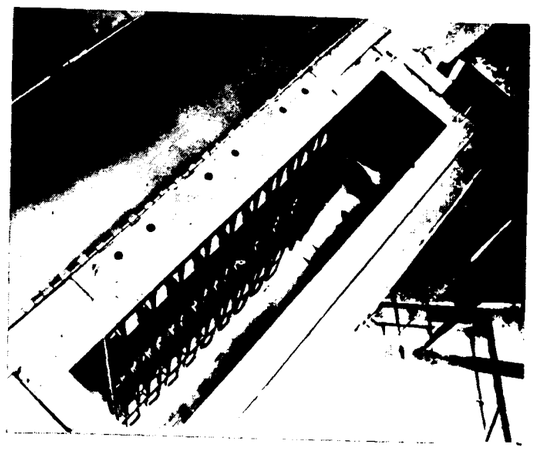

Fig. 12

replace glass lamps of 375-watt to 1200-watt rating. This device has very material value in the textile industry since it is not only glareless but also splashproof and shockproof and delivers radiant energy in a broad, flat heat pattern. Models are available for practically all existing glass lamp replacement purposes.

In Fig. 6 is shown a group of four type RP radiant panels placed face to face ahead of a loop dryer with initial evaporating capacity of 900 pounds of water per hour. In an effort to increase the capacity of this dryer by 25 percent, it was decided to preheat the goods before they enter the dryer by use of radiant panels with installed capacity of 86.4 kilowatts. The drying capacity was actually increased from 900 pounds per hour to 1284 pounds per hour or an increase of 42.7 percent with an economy of 0.225 kilowatt hours per pound of water of increased drying capacity.

Although usually used on an enclosed tenter, type RAD radiant heaters are shown in Fig. 7 on an open tenter. These heaters are rotatably mounted so that radiation can be turned off the work in the event of stoppage. Complete information as thus far determined on resin finishing is available in "The Textile Report" on request. In Fig. 8 the heaters are shown rotated off the work with the tenter stopped.

In Fig. 9 is shown the operating view of a preboarding machine powered with type RAD radiant heaters and having a capacity of 305 dozen pair of socks per 8 hour shift. Fig. 10 shows this machine in the open (for maintenance) position. A similar steam-operated device has a production capacity of 230 dozen pairs per 8-hour shift. Operating cost of the steam machine is 7 cents per dozen and of the electric machine 5 cents per dozen showing a saving of 28 percent in operating cost for the electrically operated device.

Initial cost of the steam machine is $5000.00 against the electrical machine at $3200.00. The installation cost of the electrically operated machine is considerably less than that of the steam machine since no boiler capacity is required. Furthermore, the electrical machine may be operated at any time regardless of availability of steam supply. Electric capacity is 12.8 kilowatts in type RAD radiant heaters and the time of exposure in the heated zone is 6–8 seconds.

In Figure 11 a thin web of cotton linters is being roll printed with polyvinyl chloride. Prohibitive cost and space requirement for steam drying equipment dictated the use of type RP radiant panels mounted above the web after the printer as shown in Figure 12. Drying time is two second at a power cost of less than one tenth of the acceptable power cost of $.003 per square yard.

Wide interest in industry as to the economy and efficacy of straight water evaporation by far-infrared has led to extended investigation at a leading university. In Figure 13, cost of steam evaporation is compared with that of electric evaporation using type RAD radiant heaters. From the curves it is seen that, at a steam cost of 75 cents per thousand pounds, an evaporating rate of 2.5 pounds of steam per pound of evaporation would give an evaporating cost of .18c per pound of evaporation. The same cost would be shown by an economy of .250 kilowatts per pound of evaporation and a power rate of .75 cents per kilowatt hour.

The indicated economy of 0.250 kilowatts per pound of evaporation is not at all unrealistic since the test work leading to this figure was performed at room temperature whereas goods entering a radiant dryer will be preheated somewhat by previous operations. It is believed that interesting economy will be demonstrated if all of the realistic costs of steam operation are taken into consideration before comparisons are made.

QUESTIONS AND ANSWERS

Question: Is it possible that the element itself loses efficiency after a certain length of time? In other words, does it drop in efficiency?

Answer: Actually it is found from practice that the metal sheath radiant heater will draw the same wattage from the day it is first connected until it is no longer usable. The filament of a lamp tends to evaporate and the wattage slowly goes down.

Q: In other words, there is no deterioration in the element itself?

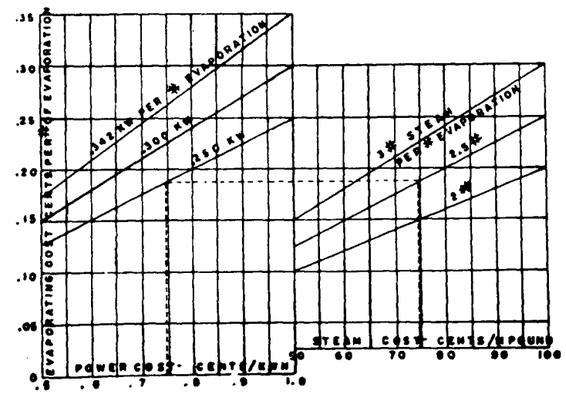

Fig. 13
Cost of water evaporation from textile webs. Chromalox radiant heaters vs steam

A: Not until, all of a sudden, its normal life has been expended. It's one of the peculiar things about the business. The drop in wattage, in a normally made and normally used metal sheath heater is practically negligible over the whole life of the heater, and, of course, wave length is determined by the temperature of the source.

Within a typical 10,000-hour life, the resistance will stay within 5 per cent of the original resistance, so, therefore, the wattage output is the same and the temperature on the sheath does not vary. The wave length stays substantially constant. A metal sheath heater of any type, not just the type here, burns out by straight open circuit or short circuit. It does not gradually deteriorate.

Q: Attention has been drawn to the fact that other sheaths are more efficient for some of these types of heaters, other than metal. Ceramics is an example. Is there any engineering basis to this?

A: Well, to answer your question, and to try to do it so no one is further misled, the difference between the radiant ability of any source as against any other source is a characteristic of the surface known as its emissivity. A surface which is largely non-emittive will not radiate well and its temperature must rise. The rise will continue until the wattage input is entirely dissipated by radiation, convection and conduction. If a surface is highly emissive, it means it will radiate well and operate at a low temperature. Frankly, emissivity is one of the things that enters our art but very little for the very reason that emissivity is so high that there is very little chance of improving it by a choice of other materials.

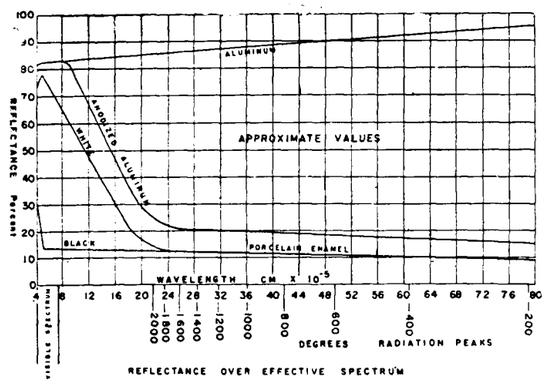

Fig. 14

Choice of sheath material is largely a function of ability to withstand temperature and as far as a ceramic is concerned, it might have great disadvantage in terms of strength, shock resistance and adaptability to being given a variety of shapes.

Q: In most of the pictures applying to electrical heaters that you have shown, the heaters were on the upper and lower surfaces. Where you have a condition with heaters on the upper surface? What materials do you recommend to do the best job with regard to reflectance of the radiation?

A: We have found from practice that anything which is coated with aluminum or made of aluminum is an excellent far-infrared reflector. In the early days we didn't know too much about the business of reflectivity, and we equipped our radiant heaters with a nice, bright aluminum reflector. The brightness hasn't a thing to do with it, as a matter of fact, because we now furnish dull aluminum-coated steel as reflectors. In large operations where you need the strength of steel and the reflectivity of aluminum, this combination gives an admirable result.

The aluminum-coated steel now is only available in a very rough aluminum coating. It is absolutely non-reflective, as far as visible wave-lengths are concerned, and yet it is as reflective as polished aluminum, meaning 90 percent or so, as far as far-infrared is concerned. You find as you get into this business that there are certain things which are very difficult to heat, and those are the things which are good reflectors.

If you are working with a piece of cloth which has a metallic thread of aluminum color, this thread will be hard to heat because it is a good reflector. There are ways to counteract this. For example, put the reflective metallic piece of goods into a box with some more reflectors around it. Bottle in the radiation, and if the work reflects the radiation, make it reject to a reflector, which bounces it back again.

Q: The reflectivity of anodized aluminum is only a fraction of that of metallic aluminum. Now, if a couple of molecules of aluminum oxide appear as a layer on a surface of aluminum, what happens to the reflectivity?

A: The normal and invisible layer of aluminum oxide which you find after finishing aluminum is apparently not reflective and is therefore penetrated by the radiation. If a thick coating of oxide is put on an aluminum reflector, then the coating becomes the reflector because the radiation will not see through it to the aluminum underneath. That is why on the curve (see Fig. 14) it shows anodized (oxidized) aluminum as a poor reflector of far-infrared radiation. In other words, the radiation does not see through the anodized surface. That surface is the reflector and it is a poor one.

In all of these things great care is necessary to evaluate what goes on and to then determine the answer. I remember, as an example, when developing the foundry practice of shell molding, which is the art of putting resin in sand and then curing the resin in the sand to make a hard shell, a radiant heater with a nice shiny aluminum reflector in it was used. The reflector turned black in two or three cycles because of the fuming of the plastic resin binder.

We thought we would be unable to do the job but it turned out that the black coating on the reflector became a very good absorber, and because of this it got hot and became a radiator. So the reduction in radiating efficiency was practically nothing.

MORE PRODUCTION OF ENGINEERING GOODS

Light engineering industries in India recorded a substantial increase in production in 1956, compared with 1955. Production of sewing machines rose from 100,000 to 127,000, bicycles from 500,000 to over 600,000, typewriters from 500,000 to about 1,300,000, umbrella ribs from 295,000 dozen sets to nearly 500,000 dozen sets and welding electrodes from 121,000 feet to 180,000 feet.

New Developments in Peroxide Bleaching

By J. L. Moore and T. E. Bell
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The authors discuss several developments of major importance, which have attracted considerable interest during the past three years. Some of these developments are concerned primarily with the chemistry of the bleaching process, some with the mechanics and some with both.

Considerable coverage is given the single-stage continuous bleaching process, after which single-stage kier bleach, non-silicate bleach, and new equipment are briefly discussed.

IT is a pleasure to have this opportunity to discuss with you some of the significant recent developments in peroxide bleaching which are of special importance to the Southern cotton textile industry. We certainly feel indebted to Prof. Campbell for his invitation to address you on this interesting subject.

INTRODUCTION

As most of you are aware, there has been what might almost be called a revolution in cotton bleaching methods since the introduction by Du Pont, in co-operation with Cannon Mills and Renfrew Bleachery, of the first commercially successful continuous peroxide bleaching process in 1939—1940. From a rather small and sometimes shaky beginning, this process has grown until today an estimated 85% of all bleaching of cotton piece goods is carried out continuously with peroxide. In addition, a large quantity of vat-dyed cottons is oxidized with hydrogen peroxide or sodium perborate. All in all, the cotton textile industry and the peroxygen chemical industry have many mutually interesting points of contact.

Of major importance, and therefore worth discussing at this time, are several developments which have attracted considerable interest during the past three years. Some of these developments are concerned primarily with the chemistry of the bleaching process, some with the mechanics, and some with both.

SINGLE-STAGE CONTINUOUS BLEACHING PROCESS

We believe that the most important development of the past three years is the single-stage continuous bleaching process, which was announced at the 1954 annual meeting of the AATCC in Atlanta.

Those of you who were associated with the early development of the continuous peroxide process will recall that it was conceived as a single-stage operation. Even in its early development the continuous peroxide process produced acceptable results in bleaching a number of fabric constructions in a single-stage. The two-stage process was developed to take care of those fabrics which could not, at that time, be bleached successfully by single-stage. We are confident that, had the knowledge of steam conditioning, cloth saturation and chemistry of the process been as great 16 years ago as it is today, the majority of continuous bleaching ranges would be single-stage rather than two-stage.

Since our earlier report (1), a great deal of laboratory and field work on this process has been done, and it may now be justly considered commercially successful. Several ranges have been running for more than a year, and many more are either in the construction or the planning stage.

As those of you who have investigated this process will agree, it is extremely simple in its basic concept. Theoretically, and practically on some fabrics, it is possible by simply saturating a piece of grey cotton fabric with an alkaline peroxide solution, squeezing to remove excess moisture, heating to 180°-212°F and storing from 60 to 90 minutes, to produce a piece of cloth comparable in nearly all respects to that produced by the most elaborate multistage system. In most cases, of course, it is not quite so simple since many fabrics require desizing, souring or mild scouring as a preliminary treatment, either to improve results, reduce costs or both.

TABLE—I

Comparison of quality of fabric produced by single-stage and two-stage bleach processes

	Average Analyses	
	Single-stage	Two-stage
Hunter Whiteness	87.2	86.5
Fluidity, Cuam	6.3	4.9
Non-cotton, %	0.98	0.43
Enzyme extractables, %	0.16	0.17
Oils, fats, waxes, %	0.26	0.26
Ash, %	0.28	0.22
Absorbency, seconds	1.9	2.5

To give you some idea of the quality of fabric produced by this simple method, we have prepared a table which compares average results from 27 samples run with the new single-stage process with 23 samples run with the two-stage process. (See Table I)

The figures given in Table I are average results; the tests were not all made in exactly the same manner. About half of the single-stage samples were analyzed in accordance with the methods described in the *1955 AATCC Year Book*; the balance by a modified method in which each sample was tested successively for water extractables, enzyme extractables, fats, oils, waxes and ash. The two-stage samples were analyzed by older methods, but substantially in accordance with the AATCC methods. These analytical differences affect the averages somewhat and the data are given simply to provide order-of-magnitude figures.

The figures in Table I indicate that the bleaching results obtained with these processes substantially the same. We attribute the higher non-cotton value obtained in the single-stage process to a residue of converted waxes; this is definitely beneficial, since it increases weight and improves the hand and absorbency. We believe that some of the water-resistant fats and waxes are converted by hydrolysis to products of lower molecular weight, which actually serve as wetting or rewetting agents.

To achieve the results presented earlier, careful attention to the bleaching process is essential. It should be remembered that, in the single-stage method, all processing takes place in one step and that careful control is necessary to get consistently satisfactory results.

While the methods and formulas used vary with the fabric being processed, the end result desired and the equipment available, there are certain general conditions which apply. The following is a basic method, which will give good results on most fabrics in most equipment.

SINGLE-STAGE PROCESS

Pre-treatment

1. Singe: Except for knit goods, most fabrics are singed, using the conventional equipment best suited to the fabric.

2. Desize: In many cases an enzyme desizing is necessary or desirable. This is carried out by saturating the cloth usually in the quench box of the singer, with

1.25% Enzyme desizing agent
2.1% Wetting agent

Scour and Bleach

The cloth is washed after desizing and then saturated as follows:

2.5—3.5% Albone 35 hydrogen peroxide
1.5—2.5% Sodium silicate 42° Be
0.3—0.5% Caustic soda (100%)
0.3—0.5% Borax decahydrate

Following saturation, the cloth is squeezed to 100—110% liquid, to remove excess chemicals and water. It is then heated by steam to 205°—210 F and stored in a J box for 60—75 minutes to complete the reaction.

In cases where complete freedom from residual starch is not a requirement, the process can be modified by eleminating the enzyme pretreatment and substituting for it either a mild scour with a wetting agent and a phosphate, such as sodium tripoly-phosphate, or a grey sour.

The single-stage process is not limited to white goods, but is effective also on goods to be dyed and on yarn-dyed fabrics. Dyes which ordinarily stand the two-stage process are satisfactory also in the single-stage system.

The chemical cost of operating the single-stage system is somewhat higher than the two-stage process but the

TABLE—II

Estimated cost and investment comparison. Single-stage vs two-stage systems for continuous peroxide bleaching of woven cotton fabrics

NOTE: This estimate is based on an annual production of 50 million yards of 80×80 fabric weighing 4 oz./yd. or 12,500,000 pounds.

Essential materials	Unit price	Units used	Single-stage	Units used	Two-stage
Albone 35 hydrogen peroxide	18 ¢	3.0%	$67,500	1.0%	$27,000
Sodium silicate	3 ¢	2.0%	7,500	1.0%	3,750
Caustic soda	3.4¢	0.5%	2,100	4.1%	17,400
Borax	4.5¢	0.3%	1,700		—
Total cost—essential materials			$78,800		$48,150

Utilities		Single-stage		Two-stage
Water	10¢/M gal 3M gal/1000 lb	$ 3,750	6M gal/1000 lb	$ 7,500
Steam	60¢/M lb 1M lb/1000 lb	7,500	2M lb/1000 lb	15,000
Power	1¢/kw-hr 28 kw-hr/1000 lb	3,500	47 kw-hr/1000 lb	5,850
Labor (3 shifts)	$2.00/hr 1 man/shift	12,580	2 men/shift	25,000
Overhead	50% of operating labor	6,252		12,500
Employee benefits	15% of operating labor	1,900		3,700
Maintenance	3% equip, 1% bldg	3,300		5,300
Taxes & insurance	½% equip & bldg cost	800		1,300
Depreciation	8% equip, 4% bldg	9,800		15,800
Total utilities, etc.		$ 49,300		$ 91,950
Total operating cost		$ 128,100		$140,100
Estimated operating saving		$ 12,000		

Investment		
Equipment cost + 17% for Installation	$100,000	$160,000
Buildings	72,000	120,000
Total	$172,000	$280,000
Savings on Investment	$108,000	

over-all operating cost is lower. Additionally, there is a very large saving in capital investment, which for a new mill is often the deciding factor. Table II covers both operating and investment costs and shows clearly that, under today's conditions, a new single-stage system is much more economical than the two-stage process.

ADVANTAGES OF PROCESS—

(1) *Lower Initial Investment.* The initial investment per unit of cloth produced is approximately 60% of the investment required in a two-stage system of equal capacity.

(2) *Lower Operating Cost.* There is a slight advantage in operating costs and in many cases, they are lower than those of the two-stage process.

(3) *Excellent Results.* Analyses of fabrics bleached with both one—and two-stage processes indicate that results with the single-stage method are equal to and often superior to those obtained by the two-stage method.

(4) *Less Mechanical Handling.* Since one J box and the saturating and washing equipment usually employed in the two-stage range are eliminated, there is much less mechanical handling.

(5) *Less Utilities.* Due to the reduced equipment necessary, requirements for power, water and steam are substantially reduced

(6) *Labor.* The labor required per unit of cloth produced is approximately two-thirds that of the two-stage system.

(7) *Space.* The building space required is about 60%, a particularly important detail when new equipment must be installed in existing buildings.

(8) *Increased Production.* In mills now operating two-stage system, production can be doubled by splitting the existing range in two and operating as two single-stage systems. Usually the purchase of one extra washer will be the only additional investment required.

SINGLE-STAGE KIER BLEACH

The single-stage process is also adaptable to batch bleaching in kiers, slack washers or package machines. Since kiers are still used in some mills, a process such as this can frequently be used to increase production or reduce processing time.

The following is a description of a general method which has been found satisfactory. The particular fabric used in this case was 80×80, 4-yd. print cloth, but the process can be adapted to a wide variety of fabrics by making minor changes in formula or procedure.

The cloth (8,000—8,300 lb.) is signed and than saturated with, an enzyme desizing solution, stored for a period and then washed with warm to hot water into the kier. A mechanical kier piler using an alkaline peroxide bleaching solution is used to load the goods into the kier.

The bleach solution charge is made up to contain: 205 lb. sodium silicate, 6 gal 50% liquid caustic soda, 35 lb. Borax, 175—250 lb. Albone 35 hydrozen peroxide, 5—10 lb. wetting agent and detergent. The chemicals are dissolved in 1500—2300 gallons of water, depending upon the water carried into the kier by the goods. The solution is heated to 110°F before being run to the kier.

When all the cloth has been loaded into the kier, it is held in place by stainless-steel chains. The bleach liquor is circulated through the goods and heated to a temperature of 190°—200°F over a period of 1½ hours. Bleaching is carried out at 190°—200°F for 4 to 5 hours. The bleach charge is drained to the sewer and the goods washed in the kier with hot water. Following this, the cloth is pulled through a washer containing warm to hot water to the white bin.

Results of the single-stage kier-bleach are equal to the customary two-boil peroxide method. While the chemical cost is somewhat higher, the over-all bleaching cost is, in most cases, comparable to, if not lower than, that of the two-stage kier process. The single-stage kier process has the further advantages of doubling production if required, and decreasing the mechanical handling, which is very important if fragile fabrics are being processed.

NON-SILICATE BLEACH

During the past two years, there has been increased interest in bleaching formulas which do not contain a silicate for stabilizing purposes.

Non-silicate formulas have been used for textile bleaching, particularly in the wool-bleaching field, where tetrasodium pyrophosphate replaced silicate many years ago. Some fifteen years ago, a process based on a formula containing sodium peroxide, magnesium sulfate and tetrasodium pyrophosphate was developed for bleaching cotton knit goods. This was successfully applied to batch bleaching in kiers and slack washers, but was never used extensively in continuous processing.

A great many attempts have been made, mostly unsuccessful, to develop a formula which would eliminate silicates in the continuous peroxide bleaching process and still do a satisfactory bleaching job at a reasonable cost.

Successful large scale trials employing the following formula have been carried out:

1.5% Albone 35 hydrogen peroxide
2.0% Sodium tripolyphosphate
0.1% Epsom salts
0.2% Perma Kleer 80 dry beads

The headtank solution which feeds the saturator is made up at about 5 times the above concentration. At 80° F, the solution is stable for 4 to 8 hours.

Preliminary data indicate that the above formula can be modified for single-stage bleaching by both the continuous and kier processes.

In these trials, the goods were caustic-treated, washed, soured with sulfuric acid and washed prior to the peroxide bleach. We would like to point out that our most successful non-silicate runs have included a sour between the caustic scour and the peroxide bleach. This seems to be helpful in improving the stability of the bleach bath and also in keeping the fluidity low. It may not be necessary in all cases, but should be given consideration.

An indication of the results to be expected may be seen in Table III. The fabrics were bleached in the two-stage continuous process.

As is obvious from these data, the nonsilicate process compares favorably with the more usual silicate method, and can be used as a substitute if conditions necessitate. It is simple to use, and requires no special handling or controls. It is available without license to all peroxide users in the United States.

Since it is a little more expensive chemically (about $1/1000 lb.) it will be used most advantageously in mills where scale is especially troublesome. In these cases, reducing the damage done to goods being prepared for dyeing and eliminating the cost of periodic shut-down for descaling may more than compensate for the higher chemical cost.

EQUIPMENT

No paper on new peroxide bleaching developments would be complete without some reference to new equipment. In the past two years, Proctor & Schwartz, with assistance from Du Pont, has perfected a single-stage system for cotton knit goods which uses a catenary conveyor belt for cloth storage instead of a J box. This is in successful operation at a Southern mill, and it is a real contribution to the art of peroxide bleaching.

Ever since the first J box was designed and built, there has been a demand for improvements which would permit operation at higher speeds, at higher temperatures and with less mechanical handling of the cloth. Du Pont, with the help of the engineering staff at Jos Bancroft & Sons, has recently redesigned the J box to do all of these things and also to reduce the initial cost. This has been done by removing part of the heater tube, by moving the steam distributor to the front of the J box, and by simplifying the piling mechanism. This results in a J box of improved operating characteristic, which is especially suited to preparing goods for dyeing.

TABLE III

Average analyses of cloth processed with and without silicate

	Typical Analyses	
	Non-silicate process	Silicate process
Hunter whiteness	87.0	86.5
Fluidity, Cuam	7.1	4.9
Non-cotton, %	0.49	0.43
Enzyme extractables, %	0.13	0.17
Oils, fats, waxes, %	0.18	0.26
Ash, %	0.03*	0.22
Absorbency, seconds	1.2	2.5

*Goods were soured after caustic scour

Any existing J box can be changed over to this new design at a reasonable cost, and a number of mills have already made the conversion.

There are also underway studies aimed at improving the continuous process by increasing the speed of bleaching and thus decreasing the size of the storage chamber required. These studies are past the laboratory stage, and are now being developed in the machine design section of a prominent manufacturer of textile equipment. When perfected, the textile industry will be advised promptly.

SUMMARY

The past several years have seen the perfection of a new single-stage bleaching process, a new silicate-free formula, and new types of storage units for continuous processing as well as a start toward still better processes and equipment. For much of the incentive to do these things, the chemical and equipment manufacturers are indebted to the textile industry. With their help and cooperation, we are certain that the progress outlined today will continue on an ever increasing scale, with benefit to all concerned.

LITERATURE CITED

(1) Bell, T. E., Terhune, H. D., Potter, H. L., and Rowe, M. H., " Some Notes on the Technology of the Single-Stage Continuous Bleaching Process ", *Am Dyestuff Reptr.* 44, No. 10, P317 (May 9, 1955).

The Du Pont Solo-Matic Bleaching Process

By H. D. Terhune, E. I. du Pont de Nemours & Co., Inc.,
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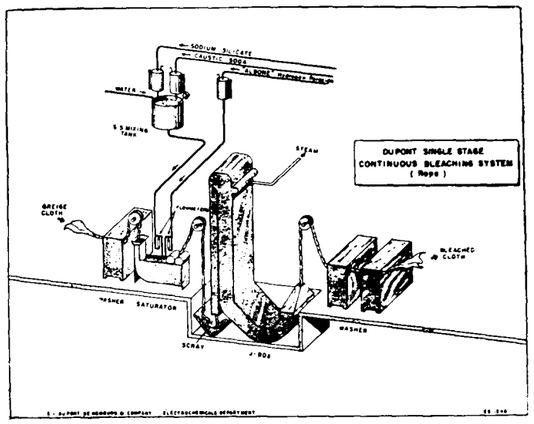
THE Solo-Matic continuous bleaching process, developed and perfected by Du Pont is an advanced method for bleaching woven cotton textile fabrics of all types and weights. The simplicity of the Solo-Matic process with its inherent advantages of a single chemical bleaching treatment and reduced mechanical handling of cotton fabrics makes this method of bleaching the natural successor to multi-stage continuous bleaching processes. The Solo-Matic process is the answer to the ever increasing costs for labor, building, and fabrication of textile processing equipment. It is also the answer to the ever increasing demand for higher quality finished fabric.

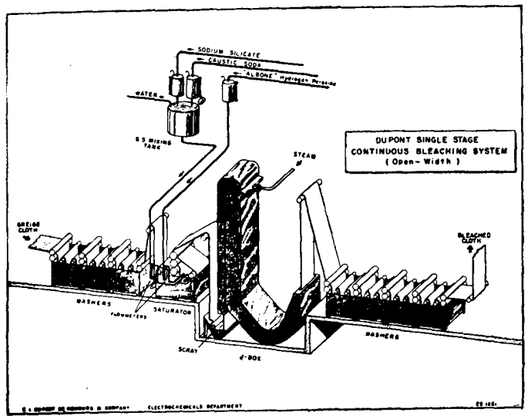
Of the many features of the Solo-Matic process, the simplicity and mildness of the chemical treatment of the cotton is particularly outstanding. Following any conventional pretreatment such as desizing or souring, the cloth is washed or mildly scoured before it is saturated with an alkaline peroxide solution and stored hot in a J-box for the bleaching action to take place. For some end uses the cloth requires only a simple scouring treatment before bleaching. No caustic treatment of the cloth is required. In addition to its primary function of whitening the cotton, the chemical formula used by the Solo-Matic process is designed to modify the natural cotton impurities to facilitate their removal when the bleached cloth is washed on removal from the J-box. By careful adjustment of the balance between alkalinity, peroxide concentration and bleaching temperature, the Solo-Matic process can produce bleaching results superior in many respects to any other commercial cotton bleaching process.

The Solo-Matic process is designed to bleach any type and weight of cotton fabric normally bleached by any multi-stage bleaching process. Fabrics bleached by the Solo-Matic process are properly prepared for finishing white or dyeing. The whiteness of the bleach produced by the single stage process is equal to any other process. If less than maximum whiteness is required for fabrics to be dyed or otherwise aftertreated, the degree of bleaching obtained can be easily controlled by minor chemical adjustment of the bleaching formula. Fabrics bleached by the Solo-Matic process compare favorably in all respects with multi-stage process bleaching results. This is clearly shown in the following analysis:



	Solo-Matic (Avg. of 27 samples)	Multi-Stage (Avg. of 23 samples)
Hunter Whiteness %	87.2	86.5
Fluidity Cuam Rhes	6.3	4.9
Noncotton %	0.98	0.43
Water Extractables %	0.43	—
Enzyme Extractables %	0.16	0.17
Fats, Oils, and Waxes	0.26	0.26
Ash %	0.28	0.22
Absorbency, seconds	1.9	2.5
Alkalinity as % Na_2O	0.08	—

The significant and important difference between multi-stage and Solo-Matic bleached fabrics is in the absorbency and total non-cotton content of the two fabrics. The high absorbency of fabric bleached by the Solo-Matic process is a distinct advantage in dyeing and other afterbleaching treatments. Rapid absorption of dyestuffs is particularly important for fabrics dyed through continuous pad-steam ranges. One mill has been successfully slop-pad dyeing Solo-Matic bleached cloth for over a year. The slightly higher non-cotton content of cloth bleached by the Solo-Matic process is responsible for its fuller hand and greater weight as compared with fabrics bleached by other methods. These desirable characteristics are not readily obtainable by conventional bleaching processes.



Fabrics formerly difficult if not impossible to dye after continuous bleaching are easily dyed without defects after bleaching by the Solo-Matic process which involves the use of a minimum of mechanical equipment. In the Solo-Matic process, the natural waxes which protect the cotton from crease, bruise and friction marks are not removed until the fabric passes through the final washing treatment. This is one of the most important features of the Solo-Matic process.

The new Du Pont type J-box was specifically designed for the Solo-Matic process; however, other types of J-boxes and conveyor systems are readily adaptable to the process. The new J-box retains the exclusive Du Pont patented feature of heating the cloth before it is stored in an insulated chamber to permit the bleaching action to take place but the original cloth heating chamber has been redesigned to minimize mechanical handling of the cloth as it passes into the storage chamber. A new steam control system feeds the correct amount of steam to the J-box to heat the cloth efficiently and prevents wasteful loss of steam through the cloth entrance to the heater chamber.

The new J-box has fewer moving parts than earlier J-boxes. The new J-box is therefore less costly to construct and it requires less maintenance to keep it in perfect operating condition. An additional feature of the new J-box is that only a few minor mechanical changes by mill personnel are required to convert an open width box to rope or a rope box to open width. These features along with other design improvements insure bleaching results of uniform excellency when the new J-box is used in conjunction with the Solo-Matic process.

Mills having older type Du Pont J-boxes can obtain all of the advantages of the new J-box by a simple conversion job that can be carried out at low cost by any of the major fabricators of continuous bleaching equipment. Several of the older J-boxes have been converted and are performing satisfactorily. We strongly recommend converting all J-boxes that are to be employed in the Solo-Matic process.

Mills having existing single or two stage continuous bleaching ranges can benefit greatly in most instances by adopting the Solo-Matic process. The process is readily adaptable to existing equipment with little or no modification. Mills having a single stage range through which cloth is passed once for caustic treatment and a second time for bleaching can reduce their operations to a single pass of the cloth through the range for a full bleach. The Solo-Matic process requires more chemicals to accomplish a full bleach in one treatment; but labor, power, water, and steam requirements are reduced by nearly 50%. More important, however, is the doubling of the output capacity of the bleaching range. With little or no additional investment, adoption of the Solo-Matic process increases the capacity of a single stage range by 100%.

Mills having two stage ranges can also double their bleaching capacity by adopting the Solo-Matic process. This is accomplished usually by installing one additional washer and converting the range to two complete Solo-Matic units. In addition to increasing the bleaching capacity this arrangement also gives greater flexibility by permitting the mill to handle simultaneously such dissimilar fabrics as white and colored piece goods and fabrics varying greatly in weight and construction. Two Solo-Matic units also provide insurance against complete stoppage of production in case of failure of any of the numerous mechanical or electrical units in the bleaching system. The advantages of converting from the two stage to the Solo-Matic process are many but the higher quality bleaching results produced by the Solo-Matic process frequently alone justify discarding the old process for the new.

From the cost standpoint, the principal advantages of the Solo-Matic over multi-stage continuous bleaching systems may be summarized briefly as follows:

1. The continuous bleaching range for the Du Pont Solo-Matic continuous bleaching process, exclusive of desizing or souring equipment, requires only slightly more than one half the number of units in a conventional two stage continuous bleaching range. The initial investment cost in equipment is therefore only about 60% of the cost of a two stage range of equal capacity.

2. The small compact Solo-Matic range requires much less space than a two stage range. If placed in an existing building, the 40% space saved over a two stage range can be put to other profitable use: if building a new bleachery, the saved space can result in lower building investment.

3. The labor required to operate the Solo-Matic process is 50% lower than a two stage bleaching system and savings in steam, water, and power average 30% to 40% below two stage costs.

4. Taking all pertinent cost factors into consideration, it is shown in the accompanying cost analysis table that the Solo-Matic or single stage process operates at a lower cost than a two stage process of equal capacity. Additional benefits, but more difficult to ascribe specific values, are reduction or elimination of seconds due to mechanical defects, the greater fullness of hand and heavier weight, and, the improved dyeing qualities due to the higher absorbency of fabrics bleached by the Solo-Matic process.

5. If new bleaching equipment housed in new building space is required, selection of the Solo-Matic process calls for an investment of less than 60% of the cost of a corresponding two stage system. In the example shown, the saving in investment is in excess of $100,000. The actual gain, however, is far greater because the money saved can be invested in other profitable mill projects.

The ultimate objectives in developing and perfecting the Du Pont Solo-Matic process have been to obtain bleaching results of the highest possible quality at the lowest possible over-all bleaching cost. Each stage of the development of this project has been exhaustively tested, first in the laboratory and then in the field before the process was considered ready for commercial promotion. The basic formula used in the early work on the Solo-Matic process had ten years of successful application in the knitgoods finishing industry. The final Solo-Matic formula, which evolved from the knitgoods bleaching process, has now been in use for almost two years in several mills which handle a wide variety of weights and constructions of woven cotton fabrics.

The principal objectives of this development program—high quality bleaching results at low cost—have been attained and the Du Pont Solo-Matic continuous bleaching process is ready to establish its place in the textile finishing industry.

ESTIMATED COST & INVESTMENT COMPARISON
SINGLE STAGE vs TWO STAGE COTTON BLEACHING

BASED UPON AN ANNUAL PRODUCTION OF 50,000,000 YARDS OF CLOTH AVERAGING 4 YARDS / LB.

			SINGLE STAGE COTTON BLEACHING		TWO STAGE COTTON BLEACHING
PRODUCTION OUTPUT, LBS./YR.			12,500,000 LBS.		12,500,000 LBS.
ESSENTIAL MATERIALS	*UNIT PRICE*	*UNITS USED*		*UNITS USED*	
"ALBONE" 35	@ 18 ¢ / lb.	3.0%	$ 67,500	1.0%	$ 22,500
HYDROGEN PEROXIDE	@ 3 ¢ / lb.	2.0%	7,500	1.0%	3,750
SODIUM SILICATE	@ 3.4 ¢ / lb.	0.5%	2,100	4.1%	17,400
CAUSTIC	@ 4.5 ¢ / lb.	0.3%	1,700	—	—
BORAX			$ 78,800		$ 43,650
● TOTAL ESSENTIAL MATERIALS					
UTILITIES					
WATER	@ 10 ¢ / 1,000 gal.	3,000 gal. / 1,000 lbs. Cloth	$ 3,750	6,000 gal. / 1,000 lbs. Cloth	$ 7,500
STEAM	@ 60 ¢ / 1,000 lb.	1,000 lbs. / 1,000 lbs. Cloth	7,500	2,000 lbs. 1,000 lbs. Cloth	15,000
POWER	@ 1 ¢ / KW-HR.	28 KW-HR. / 1,000 lbs. Cloth	3,500	47 KW-HR. 1,000 lbs. Cloth	5,850
LABOR (3 SHIFTS OPERATION)	@ $ 2.00 / HR.	1 MAN / SHIFT	12,500	2 MEN / SHIFT	25,000
OVERHEAD or BURDEN	50% OF OPERATING LABOR		6,250		12,500
EMPLOYEE BENEFITS	15% OF OPERATING LABOR		1,900		3,700
MAINTENANCE	3% EQUIP. COST, 1% BUILDING COST		3,300		5,300
TAXES & INSURANCE	½% EQUIP. & BUILDING COST		800		1,300
DEPRECIATION	8% EQUIP. COST, 4% BLDG. COST		9,800		15,800
			$ 49,300		$ 91,950
COST			$ 128,100		$ 135,600
● TOTAL COST					
● ESTIMATED SAVINGS IN OPERATING COST			$ 7,500		
INVESTMENT					
EQUIPMENT COST plus 17% FOR INSTALLATION			$ 100,000		$ 160,000
BUILDINGS			$ 72,000		$ 120,000
TOTAL			$ 172,000		$ 280,000
● SAVINGS IN INVESTMENT			$ 108,000		

Nonwoven Fabrics—The Chemical & Processing Techniques

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INTRODUCTION

THE recent growth and expanding interest in the manufacture of nonwoven fabrics represents one of the most significant departures in the textile industry in a number of years. Textile and chemical technology have been combined in order to produce a wide variety of versatile end products suitable for an unlimited number of industrial, domestic and personal uses. Nonwoven fabrics are by no means a new commodity; however, newer techniques and processes have enabled manufacturers to produce a more complete line of fabrics and have allowed definition of many new end uses. The original development of nonwoven fabrics has been discussed frequently and need not be further mentioned herein. At this time an attempt will be made to present a comprehensive set of data on the manufacture, end use, and potential of many nonwoven fabrics of specific types.

DISCUSSION

Fibers—During the past year, sixty to sixty-five million pounds of cellulosic and synthetic fibers have been utilized in the manufacture of nonwoven fabrics. Of this volume, cotton and rayon constitute 90% to 95% of the total. The newer synthetic fibers, however, are gaining more prominence in this field and offer properties not entirely obtainable with cellulosics. Nylon and acetate are the two most frequently encountered synthetics. The addition of nylon to the web significantly enhances the general physical strength of the bonded fabric. The necessity for synthetic fibers will become more prominent with the growing interest for the use of bonded fabrics as interlinings for wash-wear suitings. A rapid drying rate will be provided with a minimum of dimensional distortion. Many of the present interlining fabrics will contain from 20% to 50% of the polyamide fiber with current attention being directed towards substantial increases in tensile and tear strength. A great deal of interest is presently being directed toward the formation of bonded fabrics capable of being tufted in order to replace the woven jute fabrics commonly used as rug backings. Here too, the incorporation of nylon is of significant importance in that in the tufting operation high strength, as well as mobility of the fiber, is important.

Acetate is also gaining prominence in this field. Although the strength imparted does not approach that of nylon, secondary acetate does provide functionality to the fabric with regard to both hand and appearance. Acetate, always considered a fashion fiber, should find expanded uses in this field.

In view of cost, certain limitations have been placed on acrylic and polyester fibers. The latter, however, exhibit properties not obtainable with other synthetic fibers when factors such as acid-, alkali- and oil-resistance, as well as stability and electrical properties, are necessary. The polyester fiber makes definite contributions to industrial purposes such as filters, gaskets, etc.

FORMATION OF THE WEB

Synthetic and cellulosic fibers are mechanically processed in one of three principal methods in order to form bonded fabrics. As a general rule, the fiber processed will have a staple length of approximately $\frac{3}{4}$" to $1\frac{1}{2}$". Following opening and picking, the webs are presently formed by the card, garnett or Rando-Webber (1) In many cases it is difficult to describe why one unit has an advantage over the other due to the fact that versatility with existing equipment and imagination of the operator play an important role. In general, for quality fabrics, a card is used rather than a garnett. The rate of productivity is not high; however, uniform fiber lay with little variation is obtained. For quality fabrics of one to two ounces per square yard, a capacity of 25 to 45 lbs. per hour may be expected. The capacity may be increased substantially when weight per square yard is increased, while sacrificing appearance and uniformity. The garnett, while considered inferior to the card for these lighter webs, is capable of high speed, and for battings, packings, etc, as much as 300 to 400 lbs. may be produced in a single hour. At a lower rate of productivity, however, a garnett will not provide strength or uniformity in the unbonded web comparable to that of the carded web for the beforementioned highquality, light-weight webs.

Either carded or garnetted webs are normally cross-lapped when strength is desired in all directions. This is essentially a distribution of the strength obtained in the machine direction so that a substantial increase in the unbonded web and bonded web is obtained across the fabric. In the unbonded state the average strength in any direction after crosslapping is usually less than that obtained in the machine direction of the web which has not been crosslapped. Surprisingly good uniformity and tensile strength is obtained with a bonded cellulosic or cellulosic-synthetic web which has been carded and handled in this fashion.

The Rando-Webber (1) represents a relatively new type of web former. This unit produces web with equal strength in all directions without crosslapping. The Rando-Webber will process stock at a rate of up to 300 lbs. per hour on a 40" machine. Here again, we are concerned with the matter of quality in that a relatively high-strength, uniform web, in the one—to two-ounce category, would be produced at a rate of 40 to 70 lbs. per hour. The Rando-Webber is capable of processing a large variety of fibers, as well as processing wastes. In the latter cases uniform webs have been produced from garnetted threads, leather, paper shoddy, foam, yarn wastes, etc. A greater degree of versatility is offered with this unit and the prehandling can be kept at a minimum.

Still a newer type (2) being proposed for the manufacture of bonded fabrics is a modified card utilizing an air-doffer principle. This unit involves feeding the open stock into a single card, or a duplex unit of two cards, feeding into a second of greater width, and then air doffing to avoid, distortion and obtain uniformity of the finished web.

It is difficult to prescribe any specific unit for this industry. Unquestionably, quality or quantity may be obtained on each of the above systems. This will depend primarily on the type of fabric, or fabrics, to be manufactured with regards to economy, availability and uniformity.

Application of Resin—Following the formation and fabrication of the web, synthetic polymeric emulsions are applied by either impregnation, foaming, spraying, printing or kiss roll. At the present time there are only two saturators available to the industry on a commercial scale. Due to the fact that the fibers are in a fluid state immediately after saturation and immediately during nip-roll compression, some protection is necessary in order to avoid accentuated distortion of the mat. At saturator has been devised (3) in which the web is saturated between two screens and the excess liquor removed by a set of nip rolls. The web is still contained within the screen during the compression and up to a point where adequate strength is provided by the bonding agent.

Still another method (4) involves saturation of the web by passing it around a perforated cylinder which is immersed in the emulsion. The web in this case is supported by a single screen and held intact with the surface of the cylinder. Following the saturation, the excess liquor is removed by vacuum extraction. During the extraction cycle, greater penetration of the resin into the stock is assured because the liquor is transferred directly through the web.

Several years ago a patented process (5) was presented which involved foaming of an emulsion polymer onto a web. This procedure was described in the patents as gravity feeding of a foam on the surface of the fabric, the excess being removed by a doctor blade. Such a method is claimed to allow uniform application of resin with a minimum degree of web distortion. Resin may be applied in succeeding operations until the desired strength is obtained to enable handling the goods as a woven fabric. Polymer may also be applied to the web by a print roller which provides localized bonding. Such techniques would be used primarily for disposable items since adequate strength for repeated processing is not provided. Fabrics prepared by the above principles afford an item relatively compact and approaching the behavior of woven fabrics. There are cases where resistance to laundering and drycleaning are not essential and where loftiness is a desirable characteristic. In these particular cases a degree of original tensile strength is desirable, and rather than impregnate the fabric and lose this loft, the web either may be sprayed or coated on the surface by a kiss roll. In the former case, webs may range from $\frac{1}{2}$" to 2" in thickness. Common techniques would involve spraying an extremely fine mist of emulsion onto one side of the fabric, drying, then reversing the fabric and spraying the other side, followed by a second drying operation. Webs produced in this fashion have relatively good tensile strength, uniformity of resin and resilience. In fabrics of this type, end uses may call for deposition of the resin on the surface for applications such as dielectric heat sealing.

An additional technique for imparting increased tensile strength is to pass the fabric over a kiss roll which revolves in the treating liquor. The use of the product may demand application of the bonding material to either one side or two. Since fabrics of this type are not subjected to extreme conditions, the lack of bonding agent in the center of the web is not important.

When webs are saturated by either of the two above-mentioned methods, consideration must be given to the

desired hand of the finished fabric. Where smoothness of hand or a greater surface effect is desired, application of the resin can be made in two or more steps. In some cases it may be desirable to avoid applying all of the resin in one pass since varied hand effects may involve a two—or three-stage application. This perhaps could be avoided in many cases if the degree of wet pick-up would be similar to that involved for a woven fabric. However, in some cases wet pick-up may range from 300% to 600% and deposition of the polymer under conditions such as this will cause undesirable properties for specific fabrics. Versatility in hand can be accomplished by both hot-air and hot-can drying.

It should be mentioned that the techniques described above for formation of the web, as well as the application of resin, are representative of the more commonly known and frequently discussed methods of manufacture. Without question, there have been departures from these techniques which offer specific advantages in the finished product. Many of these modifications, whether minor or major, are not disclosed since they are representative of achievements at the manufacturing level which offer the producer significant advantages in production.

Drying—Much consideration must be given to the drying techniques involved with the above methods of application of resin. Migration of the polymer on webs which have been saturated must be carefully controlled. If the webs contain a high degree of polymer and water, the same precautions should be followed in the initial stages of drying as those for woven fabrics. The escape of water encourages shifting of the polymeric particles to the heated surfaces of the fabric thus causing a "hungry" area. An ideal case would then be that of an emulsion which is relatively stable for processing conditions but which will coagulate rapidly when deposited on the fabric. In air drying, the early stages should be confined to a temperature of 200 to 260°F. Roughly, 50% of the water should be allowed to evaporate before the web is exposed to temperatures in excess of 300°F. Although many thermoplastic polymers are adequately fixed with drying alone, exposure to a high temperature in the vicinity of 300°F is favorable in order to allow greater flow and subsequent bonding of the staple fiber. In cases, however, where thermoplastic polymers are used in conjunction with thermosetting resins, a temperature in excess of 280°F is necessary in order to allow the thermosetting resin to crosslink with itself, the fiber, and, in some cases, the polymer. Can drying is also an entirely favorable operation, but, here, too, consideration must be given toward migratory properties of the resin. It is advisable to maintain the temperature of the first two or three cans below 250°F and then heat the remaining portion of the battery to a maximum practical temperature. When drying on cans, deposition of the polymer can usually be avoided by the use of either Teflon or silicone coatings. Since the fabric contains such high concentrations of polymer, one might anticipate a self-cleansing action during the early stages of drying.

Bonding Agents—Since, in many cases, the bonding agent employed constitutes a major portion of the weight of the fabric, many factors must be considered in the selection of the proper resin. For usage in apparel, for example, concentrations of 40% to 50% resin on the finished weight of the fabric are common. There is a considerable number of specific types of polymers, and each classification thereof offers inherent properties on which subsequent fabrics are dependent. Both thermoplastic and thermosetting resins play an important role, and combinations thereof deserve critical attention.

Properties such as mechanical stability, particle size, flexural rigidity, stability to ultra-violet light and heat, migratory behavior, heat sealability, adhesion and economy must be given due consideration. When a certain chemical type is being considered, however, it must not be construed that all emulsions within that type have similar behavior. As an example, polyvinyl chloride polymers may present aging properties ranging from poor to good, nitrile latices provide poor-to-fair solvent resistance, and acrylic polymers poor-to-excellent washfastness. In essence, each polymer must be handled as an entity since differences exist within a rubber group as well as between two different groups.

Synthetic polymers generally used for the manufacture of nonwoven fabrics are susceptible to various chemical and physical changes if care is not taken in the manufacture of the emulsion or in its use. For current methods of high-speed production and the versatility demanded of the resins, mechanical stability of the emulsion is an important factor. Resistance of the polymera to coagulation during processing is primarily a function of the soap system used for emulsification, particle size, uniformity and pH. It is no accident that the predominent number of synthetic polymeric emulsions are supplied on the alkaline side. By nature, the emulsion stability is markedly improved by the addition of various bases in order to obtain a pH of 7 or higher. No generalities can be formed regarding the type of soap system used to emulsify an

unlimited number of monomers. A sulfonated ethylene oxide condensate may be an ineffective emulsifying agent for methylacrylate but entirely satisfactory for butadiene-acrylonitrile polymer. In the manufacture of the emulsion the emulsifying agent plays a role capable of causing numerous side effects. The rate of reactivity, molecular weight, average distribution of particle size, etc., are factors constantly plaguing the emulsion chemist. Each polymer is handled as an entity and systems are employed which provide optimum properties for the intended use of the polymer.

Some synthetic polymeric emulsions are attacked and subsequently breed bacteria when used under adverse conditions. Additions of bactericide, alkali or acid will readily control this growth. The acid addition, however, as mentioned earlier, will be dependent on the possible detriments it may cause the emulsion. There is no doubt regarding the occurrence of bacteria; obnoxious odor accompanied by a blue color is obvious. This blue color, incidentally, is markedly different in intensity from the bluish optical cast caused by the preparation of emulsions with infinitely small and uniform particles. Formaldehyde, as well as the above-mentioned agents, may be employed to avoid the initial attack of bacteria, or as a later addition to avoid further growth. Additions of formaldehyde to a contaminated emulsion will retard further growth but will not offset the chemical degradation caused by bacterial action.

Oxidation of the polymer and accompanying physical changes of the nonwoven fabric is a factor deserving utmost attention. Natural rubber and many synthetic rubbers require antioxidents to minimize the occurrence of brittleness, discoloration, etc. These unsaturated linear polymers are readily attacked by small quantities of oxidizing agents. From a textile point of view this property is a severe detriment and limits the potential use of many synthetic polymers. In contrast, selectively stabilized polyvinyl chloride emulsion show good behavior in this respect and the fully saturated acrylic polymers or copolymers are optimum with regard to resistance to oxidation processes.

The degree of firmness or softness imparted to a textile fabric is obtained in many ways. Specifically, for nonwoven fabrics, drapeability is obtained with polymers which have been plasticized either internally or externally. The former, of course, is more desirable since plasticization has been accomplished by building the softer monomer (acting as plasticizer) into the resultant polymer in any desired ratio. Externally plasticized polymers, on the other hand, require caution in use. Due to the lack of homogeniety, migration of the plasticizer is quite common. An externally plasticized polymer has restrictions on a web destined for apparel since loss of the plasticizer on laundering or with chlorinated solvents will cause a marked increase in the rigidity of the web.

Types of Bonding Agents—Of the synthetic polymers encountered, the following represent those used in greatest volume for nonwoven fabric manufacture: polyvinyl chloride, acrylic, butadiene-acrylonitrile or nitrile latices, butadiene styrene, and polyvinyl acetate.

Polymers of vinyl chloride show marked color changes and increasing stiffness unless suitable stabilizers are used. This discoloration is caused by the loss of the halogen and formation of hydrochloric acid, which, combined with oxygen, attacks the newly formed double bonds. The stabilizers utilized either accept the liberated acid and or saturate the recently formed double bond. As a class the polyvinyl chloride polymers must be characterized as being not resistant to oxidation; therefore, marked discoloration and stiffness occurs. Recent work, however, has led to the development of newer and improved types which are internally plasticized and relatively resistant to degradation by ultra-violet light and heat. The introduction of these features has broadened the potential use of these polymers as bonding agents for nonwoven fabrics. The polyvinyl chloride polymers provide a low degree of elongation with fairly good tensile strength. Dryclean-ability of the group will range from fair to good, although washfastness in many cases is marginal. In general, the newer types of polyvinyl chloride polymers have made contributions to the bonded fiber industry. Economy and general properties in use have substantially increased the market of these polymers.

The acrylic polymers, copolymers, terpolymers, etc., have shown continued growth in the bonded fiber industry. Until recent years these materials were characterized by good performance, but they were considered excessive in cost. Technological improvements in the manufacture the monomers and subsequent polymers has offset the pre-existing price differential. In most cases they are now competitive with the conventional latices employed in this industry and provide inherent properties desirable in the manufacture of nonwoven fabrics. The acrylic polymers are fully saturated and degradation of the polymer in normal use is nonexistent. Since they are fully polymerized, and thereby saturated linear polymers, oxidation processes do not affect the appearance or stiffness of the film. The acrylic polymers are internally plasticized and

any degree of flexibility may be obtained. As in the conventional emulsion polymerization, the ratio of monomer is the determining factor in providing soft or firm film characteristics. The new type acrylic polymers offer optimum conditions regarding mechanical stability. Of this newer group, the polymers provide good durability to laundering and drycleaning. As may be expected, this durability is significantly enhanced by the use of thermosetting resins to provide a crosslinking mechanism. The versatility of the acrylic polymers is apparent since their general properties allow them to be used in all the conventional processes for the preparation of nonwoven fabrics. Among the softer varieties, good tensile strength is obtained, with fair-to-good tear strength imparted to cellulosic and synthetic webs. Of the softer variety, good resilience is obtainable; however, the rate of recovery is somewhat slower than that obtained with several of the synthetic rubbers. Although the rate is somewhat slower, the degree of recovery is equally as great, thus allowing treatment of the web as a wash-wear fabric. It is anticipated that the newer types will have the characteristic bouncy feel while still maintaining the properties required to obtain the intrinsic behavior of a textile fabric.

Of the types mentioned above, reference is made to acrylic polymers which are solely based on acrylic monomers, such as methylacrylate, ethylacrylate, methylmethacrylate, etc. In addition to this type, the term *acrylic ester* has become common in a different sense of the word. Although the term *acrylic esters* would be definitive of the above type, it could also include copolymers of an acrylic monomer and a foreign synthetic latice to perhaps provide intermediate effects. Acrylic monomers may be copolymerized with numerous synthetic monomers to meet specific end-use requirements. Such products have found wide use; however, their over-all properties do not quite match the behavior of the acrylic polymers *per se*.

Butadiene – acrylonitrile latices, when used as bonding agents for nonwoven fabrics, provide good-to-excellent tear strength on webs composed of both cellulosic and synthetic fibers. This degree of tear strength is accompanied by fair tensile strength and softness of hand where desirable. The nitrile latices as a group are susceptible to oxidation. Here again, within a chemical class, degradation of the acrylonitrile latices, when exposed to ultra-violet light or heat, ranges from extreme-to-moderate change in color and/or stiffness. Without question, this property somewhat restricts the use of these polymers from select applications where stability is necessary. Aside from this, in fields where such aging properties are not essential, the nitrile latices are used extensively where economy, mechanical stability, elongational behavior and versatility are attractive. The launderability of these polymers may range from fair to good, and in general the drycleanfastness is rated as equally good. With these materials, the addition of thermosetting resins also enhances these latter properties to a marked degree.

Polymers based on butadiene-styrene offer a factor of economy which cannot be overlooked in this industry. In general use, the restrictions are obvious due to the relatively poor mechanical stability of many in this class and the residual tack, which all too frequently occurs. Butadiene-styrene polymers are the most rapidly attacked by heat and ultra-violet, and severe discoloration, with a substantial increase in firmness, is noted. Further work will undoubtedly lead to improved types in which some of these factors may be offset. Tremendous quantities of these polymers are consumed in unrelated applications in the textile industry, and although there may not be a direct correlation to nonwovens, improvements may be anticipated which might reduce the limitations in this field.

Polyvinyl acetate has been a conventional finishing agent in the woven fabric industry for many years. It shows promise in select fields in the manufacture of nonwoven fabrics also, and its general behavior in application and use is attractive for these outlets Webs bonded with polyvinyl acetate lack the resilience which, in many cases, is desirable in this field. The degree of recovery is relatively poor and the adhesion to many of the synthetic fibers is marginal. Fastness to laundering and drycleaning ranges from poor to fair.

The comments pertaining to the above synthetic latices are primarily in reference to their use as a self-bonding agent. In most cases the fastness properties are substantially improved by the addition of thermosetting resins of either the ethylene urea-formaldehyde, melamine-for-maldehyde, methylated urea-formaldehyde or epoxy type resins. For example, certain of the acrylic polymers contain functional groups capable of crosslinking with themselves or with the thermosetting additive. Combination of the thermoplast and thermoset thereby minimizes swellability in solvents, further reduces any residual tack, and adds a greater degree of resilience to the fabric. Where a minimum change of hand is desired, the ethylene urea derivatives are suggested due to their inability to react with themselves and the fact that crosslinking occurs only with the thermoplastic polymer or the fiber. The use of thermosetting resins of this type will require further consideration in the curing of the finished fabric. In most cases temperatures of 300°F or higher are desirable in order to

obtain a higher yield of reactivity between resins. Conventional catalysis is suggested, and metallic salts, ammonium salts, as well as amine hydrochloride catalysts are adequate. The reactive resin, depending on its chemical behavior, will be used either in the original bonding of the fiber in conjunction with the thermoplast, or as a subsequent top treatment. Several factors must be considered in the selection of the thermosetting resin with each specific synthetic latice. These factors are: flexibility, resistance to chlorination for special end uses, economy, discoloration, and rate of reactivity. As mentioned above, the effect of thermosetting resins used in conjunction with latices is most apparent when the latter agents exhibit some functionality and ability to crosslink either with themselves or with the thermosetting resin. In general, the ratio of thermoplast to thermoset resin will range from 8.5/1.5 to 9.5/.5. A compromise is sometimes essential in order to impart minimum hand with certain of the thermosetting resins while improving the durability of the polymer to the desired degree. For example, in a web composed of nylon and acetate, the melamine-formaldehyde resins as well as the methylated urea-formaldehyde condensates tend to give a degree of crispness and firmness to the fiber.

In many cases, nonwoven fabrics will be exposed to chlorination procedures similiar to those encountered for woven goods. In essence, the behavior of the thermosetting resin on nonwovens parallels its property on woven fabrics. In this respect the epoxy resins, because of their non-nitrogenous nature, exhibit no chlorine degradation.

Both the melamine and ethylene urea derivatives will pick up and retain chlorine; however, with hot chlorination, discoloration is markedly less with the latter material. On some nonwoven fabrics, because of the location of the thermosetting resin, discoloration may be more noticeable than on woven goods. This may be due to the fact that prebonding techniques with elastomer alone restrict the thermoset from the interstices of the fiber and a greater portion is deposited on the surface where it is more rapidly attacked by chlorine. Although discoloration may occur, it is not associated with high strength loss as in the case of woven fabrics. While the same mechanism occurs in the release of hydrochloric acid, the high concentrations of thermoplast tend to offset the actual degradation of the cellulosic fibers. The conventional urea-formaldehyde paste may be used satisfactorily; however, the limited storage stability and greater potential of odor development on the cured fabric are restricting factors.

Further consideration is being given to thermosetting and thermoplastic resins used in other industries as these may be readily adaptable to the subject application. For example, many manufacturers desire bonding agents capable of resistance to chemical and physical degradation comparable to the fiber which they are bonding. For numerous industrial applications, bonding agents resistant to acid, alkali, oils, etc., would allow greater versatility for the production of industrial filters, gaskets, etc. Some attention has been given to the use of polyester-styrene resins, which may provide chemical resistance comparable to Dacron polyester fiber (6).

Further, nonwoven fabrics which are subsequently used to prepare laminates would be more receptive to lamination techniques if the bonding agent for the fiber was chemically similar or identical to the laminating resin. Since styrene-polyester resins are normally used for this purpose, special steps may be required for emulsification, application, etc. The styrene is not a diluent for these resins but a coreactant for the polyester. Factors such as air inhibition should not be as critical in handling of the web as for molding or lamination of the same resin.

The monomeric and polymeric plasticizers enhance the heat sealability factors of numerous thermoplastic latices. Plasticizers will change the power factor of the film, thus allowing a greater degree of excitement of the polymer under standardized heat-sealing frequencies. Dibutyl phthalate and dioctyl sebacate are two monomeric types which exhibit this property. Alkyd resin may be utilized to provide improved fastness properties to the polymer and, perhaps, to the selective coloring agents which may be used in the saturation. The incorporation of pigments and/or direct dyestuffs to the saturating system provides a method to uniformly dye the fabrics as well as to apply required amounts of bonding agent. Since, in most cases, the ratio of thermoplast to pigment is extremely high, further protection may not be necessary depending upon the use for which the fabric is destined. Chemical suppliers are constantly striving to offer new and improved types of resins for this industry, as is evidenced from past work. A great deal of the limitations of the fabric are primarily functions of the bonding agents employed. The combined efforts of supplier and consumer has led to definite advancements in this direction.

Battings, Waddings, Packings, Etc.—For a number of years thick webs composed primarily of cellulosic, but in some cases synthetic, fibers have been produced for various industrial, domestic and apparel uses. Webs of this type may vary in thickness from approximately one-half inch to two inches. These webs, as described earlier, generally are produced on a garnett at speeds up to 300 lbs. per hour. Depending on specific end uses, they may be used directly from the garnett or after subsequent wet—or dry-bonding techniques. The end use primarily will dictate the finishing techniques required. In many cases adequate strength is imparted to webs of this type by processing on a needle loom. This method involves entanglement of the fiber at multiple locations to increase the tensile strength in order to obtain satisfactory processing conditions. Since the loftiness must be maintained, the tendency is toward dry-powder bonding in order to obtain the desired properties. These products may be based either on thermoplastic or thermosetting systems. The procedure for distribution of the bonding agent is also dependent on the degree of uniformity required and the end use.

One such patented method (7) involves the sprinkling of powder on a light garnetted web immediately prior to crosslaping. Such a technique allows distribution of the resin between each individual layer and insures greater bonding efficiency and economy. After crosslapping the thickness is obtained by varying the speed of the crosslapping belt or screen. The web is then carried into the heated chamber, and on slight compression fusion of the polymers occurs, thus substantially increasing the strength of the web. Thermoplastic powders are the principal chemicals used in this operation. Copolymers of vinyl chloride and vinyl acetate may be used effectively.

A newer type, based solely on acrylic monomers, has been developed and may offer intrinsic value to webs bonded with these materials. The latter are supplied in bead form and have a relatively uniform particle size. Discoloration of the polymer is avoided, thus allowing processing at substantially higher and more efficient temperatures. Of significant importance is the fact that it is possible to vary the average particle size of the polymers in order to provide versatility in related applications. It can be seen microscopically that fusion of the particles occurs at the junction of the fiber and a degree of flow may be noted along the length of the individual fibers. Webs bonded by these techniques generally contain from 15% to 30% thermoplastic powder or bead based on the final weight of the fabric. It is conceivable that compressed webs with greater drapeability could be obtained by similar techniques since fil n continuity is avoided.

Phenol formaldehyde condensates may also be used in such a process. They have application only where discoloration of the web is not a hindrance since the conventional phenol trait is quite obvious. The economy, however, is attractive for many industrial applications, and for these uses these materials aptly provide satisfactory behavior.

Lofty webs commonly used in the quilting trade frequently require the addition of bonding agent in order to provide sufficient strength for the quilting operation. Loft is essential in order to maintain the intrinsic behavior of the web for apparel usage. There is evidence that, due to the physical form of the acrylic bead polymers, they may be uniformly applied to a thick web by gravity feed, provided it is not excessively dense. The filtration of the bead occurs throughout the web, thus allowing localized bonding sites.

The techniques described above are fairly well established; however, the increasing availability of new type bonding agents in solid form may open up new avenues for the manufacture and distribution of these items.

Fiber Bonding—A great deal of attention is being directed toward the development of improved synthetic thermoplastic fibers, which may be used effectively as the bonding agent for similar as well as different fibrous materials. Such techniques would allow the preparation of a completely fibrous nonwoven fabric, the thermoplastic fiber being used at varying concentrations on the total weight of the web in order to impart the desired degree of strength, drapeability, appearance, etc. Webs of this type would be prepared in the normal fashion after the fiber in question is mixed uniformly. After the web is formed, it may then be compressed during a heating cycle at a temperature in excess of the fusion point of the thermoplastic fiber. This then allows bonding at the crossover points of the thermoplastic fiber and the fiber to be bonded. It is expected that minimum hand buildup will be obtained by proper fiber selectivity and that the integrity of a textile fabric will be more obvious. Such procedures are common presently in the felt industry, and without question an extremely high degree of strength is obtained; however, more is to be desired with regard to softness and drapeability. It is quite likely that, in the near future, thermoplastic fibers will make more definite inroads into the bonded fiber industry and presumably open up newer and perhaps more difficult markets.

Paper Process—There has appeared recently on the market bonded fabrics manufactured by paper processes. Such techniques offer the possibility of producing bonded fabrics at a fantastically higher rate of speed

than is normally encountered in the textile industry. A great deal of attention is being directed to this effort in certain quarters and the results to date have been quite promising for specific outlets. Both fiber and latex manufacturers have considered many specific means of bonding fibers for this industry. Beater additions, as well as impregnations or sprayings after formation of the web, etc., all have been thoroughly exploited. The major types available thus far still have the inherent properties of a papery item and the softness and drapeability normally associated with textile fabrics has not been obtained, or at least produced commercially. Closely related to textile and paper applications is the formation of papers composed of synthetic fibers. Short staple is processed for this use, usually in the range of $\frac{1}{4}$" to $\frac{3}{8}$" in length. The fiber is dispersed, and after formation of the substrate, latices are applied. There is a great deal of related technology involved in both the paper and textile techniques and unquestionably there shortly will be some overlapping of the two independent operations.

PRESENT AND FUTURE

A recent publication (8) has attempted to summarize the actual consumption of nonwoven fabrics during the 1956 era. The markets mentioned were as follows:

	Million lbs.
Paddings and packings	20
Industrial wipers	1.0
Coated fabrics	25.0
Disposable items	12.0
Apparel usage	7.5

At the present time, the greatest growth potential appears to be in the outwear field. Since little progress has been made thus far in producing items of this type, it is generally agreed upon that bonded fabrics made adaptable for outerwear use should be handled in the conventional procedures currently recommended and followed for woven goods. With regard to drycleaning and washability, the consumer will expect comparable or perhaps even better behavior from nonwoven fabrics. Still to be given a great deal of consideration are the many conceivable methods of finishing nonwoven fabrics, which may produce unique and novel effects for use in the apparel trade. Very attractive prints have already appeared, as well as dyed grounds, but little emphasis has been placed thus far on mechanical finishes which may be imparted to the nonwoven fabric. Such techniques should improve the acceptability of nonwoven fabrics in this field.

Nonwoven fabrics for various industrial uses may be considered as an entity depending upon the end-use requirements. Here again, however, where competition will be woven goods, economy, serviceability and utility must be made more obvious. It is estimated that nonwoven fabrics as a class will double or triple in volume every three years. Many factors, of course could affect this in one manner or another. The influx of new processors of bonded fabrics is representative of the interest this commodity has aroused and of the possible growth pattern which is sure to follow. The over-all picture is extremely encouraging, and a considerable amount of research time of the manufacturer, chemical supplier and fiber producer is being spent in this direction. The combined efforts of the three parties working cooperatively should substantially increase the efficiency, productivity, merchandiseability and acceptability of nonwoven fabrics.

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(2) Proctor and Schwartz, Inc., Philadelphia, Pa.
(3) Rodney Hunt Machinery Co., Orange, Mass.
(4) John Waldron Corp, New Brunswick, N J.
(5) Pellon Corp, Lowell, Mass.
(6) Trademark E I du Pont de Nemours & Co, Inc, Wilmington, Del.
(7) Permex Corp of America, Hawthorne, N J.
(8) Emery and Fuller, Merchandising Division, Textile Fibers Dept, E I du Pont de Nemours & Co, Inc, Wilmington, Del.

IRON ORE

According to a statement made by Shri N. Kanungo, Minister for Commerce in the Parliament, India exported last year 1.793 million tons of iron ore while the Second Plan have set a target of two million tons of export by the last year of the Plan. The State Trading Corporation, according to the Minister, hopes to exceed the target in 1957-58.

Hindusthan Steel Ltd. is reported to have placed an order with an American firm for supply of ore moving machinery on deferred payment basis. The plant reportedly will be established in Barsua, near Rourkela and will cost $5.5 millions. The report added that ten per cent of the value is payable on order and the balance is payable in quarterly instalments spread over a period between October, 1958 and October 1959.

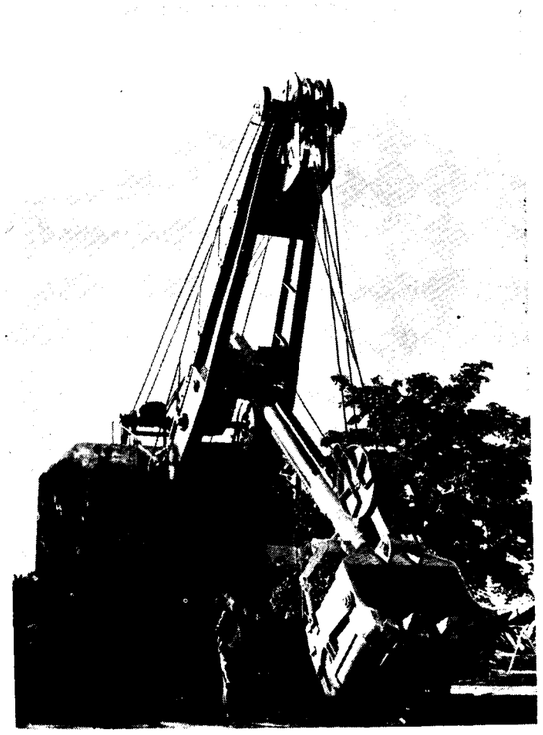
The Development of Exports of Czechoslovak Machines and Machinery Equipment to India

By Director of Publicity
STROJEXPORT, Praha

CZECHOSLOVAKIA admires greatly the boldness of the plan for economic progress conceived by the Government of India and stands ready to contribute to its realization by supplying machines of best quality, manufactured by Czechoslovakia's specialized and highly developed engineering industries. For this reason and in view of recent successful exhibitions in Bombay and Delhi the Czechoslovak foreign trade corporations, especially those for the export of machinery products such as TECHNOEXPORT, STROJEXPORT, MOTOKOV and KOVO, are taking part also this year with extensive exhibits in the independent exposition arranged by the Czechoslovak industries in Calcutta.

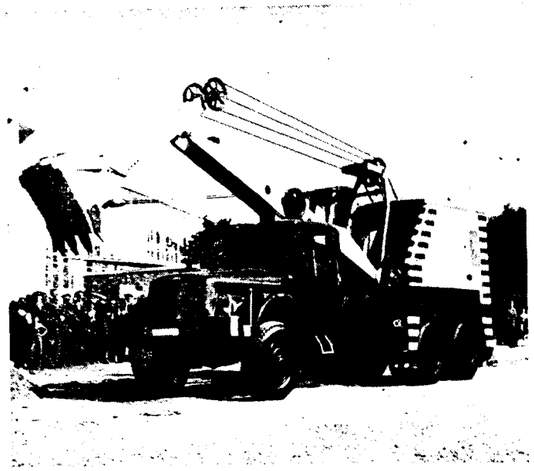
After the visit to India of Mr. Dvorak the Czechoslovak Minister of Foreign Trade towards the end of last year and after his conversations with the Prime Minister, the Ministers of Trade, Industries and Transport of India and the chief Ministers of the Bombay and Bengal Governments, the economic foreign-trade relations between India and Czechoslovakia showed an extraordinary improvement, in particular, as far as the possibility to supply a variety of machines and machinery equipment was concerned.

In view of India's far-reaching programme for industrial development calling for the expenditure within the next five years of more than 16 milliards of rupees to buy investment goods, machines and machinery equipment which it will be necessary to import and Czechoslovakia, with its highly developed industries and its tradition of machinery and plant export, is very well able to supply a great part of the required commodities. On the other hand Czechoslovakia needs in order to increase the standard of living of her people such raw materials and foodstuffs like jute, cotton, iron and manganese ore, mica, tea, spices and the like, which India exports in great quantities. Here then is a sound economic basis which reduces the difficulties arising from mutual payment to a minimum. The Czechoslovak machinery of SKODA, CKD, CZ, TATRA, First Brno Engineering Works, JAWA make have an excellent reputation in India already from prewar days. Indeed Czechoslovakia built 7 complete

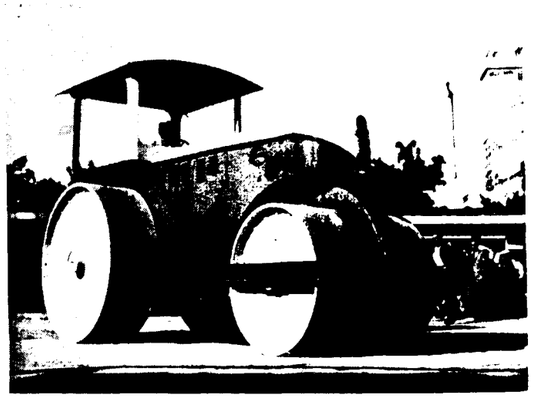


Excavator SKODA E-25

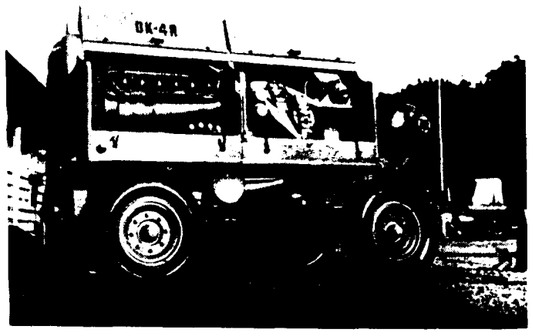
sugar factories in India, supplied the plant equipment for an aluminium works in Calcutta, the electrical equipment for the power station in Surat and only a short time ago contracts were signed for the delivery of a steam-driven power generating plant with a capacity of 45,000 kW and for equipment of a cement works with a capacity of 400 tons of cement in 24 hours and for the supplying of yet another sugar factory to process 100 to 1,250 tons of sugar-cane a day. Moreover Czechoslovakia gained in the face of keenest competition with a score of foreign concerns, an order for 50 locomotives, 2050 railway cars and 100 road rollers, and altogether increased the export of machine tools to India



Universal Excavator Type D-050 mounted on the chassis of the world known carrier "TATRA"



Road roller SKODA Type NV-15



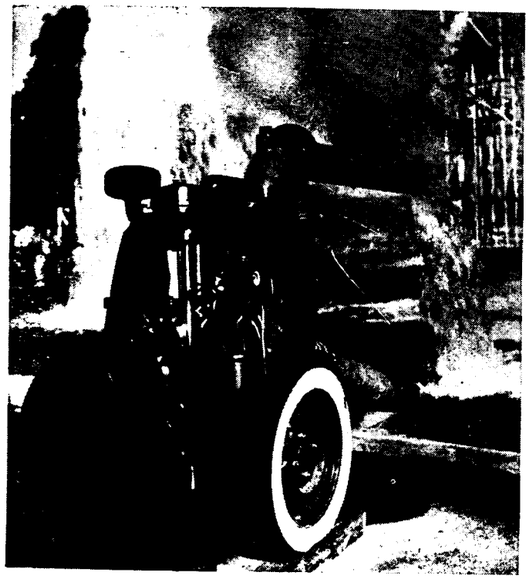
Air Compressor ATMOS Type DK-4R

in the last year by 220% as compared with 1950; many more such instances could be quoted.

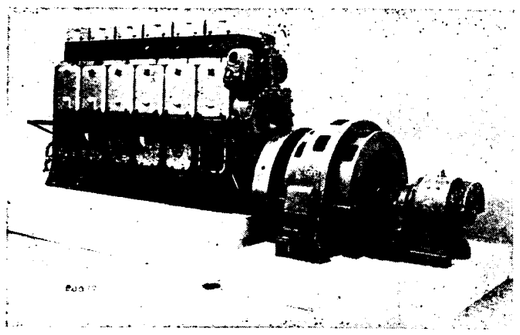
Inasmuch as Czechoslovakia offers India a novel kind of business partnership, affording the customer the supplier's technical help and knowledge it is not too much to hope that the mutual business between India and Czechoslovakia will continue to grow.

Notwithstanding the fact that the turnover of reciprocal trade between India and Czechoslovakia is on the upgrade, a comparison of figures relating to the trade with other countries of that region shows that the possibilities of a further expansion of business are not yet exhausted, not by a long way. This becomes evident when we consider that Czechoslovak exports to the countries of South-Eastern Asia rose in 1954 by 53% as compared with 1950 and that, while exports to India doubled in that time, sales to Afghanistan increased 5 times, to Indonesia 6 times and to Burma even 10 times in the same period. And yet India's economic resources are far greater, in particular her wealth of raw material necessary for the development of her industries, which by no means exploit adequately the vast possibilities and needs of the country. Neither production of electric power, steel and aluminium, chemicals nor the products of mechanical engineering have yet reached the required level. The rolling stock of Indian railways is also not satisfactory as far as size is concerned. Of railway locomotives 32% are in service for more than 40 years and 24% of the freight cars and 36% of passenger coaches need replacing. In consequence the Government of India intends to remedy these shortcomings in the course of the second five-year plan by building up domestic metallurgical and mechanical engineering industries and on the other hand by importing machines.

STROJEXPORT The Czechoslovak Foreign Trade Corporation, one of the largest concerns of its kind in the world, exporting machines and equipment to 77 countries all over the globe, exhibits at present their machines in Calcutta on the largest display area. Their network of sales agencies in India has been considerably extended during the last year, consignment stocks of spare parts have been established and their newly installed technical centers in this country have been put



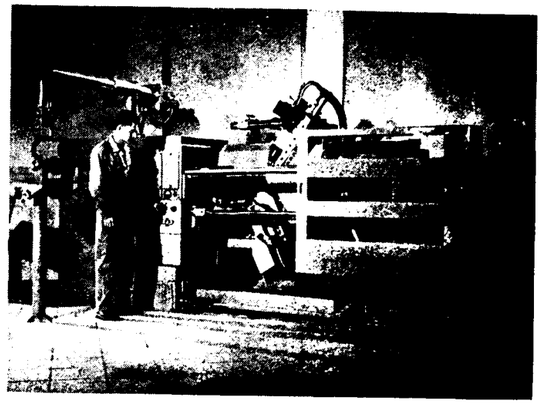
Type 150-UZA—Self-suction irrigation set with air-cooled diesel engine Tatra



Diesel Generating Set with SKODA Diesel Engine

into the hands of Czechoslovak engineering experts. As a result they were able to boost their Indian turnover during the last year by no less than 150% as compared with 1954. The earlier mentioned biggest successes achieved in the sale of machines, locomotives, railway cars and road rollers must be credited to the efforts of this very concern.

Very numerous and sizable business deals in markets abroad in the main commodities speak also for the success of the export drive of the STROJEXPORT Corporation. This firm exported, for instance, last

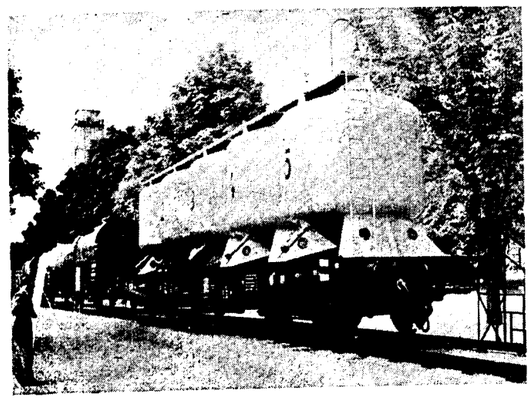


Semi-automatic Lathe model SP-31 with automatic working cycle

year to the Western states 48% more pumps than in 1953, 200% more of metal-working machines and even 290% more of combustion engines. Important deliveries of railway cars and locomotives to Turkey and Egypt have been realized; bridges and pumping stations to Egypt, flour mill equipment to Paraguay, etc. The export of products of electrical engineering, like electric motors, electric generators, transformers, rectifiers, electric high-voltage and low-voltage instruments electric spot-welding and seam-welding machinery and the like exceeded identical exports of pre-war Czechoslovakia more than twelvefold, of excavators and cranes fivefold, of machine tools eightfold, of pumps thirteenfold and of combustion engines, including diesel sets even as much as twentyfivefold. In exports of machine tools, combustion engines and pumps Czechoslovakia ranks right behind the World's top machine exporting nations the USA, the United Kingdom and Western Germany.

These few figures are sufficiently convincing proof of the high quality and growing popularity of Czechoslovak machines abroad, not only in economically under-developed countries but also in countries with well established industries. Czechoslovakia exported, for instance, in the last year to Switzerland twice as many machines as in 1954, to Belgium 2, 3 times and to Western Germany even 8 times as many as in the previous year. Machinery exports participate in the total value of Czechoslovak exports this year with more than 50% while the pre-war ratio was not quite 7%.

From the wide range of machines it has for sale the STROJEXPORT Corporation offers to buyers in India the following:



Four Axle Truck for transport of Cement

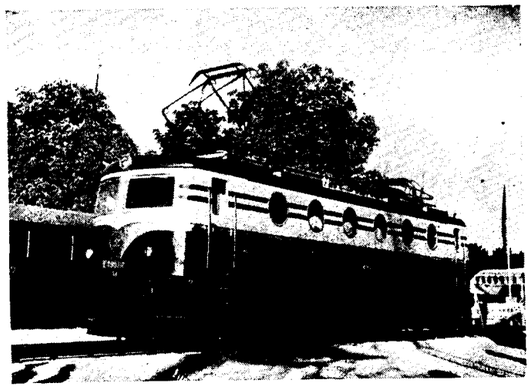
More than 400 models of highly efficient metal working-machines, of the cutting-type and of the non-cutting type. Particularly popular in India are Czechoslovak grinding machines. Over 30% of the total value of machine tools made in Czechoslovakia and ordered by Indian customers last year, was made up of Czechoslovak grinding machines.

Diesel engines and diesel sets of the world-renowned SKODA trade-mark, stationary, or mobile and marine engines, with output of 8 to 2,000 H. P. Of these, series S 110 diesel engines and sets of an output ranging from 25 to 700 kVA have received the highest praise for satisfactory performance in India.

Piston-type and rotary pumps, of all sizes, from handoperated pumps to huge pumping stations of the SIGMA trade-mark which have been successfully exported to the countries of the Middle and Far East.

Compressor stations of stationary and of mobile design, of the ATMOS and CKD make, suitable for builders, mining companies assembly plants and other enterprises, with a pressure of 3 up to 3.000 atm. abs., and of a great variety of outputs.

Electrical engineering products of all kinds.



Electric Locomotive SKODA Type E. 4990

Building machines, lifting tackle, transport and industrial plant equipment.

In view of the needs of its export Czechoslovakia plans to increase mechanical engineering production by the year 1960 by 83%. Production of electric motors is to be raised by 75%, crude oil engines by 58%, machine tools by 74%, production of special metal-working machines is to be enlarged 7,2 times, that of automatic and semi-automatic lathes 4,8 times, machinery for the food-processing industries by 219% equipment for the chemical industries by 158%, plant equipment for cement works by 197% and so forth.

With such production basis to back them up the Czechoslovak corporations for the export of machines are able to intensify still more their service to customers abroad, to increase the range of machinery available for export and to improve terms of delivery.

The customers of India can rest assured that any orders placed with the Czechoslovak foreign trade corporations in charge of machinery exports, will be executed on time, quickly and reliably, in short, exactly in such a way as is required for the fulfillment of the great industrialization efforts of India, for which the people of Czechoslovakia has such lively sympathy.

STEEL IMPORTS IN 1957-58

According to a statement by the Union Minister for Steel Mines and Fuel in the Parliament, the quantity of steel that would be imported into India during 1957–58 both against Government contracts and commercial licences would be about 1.5 million tons. The programme for import in 1958–59 is still being considered. The foreign exchange to be spent during 1957 would be about Rs. 120 crores.

Details of the Belmos "G" Range Control Gear

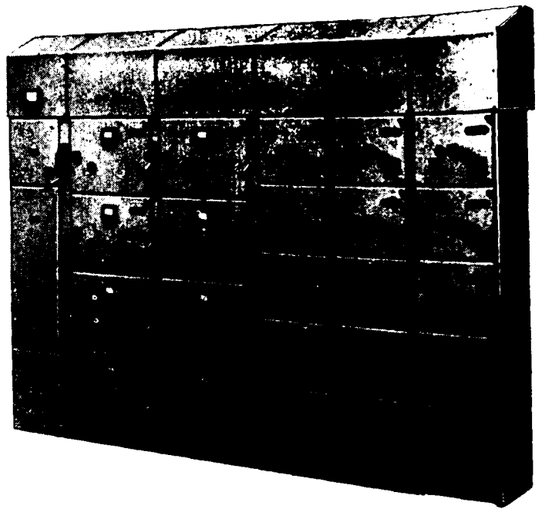
By A Special Engineering Correspondent

A NEW Range of medium voltage a. c. Motor Control Gear Switchboards, designated the "G" Range, is now in full production by The Belmos Company Ltd. of Bellshill, Lanarkshire. This compact and attractive design in four and five tiers covers the many applications now arising in industry where a number of standard direct-on-line starters for three phase motors are best grouped together as a switchboard, with either local or remote control.

The space saved is 20 to 30% compared with a two and three tier construction, such as the well established BELMOS "D" Range which the new design supplements. Further space can be saved by using a version of the design which permits the switchboards to be mounted directly against a wall.

Individual isolation and back-up h.r.c. fuse protection are provided as standard, and other features which can be added include ammeter, indicating lamps, 110 volt control circuit, and sequence interlock between starters. Already several installations, each involving over two hundred and fifty starters, have been supplied for new continuous process plants; these have demonstrated the soundness and flexibility of the basic design which enables the gear to meet the differing requirements of a variety of users in the most modern applications. Simplification and standardisation enable the range to be offered on short delivery.

The flush-fronted switchboards exhibit the well known BELMOS attention to appearance, robustness and accessibility. A choice of five attractive stove-enamelled colours is offered as the standard finish. The five tier cubicles accommodate direct-switching starters up to 12½ h.p. at 440 volts, and the four tier up to 40 h.p. (and occasionally up to 70 h.p.). When larger horsepowers or multistep starters are also involved, housings of one or two tiers can be supplied to match. A new leaflet, reference K 450, describes and illustrates this new development from Scotland in some detail.



A typical "against-the-wall" Switch Board with Incoming trunking at left

HINDUSTHAN MACHINE TOOLS

As a result of the reorganisation of production schedule, the Company was able to achieve an output of 135 machines in 1956–57, as against the original target of 57 machines. Production during 1957 58 is expected to exceed 400 machines, as against the original target of 131 machines. The revised target for 1960–61 is double the original target of 400 machines, to be achieved by working multiple shifts and increased efficiency. A technical collaboration agreement with the West German firm of Fritz Werner was signed in January last for the manufacture of horizontal, universal and vertical milling machines. Negotiations for technical collaboration, it is stated, are in an advanced stage for the manufacture of radial drills and heavier lathes. In addition, the Government has approved in principle the establishment of a foundry estimated to cost Rs. 60 lakhs; the initial planning and layout of the foundry has been completed and tenders invited on a global basis.

Wilson's New Multi-Motor Universal Woodworker, Model WTK

By Director,

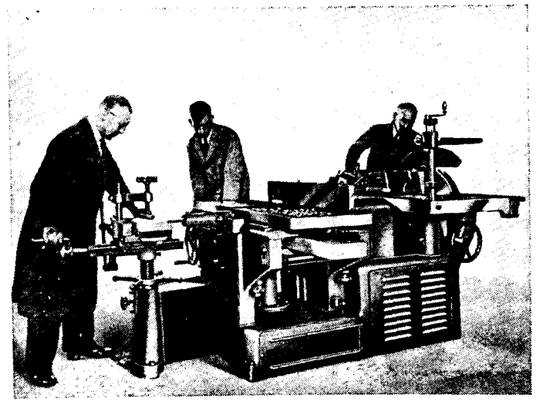
Wilson Bros. (Leeds) Ltd., Leeds, U. K.

EVER since there were Woodworking Machines, attempts have been made to combine the essential basic operations of Sawing, Planing, Mortising, Tenoning, Shaping and Moulding, into one complete unit. This latest WILSON MODEL WTK achieves this combination without the complication and limited capacity of most " Universals ".

In this advanced design up to three operators may work at the same time, quite independent of each other. Correct speeds on all three work spindles enables accurate work to be produced by three operators working simultaneously i.e. one-third the time or three times the work of a single operator type of machine. This multi-motor machine has the further advantage of operating simplicity, there are no belts, pulleys or motor to change and work is produced with the same ease and convenience as on separate machines. It will be obvious that the productive advantages of the multi-motor machine cannot be over estimated.

Where space is limited and work varied, Model WTK provides an ideal plant in one compact machine, effecting great saving in floor space and installation costs. For the Joiner or Builder, the Furniture Manufacturer or Shopfitter, the machine is equally suitable for producing the special " one off " job or dealing with repetition work. Public Service Departments, Hospitals, Factories etc., find this Universal invaluable for maintenance work and Technical Schools for Instructional purposes.

Machine has self-contained motors enclosed within the main frame, each motor is pushbutton controlled from operator's working position. Work is rip sawn or crosscut with equal facility on the rise and fall table saw bench, which takes saws up to 24″ diameter to cut up to 9″ deep. Canting fence has quick adjustment and fine screw setting. Surface planing, jointing, rebating and power feed thicknessing are always available without stopping sawing. Planes up to 16″ wide and thicknesses up to 9″ deep.



"Wilson's New Multi-Motor Universal wood-worker, Model WTK"

Mortising with hollow chisel and bit produces clean true mortise holes. Machine takes chisels upto 1″ square and has length and depth gauges fitted for repetition work. Accurate clean tenons are cut by a standard tenon head with face and shoulder cutters. Tenon cutter head is quickly fixed to spindle and will cut tenons up to 4½″ long at one stroke.

Vertical Spindle Shaper is an invaluable feature as it provides the simplest and best methods of working such a wide variety of operations. No machine without a Vertical Spindle is truly a " Universal ".

BIGGEST ELECTRIC CRANE ERECTED AT CALCUTTA PORT

A 200 ton electrically operated crane said to be the biggest in the East costing nearly Rs. 1.9 million is reported to have been completed and the machine is likely to be put into commission within a few days by the Calcutta Port Authorities. A West German firm, Messrs. C. H. Jucho, Dortmund, installed the crane. About six hundred and fifty tons of steel were needed to build the 8000 c. ft. steel and concrete foundation of the crane.

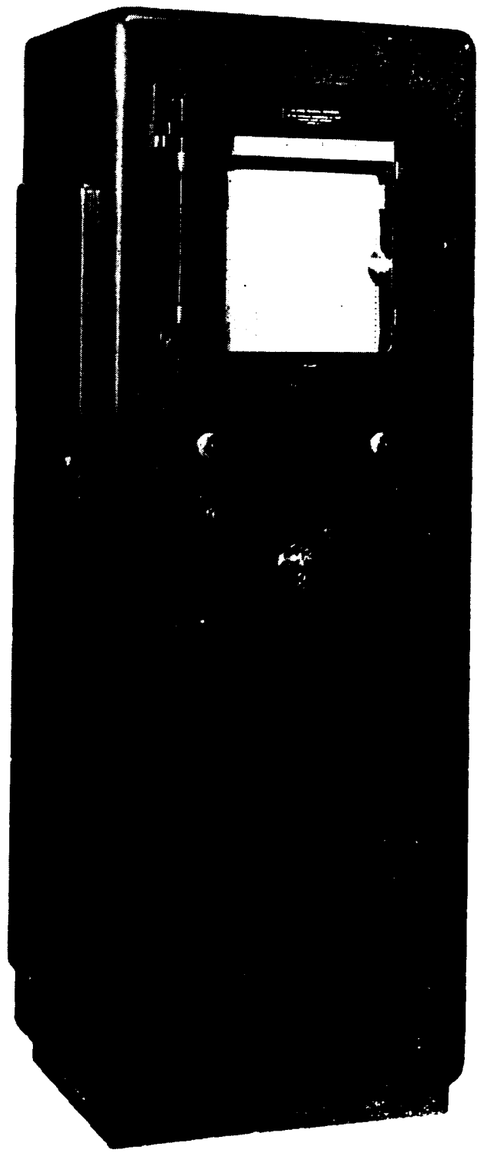
Paterson Residual Chlorine Recorder—Model 2

CHLORINATION is the method which is most widely used for the production of drinking water supplies and for the sterilisation of water for swimming pools and industrial uses. Various instruments have been produced for the automatic regulation and measurement of the applied doses of chlorine but until comparatively recently there were no reliable means of obtaining a continuous reading of the residual chlorine content of the water being treated with the object of ensuring that the applied dose should at all times meet the chlorine demands of the water.

An instrument has now been devised by the Paterson Engineering Company Ltd., of Windsor House, Kingsway, London, England, to fulfil this need. This is their Residual Chlorine Recorder of which two models are available, one giving a direct reading in parts per million and also a continuous chart record of the total residual chlorine in the treated water and the other model recording either the total or the free residual chlorine. Free chlorine is that present in the form of hypochlorite ions whereas the total chlorine includes that present in the form of nitrogenous compounds known as chloramines.

In the latter model a reference cell is supplied with a continuous sample of the treated water from a small constant head tank. Neutral ortho-tolidine is applied in a mixing chamber to the portion of the water used for residual determination which is passed through a separate measuring cell and eventually to waste. Both cells are illuminated from a single light source by means of mirrors, the light passing through filters to individual photo-electric cells. The variations in colour induced by the interaction of the reagents with the chlorine in the sample cause the photo-electric cell to operate a differential electronic recorder.

The reagents are passed to the mixing chamber by means of a multiple pump head consisting of a set of metering pumps driven by a small electric motor through a specially designed gear box. The latter also drives the pump which supplies the sample water to the mixing chamber, thus ensuring accurate proportioning of the reagents and water sample.



Paterson Residual Chlorine Recorder – model 2.

The electronic recorder, placed in the top of the case at eye level, gives a direct reading in parts per million on a horizontal scale and also provides a continuous chart record. The control panel is set in a recess below it. 'HIGH' and 'LOW' adjustable contacts operate

(Continued on page 74)

MODERN GUILLOTINE SHEARS

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

THE basis of every economical processing of sheets is the cut. The usability of a sheared sheet depends essentially on the quality of the separating cut.

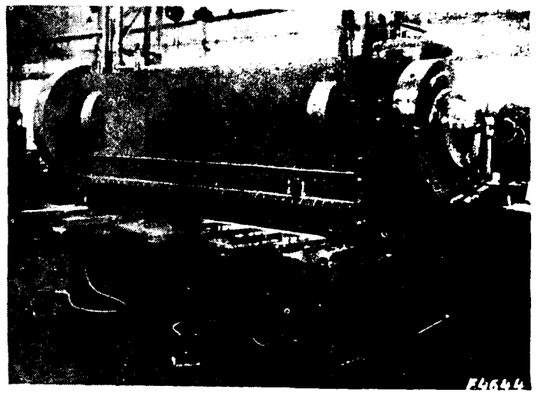
Using gas to cut out pieces is time-consuming and expensive, not only because of the cost of the gas and the slowness of the method, but also because of the tedious operations which follow, such as flux scaling and, in many cases, grinding as well.

Cracks, crushings and taper occurring in the area of cut are undesirable shearing defects and will cause serious disadvantages during the further processing of the sheets. A fundamental condition for a faultless area of cut is constituted by the sheet holder pressure which safely grip the sheets together with the cutting angle conforming to the material to be sheared, and with the pertaining clearing gap, apart from the blades arrangements themselves.

Starting from these points of view and facts proved by experience, the Machine Tool builders have, to-day, evolved their Guillotine Plate Shearing Machines to meet the present day requirements of the sheet processing industry for accurate shearing.

FRAME CONSTRUCTION

In designing the modern Guillotine Shearing Machines, there is a marked trend towards the adoption of rolled plate construction forming a light and unbreakable medium for building any shape. Not only has is to be strong enough to warrant absolute safety against fracture, but it is also to be absolutely rigid and free from vibration so as to carry out its functions against intermittent and varying resistance.



A Modern Guillotine Shear.

In cases where the machines have their main components made from iron castings, the end frames are either of heavy well ribbed sections or are re-inforced with steel tension rods shrunk in position. The beams are also of substantial iron castings either heavily ribbed or of box type construction.

Where the components parts consists of heavy rolled steel plates, the box type constructional principle is generally adopted. The end frames are united by means of the table aggregate and with the box-type cross-bar, the frame forms a closed whole. The components are electrically welded and stress-relieved by annealing.

The beams are of slab steel construction, suitably braced by steel web plates where necessary. In certain cases generously dimensioned and heavily ribbed table serves as bearer of the bottom blade and where this is

(Continued from page 72)

warning lamps when pre-determined residual chlorine readings are reached and audible alarms can also be provided if required.

The reagent reservoirs last for a week on one filling and the solutions are supplied in concentrated form for dilution with distilled water or chlorine free tap water.

The whole instrument is housed in a stove-enamelled sheet steel case with side access doors and requires the minimum of maintenance.

The model recording total residual chlorine only is similar in principle and construction but uses a single photo-electric cell and a simpler means of application of the reagent, which in this model is acid ortho-tolidine, producing a yellow colour in the presence of any type of residual chlorine.

not the case, the bottom beam is secured to the side frames by heavy bolts.

The top beam which is generally spring balanced works in long machined slideways in the side frames, fitted with renewable phosphor bronze wearing strips, take-up adjustment for wear being provided. The top beams moves in a path inclined from the vertical to reduce forward thrust on the plate thereby improving accuracy and cleanness of cut and providing an automatic back lash compensation.

In certain machines torsion bar arrangement replaces the spring balancing system for the top beam. In those cases long, elastic torsion bars are embedded into the upper part of the columns and give a very smooth and reliable working balance to the blade slide. A blade wear compensation device, incorporated in such cases, allows the adjustment of the useful shearing play.

HOLD DOWN

As a precise cut can only be made if the material is reliably held down, the holding down devices are particularly carefully and strongly designed. The holding down device leads the blade and only releases the sheet after the downward motion of the blade is completed.

In some machines the grip is applied by cam pressure and released by spring while in others the holders are operated under spring pressure. The present trend is however to have the hold-down units hydraulically operated and this method is finding increased favour with the grip plungers faced with Tufnol or similar non-abrasive pads to prevent marking of soft material.

In such cases the pump actuating the grip plungers is self-contained in the shear and full care and precaution included for by the adequate use of control valves. The hydraulic circuit is also self-contained.

There is no doubt that the hold-down pressure plays a decisive part in producing a smooth and faultless cut. Where the pressure is not correctly rated, the result will be the formation of "sword-shaped" strip or of its curling up.

SHEARING KNIVES

The knives are normally made of one piece with two cutting edges. Sometimes they are also made the 4-sided reversible type and in sections and also adjustable for fine cuts. In the latter case, the blades are interchangeable with each other.

The cut in some shears is effected by the vertical down motion of the shear slide whereas some shears are conspicuous for the inclined down motion of the top blade producing thereby a drawing cut.

The idea behind this arrangement is that with the vertical cut the material is being compressed. In its texture, pressing and crushing effects are arising with consequent deformations as well as an uneven cut. In drawing cut, on the other hand, there will not be any crushing marks, cracks and chew pressures in the material. When shearing piled thin sheets, the drawing cut is of extreme importance. The blades are greatly preserved and their standing time is prolonged manifold owing to the drawing cut. Further draw cut helps to hold the plate and prevent slipping.

ADJUSTABLE SHEARING ANGLE

Another new development in modern Guillotine Shears is the provision of adjustable cutting angle, that is the angle of the upper knife can be adjusted. The adjustment is easily made with a lever at the front of the machine which operates a dog clutch, the control has a plate showing the stock thickness which can be sheared at each setting. On the larger shears in the adjustment operated by hydraulic, pneumatic or built-in electric motor.

The arrangement is such that the speed of the shear increases as the knife angle is reduced, so that operation is faster when thin stock is being sheared; with the lowest setting, the shearing speed is doubled.

Adjustable clearing gap is another feature provided in the modern Guillotine shears. The clearing gap is of decisive influence on the appearance of the separating surface and thus on the usability of the sheared sheets or strips.

From experiments it has been found that smooth usable separating surfaces will be produced on shearing with a clearing gap of about 3 per cent of the thickness of sheet. On shearing with a clearing gap of more than 5 per cent a rather rough fractures with cracks will be the result. With too small a clearing gap, cracks will be the result owing to the material under shear being stressed beyond its strength.

DRIVING MECHANISM

Modern shears are generally equipped for direct drive by built-on electric motors. Power is transmitted by V-belts from motor to flywheel. High speed shafts run in ball and roller bearings while others are mounted in either or antifriction bearings. The gears are all

machine cut. The wheels are either cast iron or steel, and the pinions are generally forged steel. The clutch and brake arrangement with pneumatic, mechanic or electro-magnetic control ensures very quick engagement and release for operating the machine, and enables to interrupt the stroke instantaneously at any position. The clutch also acts as overload protection to the safety of the body and drive of the machine.

Among the other special features incorporated in modern Guillotine shears are: central lubrication, take-up adjustment for wear on ways of the top beam slides, front and back gauges, safety guards as protection against accidents, finger protection, photo-electric shear line indicator, the adjustable front and rear stops, treadle bar or push button control, sheet—holding-up device, supporting brackets at the table, etc.

CROSS CUTTING

Certain guillotine shears are capable of carrying out cross-cutting operation with the help of special devices. The cross—cutting becomes indispensable when notching has to be done.

The device for cutting transversal consists of top and bottom knives which are situated on the right side, transversal to the main knife. They serve for cutting the borders, which result when working long plates, which have to be pushed for cutting, in order to facilitate notably the manipulation of the plates.

The guillotine shearing machines of the present day offer many advantages which were not present in the old models and with improved designs their versatility and importance have been increased considerably.

HIGH-POWERED PLANT ROLLING MILLS

The Urals Engineering Works in U.S.S.R. is reported to have completed the designing of a plate rolling mill comprising of over hundred machines in a single production line. According to the report the mill is capable of rolling bars from 4 to 50 mm. thick and has a capacity of almost a million tons of rolled products a year. The technological process, beginning with charging the slabs into the furnaces and ending with rolling, reportedly will be carried out without participation of man. The marking, piling, stamping and other operations will likewise be mechanized. A greater part of the equipment is reported to have already been completed. The transportation of the rolling mill according to the report will require 14 train-loads.

Non-Conventional Carbonisation Process

By D. K. Dasgupta
(Trainee Firma Carlstill, West Germany)

THE production of coke by the conventional carbonisation processes in externally heated retorts or ovens is normally only possible from higher rank coals, possessing certain essential coking characteristics. The reserves of such coals are getting more and more scarce all over the world. Attention is therefore being focussed on inducing coking properties in non-coking coals by various means and on altered techniques of coal carbonisation, principally with a view to finding out ways and means for the utilisation of lower rank, poorer coking coals in larger and larger proportions. Various such processes have been suggested from time to time and a number of them have of late been developed to a final stage for the production of uniformly sized fuel both for domestic and metallurgical use in foundry cupolas and blast furnaces.

In this paper is given a brief outline of some of the processes.

SUPERSONIC RADIATION OF COAL

It is claimed[1] that coke can be made from non-coking coals of any required density and electrical conductivity by subjecting the coals to supersonic radiation.

It is stated that a plant operating on this principle with a carbonising capacity of 200 tons a day was built in Germany during the last war.

CARBONISATION UNDER PRESSURE

Fischer experimented[2] on non-coking coal of high oxygen content or even lignite and produced strong, dense coke on carbonisation at a pressure of 50 atmospheres. It is believed that the increase in pressure hinders the distillation of tar which is thereby more exposed to thermal decomposition giving a carbon residue acting as a binder for the coke. The process was developed on a semi-commercial scale, the necessary pressure being obtained without mechanical help by restricting the escape of the coal gas. On cooling the compressed gas, light oil condenses out, CO_2 is removed by simple water washing. The high pressure gas may either be distributed over long distance or liquefied by expansion to atmospheric pressure and fractioned into its component gases.

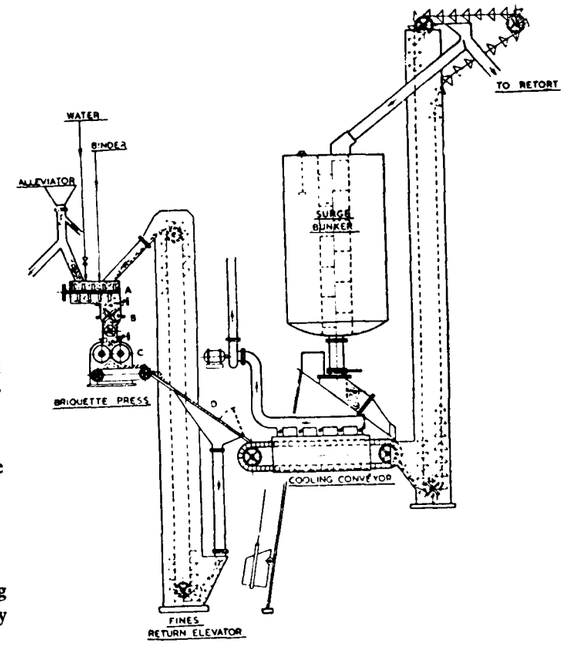


Fig. 1. Briquetting unit
(GAS WORLD 6TH FEB. 1954)

DI-ELECTRIC HEATING OF COAL CHARGE

In a normal coke oven of 18" width the coal mass at the centre remains at about 100–200°C for nearly 6–9 hours out of a total carbonising period of 18–19 hours. Such long hours of preheating are positively detrimental to the coking properties of high oxygen, deficiently coking coals. Attempts have therefore been made to raise the whole of the coal charge to the required temperature by dielectric method thereby avoiding the temperature gradient in a conventional carbonisation process.

ELECTRICAL CARBONISATION

A new electrical technique[3, 4] is known to have been developed for the carbonisation of Spitsbergen (Norway) coals which are unsuitable for coke manufacture in the usual type of ovens. The crushed coals briquetted with or without binder are preheated to 150–200°C either in a

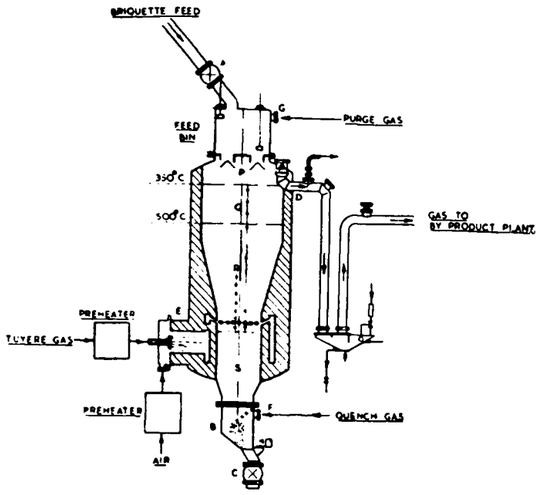


Fig 2. N F C retort
(GAS WORLD 6TH FEB. 1954)

separate apparatus or as part of the subsequent coking practice and are charged at the top of a vertical shaft. The briquettes slowly come down the shaft wherein they are preheated by hot ascending gases. At the lower end of the shaft is an electric furnace containing two sets of 3 phase electrodes. The carbonised briquettes which are now conductive form the resistor element which provides the heat for the process. The lower end of the shaft has a conical extension through which the coal briquettes are discharged. Coal gas introduced by booster at the base of the furnace cools the hot coke and are preheated. In the electric furnace the gas is further heated to 1000°C and reacts with hot carbon farming $CO+H_2$. As the hot gas flows up the furnace its sensible heat serves to carbonise the coal. The gas gets cooled to 200°C and gets mixed with the distillation gas and tarry vapours and finally passes out for purification in the by-product recovery plant. Part of the heated gas is used for carbonisation and the remainder utilized for synthesis. It is possible to produce strong coke suitable both for metallurgical and domestic uses. The yield obtained from one short ton is: coke briquettes 1250–1300 lbs.; low temperature tar 22–25 gallons; gas 22,000–24,000 cu. ft. The power consumption is 40 Kwh/1000 cu. ft. of gas produced.

FLASH CARBONISATION OF COAL

The principle of the process[5] is to pass hot gas downward through a static bed of coal whereby the rate of carbonisation can be considerably increased. A large steel-shelled bricklined retort is stated to have been constructed in the Chemical Department of the T. V. Authority. The heating gas enters at the side and cuts through a wind-box located at the lower end of the retort. The coal charge varies from 2′–4′ in depth weighing about 2000 lbs. Carbonisation is effected by the gas evolved on carbonisation pre-heated to about 1800°F the exit gas is cooled and cleaned. The yield of tar is high. Blends containing high percentage of non-coking coal are reported to yield reasonably good coke.

TWO STAGE CARBONISATION

The conventional carbonisation processes employing slot type ovens is essentially a one stage process and suffers from a major disadvantage of non-continuity of operation. Various multi-stage carbonisation processes have been suggested from time to time, again with the ulterior object of utilizing poorer coking coals.

DIDIER PROCESS

One of such processes is the Didier process invented by Dr. A. Thau[6,7]. It has a forerunner in the Weber process. It enables the production of metallurgical grade coke from non-coking coals including even lignite and brown coal provided that they yield sufficient tar for the production of pitch required in the process. Non-coking coal is carbonised at 550 – 600° in normal continuous vertical retorts or chambers with modifications. The semi-coke obtained is cooled, crushed and

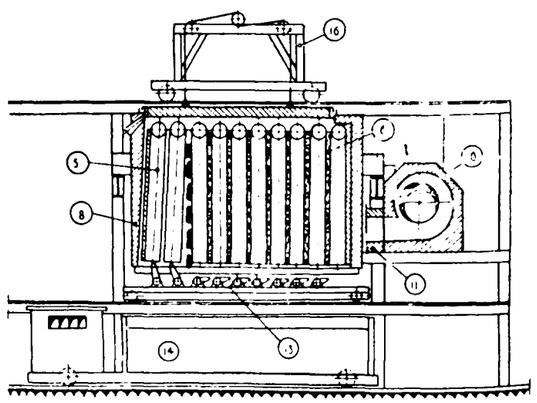


Fig. 3. Brennstoff-Technik oven
5. Heating wall. 6. Coal chamber. 8. Oven casing. 10. Fan. 11. Heating gas duct. 13. Device for opening chamber. 14. Coke car. 16. Chamber cover lifting winch.
(GAS WORLD 6TH FEB. 1954)

mixed with 5-8% of the pitch produced from the low temperature tar recovered from the process and with about 10-15% of caking coal. The mixture is briquetted at about one ton/sq.inch. The briquettes obtained are carbonised in continuous or intermittent vertical chamber ovens at 900-1000°C. Coke of the desired properties can be obtained by adjusting the temperature and duration of carbonisation at the two stages.

It is stated that the cost of the process is slightly greater than that of normal coke under German conditions. It is reported that during the last war this process was used to meet the shortage of metallurgical coke in Germany, by utilising the high oxygen Upper Silecian coal. Nothing further however has been heard since the war. The Coal Research Institute, Japan Claims[8] the invention of a process similar to the Didier. It is stated that the process has now been perfected on a commercial scale.

NATIONAL FUEL PROCESS

The process[9] has been developed by the National Fuel Corporation J. N. & American Cyanamid Company and professes to produce premium quality fuel from any coal having even a slight coking property. The coal is crushed to a fineness of 28 mesh (Tyler) and dried to less than 1% moisture. For coals of too high agglutinating value a fluidised oxidation technique has been developed to reduce the caking power to an acceptable value. The oxidised coal is mixed with a tar or pitch binder even molasses and sulphite lie have been successfully used and briquetted. The briquettes are fed continuously into the top of a vertical, cylindrical retort and descend by gravity, counter current to an ascending stream of heated gas which carbonises the briquettes at a controlled rate of heating especially at the critical temperature range. The necessary make up heat is supplied through tuyers by gas, heated in a heat-exchanger. The tar obtained is of the true primary type and provides the binder for briquetting. Hard dense and reactive types of coke may thus be made from coals not usable in normal by-product ovens.

The process enables a much wider range of coals to be used and it is claimed that the cost of a plant of the National Fuel Corporation design is 30-40% less than the capital cost of a coke plant of equal output.

BAUMCO PROCESS

In the Baumco process[9] the coal is first devolatalised at 800°C to produce a char in a fluidised or static bed which is then mixed with pitch and a coking coal and

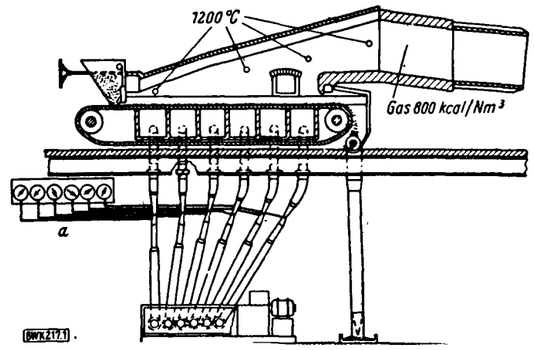


FIG. 4. TRAVELLING GRATE COKING PLANT
(BWK VOL 6, 1954)

briquetted. The former acts as a binder for the raw briquette when it is cold, the latter acts as a binder for the carbonised briquette in that, in the coking process its liquefaction and subsequent solidification cement the char particles together. The briquettes will not soften when the coking coal binder passes through the critical range. The carbonisation of the briquettes takes place in a vertical shaft chamber surrounded by heating flues in which the gas from the process is burnt under controlled condition and arrangements are also provided for the hot combustion gases to flow horizontally through the shaft, carbonisation being thus effected by both indirect and direct heating at a high temperature of about 1200°C. This process is also applicable to lignite, non-caking and poor coking coals. The coke is dense, strong, uniform and its properties can be varied by adjusting the internal heating system. This is again a form of two-step carbonisation process. The capital cost is expected to be low.

BRENSTOFF TECHNIQUE

Weakly caking coals[9] are known to yield better cokes when carbonised at a higher heating rate, this being due to an increase in the coal plasticity and its plastic range. Narrow chambers of 60 to 125 mm. width 5 meter high and 2.5 meter length made of iron are employed to carbonise the coal at 650°C. The heating gas is burnt in an external combustion chamber and the hot products circulated through the heating flues. A number of blocks of ovens are charged simultaneously. The charge of about one ton per chamber is coked in about 2 hours if briquettes are used and 4 hours if loose coal is used. At the coking temperature of 650°C the coke does not shrink away from the wall permitting free fall. The

heating walls which are pivoted at the top are therefore swung apart at the base to allow the coke to drop out. In this process briquetting is not essential, as in the National Fuel Process. Coals from upper Silesia, the Ruhr, the Saar and Lorraine are known to have been used successfully. The process is flexible and admits of starting up and shutting down at short notice. The tar yield is high but little surplus gas is left after meeting its own requirement. The low temperature coke is usable as a blending agent with high volatile coal. Experimentation is in progress to produce high temperature product by introducing a second stage of heating.

AUTOGENOUS COKING

In 1938 a patent was taken in the U. S. A. describing [10],[11] a coking stoker based on the principles of coking coals in thin layers on a travelling grate enclosed in a chamber which was more or less similar to a beehive oven with a travelling bottom. This was further developed in 1945 to produce 350 tons of coke per day for calcium carbide manufacture.

A limited supply of air is passed through the grate bar at different zones of the coal bed, the air being only sufficient for partial combustion of the volatile products (in and over the fuel bed) into CO and H_2 instead of CO_2, thus maintaining a reducing atmosphere. It is claimed that coke from a much wider range of coals (or briquettes and extruded pieces) can be produced. The coke obtained, though weaker than normal blast furnace coke is usable in a good number of chemical industries. Complete utilisation is possible of the sensible and latent heat of the hot gases is evolved for industrial heating proposes. A single unit may be built to carbonise 20—250 tons of coal per day. The operation is highly flexible and can be started and stopped at will. Capital investment and maintenance cost are much lower compared to standard by-product plant.

SIGNIFICANCE OF THESE TECHNIQUES TO INDIA

It is no doubt possible to widen the scope of utilisation of conventional coke ovens by taking recourse to judicious selection and preparation of coals and by the use of suitable additive agents such as oil, pitch, low and high temperature coke dust etc., products from partial hydrogenation of non-coking coals, extracts of coal bitumen etc. It is also not impossible to make reactive types of coke in coke ovens for domestic use for which medium temperature carbonisation has often been suggested.

The Indian coals being inherently higher in ash and comparatively deficient in swelling properties, only limited quantity of poor to non-coking coals can be utilised in blends in the ordinary way. This apart, the resources of India's coking coals are incompatibly lower compared to her vast reserves of iron ore. Successful expansion of the iron and steel industries in India depends to a large measure on adequate availability of high grade metallurgical coke. There also exists a great demand for suitable grades of smokeless fuel for domestic use in the rural and urban areas in India. Thus, in so far as India is concerned the newer techniques of coal carbonisation are worthy of serious consideration not only from the view point of augmenting the scanty reserves of her coking coals but to explore a possible outlet for the utilization of huge dumps of colliery slack for the production of domestic fuel in place of the unsatisfactory brand of soft coke manufactured at present in open stack in a most wasteful and unhygienic manner.

It is a happy augury that being conscious of these needs the Central Fuel Research Institute, India has already initiated researches on some of the above processes.

The examples given above are by no means exhaustive but are meant only to show that by constant and persistent efforts scientific and techuical ingenuity has almost bridged the gulf between coking and non-coking coals.

ACKNOWLEDGMENT

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Fatigue Tests in Timber

By A. C. Sekhar & V. K. Gupta

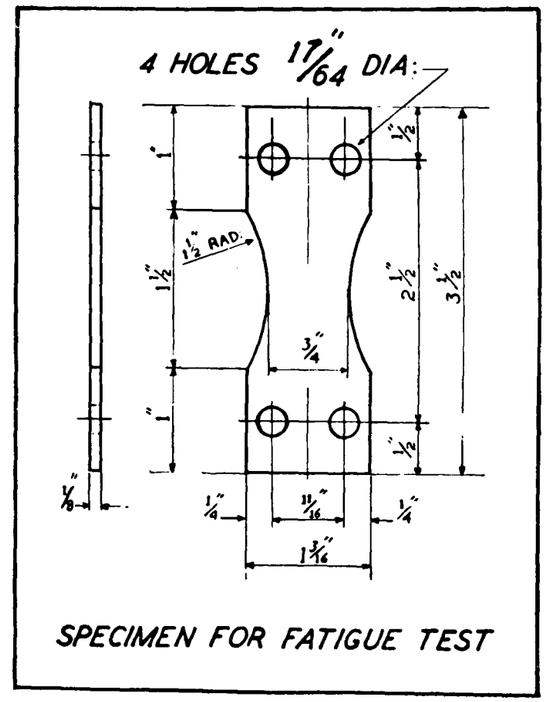
IT is well known that mechanical deterioration of a material due to fluctuating stresses (which may be varying in the same direction or alternating in the opposite directions) is known as fatigue. With the incoming of high speed machines and severely vibrating structures, the problem of fatigue investigations of various materials has assumed growing importance. In 1864 Fairbairn published in the Philosophical Transactions of the Royal Society results of some experiments on the subject and again in 1871 Wohler's drew some conclusions which still remain undisputed. Since then considerable amount of work has been done on the problem of fatigue. But still, there does not seem to be any standardised and uniform procedures of fatigue testing for similar type of materials except the tentative A. S. T. M. D-671-51T for plastics.

In the various proceedings of the American Society of Testing Materials during the last few years the work of their special committee E-9 on fatigue has been periodically reviewed and various technical papers have been presented. But, all of these related mostly to fatigue behaviour of various types of steels and alloys only, and occasionally there were a few papers relating to general topics and statistics. In this connection, the recent papers presented by SCHUETTE, ENOMOTO, and MASSONET are of some interest in a general way specially to save time in fatigue testing. SCHUETTE proposed to provide a design level curve by a new procedure called "least-of-four" method. The principle of this is to test simultaneously four nominally identical specimens under identical conditions under the presumption that the life potential of the weakest specimen will fail first. If at this time the other tests are abandoned, this single point obtained possesses significance far greater than a point taken from a single independent test. It has been theoretically discussed that a curve obtained from a series of least-of-four points is approximately 84% of any future tests of the same material can be expected to exceed and which fact makes the curve more suitable for design purposes than any of the conventional mean curve. In the paper by Enomoti, he verified on mild steel and duarlumin, the earlier experiments of Prot on the straight line relation between the stress at failure and the square root of the rate of stress increment but instead of the square root, he obtained the straight line with the $\frac{1}{2}$ power of the rate of stress increment. The intersection of this line with the stress axis has been taken as the fatigue limit.

In so far as wood is concerned among the earlier investigations mention may be made of Kraemer (1930) and Moore & Kommers (1927). They obtained load reversals by rotational tests on beams and arrived at the conclusions that the "fatigue limit" in wood is about one third of its normal breaking load as determined by static tests. Below this limit, load is supposed to withstand 14 to 125 million continuous vibrational reversals without much deterioration but if the load exceeds this limit a failure is sure to occur at about 1 to 2 millions of cycles.

General conclusions have been drawn that failure due to fatigue depends first, upon the intensity of load applied and secondly, on the rate at which the reversals are made.

F. Kollmann experimenting on white ash has found that in alternating tension and compression, fatigue limit



SPECIMEN FOR FATIGUE TEST

Fig. 1

is only 15% of breaking stress, in pure tension it is 30% and in alternate bending it is between 22% to 38%. W. J. Kommers has pointed out that the endurance strength for 50 million cycles of reversed stress is approximately 27% of the static modulus of rupture for a few species but did not obtain the endurance limit. The tests were conducted under controlled conditions of 75°F & 65% R. H. and the vibrations were all done at the rate of about 1800 cycles per minute. He observed that the S-N-curves for wood do not exhibit a knee as in the case of metals.

TESTING MACHINES AND PROBLEMS IN FATIGUE

There are various types of fatigue testing machines for simple stresses as well as combined stresses. All these can be classified either under constant load type or under constant deformation type. While each type has its own advantages and disadvantages, the constant deflection type is better suited for flat type of specimens, in which the specimens generally act as their own dynomometers.

While the general problem in fatigue testing of materials has been mostly to evaluate the limiting fatigue stress or endurance limit, (which is the greatest stress that can be applied to a material for an infinitely large number of times without causing failures). Various other problems also are connected with these studies. They can be broadly classified as follows :—

(1) Effects of range of stress, max. stress, and nature of stresses on endurance limits.

(2) Effects of rate of vibration.

(3) Effects of the internal structure of the material as also affected by external agencies like temperature and other treatments etc., or internal agencies like stress concentration.

(4) Effects of shape and size of specimens.

(5) Mechanical deterioration of the material under test with increasing vibrations.

(6) Statistical aids and time saving techniques in evaluation of fatigue data.

(7) Correlations with other mechanical and physical properties.

8) Design of suitable equipment for various types of fatigue investigations.

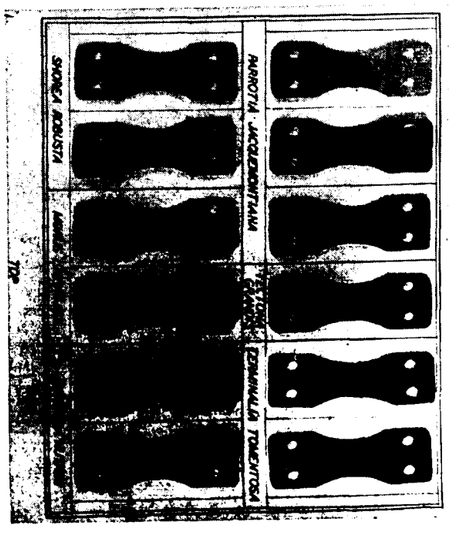


Fig. 2

In addition to these, in an orthotropic, elasto-plastic and biological material like wood the problems are more increased to take into consideration the orientation of principal axes of elastic symmetry to the direction of amplitude of vibration, to the varying plasticity in different species and to the non-homogenuous distribution of the constituents of the material and to the inherent variability due to growth conditions of a tree.

With these problems in view, a few tests on wood have just been taken up at the Forest Research Institute mainly to study mechanical deterioration in wood with increasing number of fluctuations and the few experiments that have been done so far have been reported here. With more and more data collected, it is hoped

TABLE—I

RESULTS OF FATIGUE TESTS

Serial No.	Species	Radial or Tangential	No. of pieces	Sp. Gravity at test	Initial Condition M. C.	Initial Condition % of Static M of R (Rad)		Final Condition * M. C.	Final Condition * % of Static M of R (Rad)		No. of Reversals in million cycles	How final conditions achieved *	Typical failures
1.	Tectona grandis (Dry)	R	2	0.638	6.9	36.9	(5138)	7.1	Not failed (no reduction in strength)		17.0	—	—
		R	2	0.638	6.9	55.7	(7750)	7.1	24.3	(3375)	6.86	c	Longitudinal cracking with partial cross breaks on one side only.
2.	Bambusa nutans (bamboo Dry)	T	4	0.599	15.5	71.9	(7268)	15.4	39.2	(4000)	5.20	a	Heavy cross breaking.
3.	Shorea robusta (Dry)	R	1	.848	15.0	52.9	(9000)	15.0	39.6	(6750)	4.11	a	Slight breaking across the grain.
		T	2	.850	15.3	55	(9375)	15.3	36.7	(6250)	1.89	a	(In most cases only on one side)
4.	Morus laevigata (Dry)	R	3	.584	13.6	57.3	(7667)	13.6	32.4	(4333)	2.73	a	Longitudinal splits & finally cracking across the grain.
		T	3	.587	14.3	56.0	(7500)	14.3	27.4	(3667)	0.84	a & c	
5.	Parrotia jacquemontiana (Dry)	R	3	.807	19.1	31.9	(5000)	17.3	16.3	(2550)	7.40	a	Longitudinal splits in few cases.
		T	3	.798	17.0	33.8	(5300)	16.8	18.6	(2917)	10.30	a & c	Breaking across the grain on both surfaces. (In some cases totally from upward to lower surface or breaking at an angle.)
6.	Terminalia tomentosa (Green)	R	7	1.190	66.4	30	(3450)	15.9	21.3	(2450)	6.07	a & c	Longitudinal splits finally cross breaking through the total width. In some cases specimen has broken into two pieces.
	,, (Dry)	R	3	.840	9.7	37.2	(5450)	8.4	14.7	(2150)	5.76	a & c	
7.	Dalbergia latifolia (Green)	R	2	1.132	50.1	58.2	(5350)	14.5	41.3	(3800)	30.52	a	Longitudinal splits, but finally slight cracking across the grain.
	,, (Dry)	R	1	.923	17.0	31.3	(5300)	15.1	Not failed (no reduction in strength)		30.74	—	(In some cases only on one side)
	,, (Dry)	R	4	.921	16.7	55.6	(9400)	15.0	34.0	(5750)	12.35	a	,,
8.	Picea morinda (Green)	R	5	1.051	156.3	45.8	(2900)	42.9	12.6	(800)	1.25	a & c	Heavy cross breaking across the grain and rapid decrease in strength. (In some cases specimens have broken into two pieces.)
	,, (Dry)	R	5	.487	18.3	56.8	(5650)	16.7	32.7	(3250)	2.71	a & c	

* Final conditions mean after failure as explained in the text i. e. Either (a) – Failure completely across the width.
(b) – 50 Millions cycles have reached.
(c) – Bending moment decreases to 50% of what is originally applied.

to evolve a suitable standard procedure of evaluating fatigue properties of timber and evolve safe working stresses under severe conditions of vibrations.

At present small specimens as shown in Fig. 1 are being used for studies on variation of stress with increasing number of vibrations. These specimens are tested on Avery Testing Machine, Model No. 6301 which has a constant rate of vibration of about 1420 cycles per min. and varying amplitude. The ends of specimens are clamped in the machine.

In these experiments it has been generally observed that in the matter of fixing failures there is certain amount of difficulty in wood. Some typical failures are shown in Fig. 2. Lowering of bending moment is not always associated with any visible failure. Some types of failures specially longitudinal splits do not necessarily lower the bending moment. Hence, for purpose of evaluation, a complete failure is taken as that which occurs throughout the entire width of the specimens. In some cases the complete failure has occurred only on one side of the specimen. The experiments in each case were continued until either a complete failure has occurred on any of the surface or until the initial bending moment is reduced to half its value or until fifty million cycles are reached.

DISCUSSIONS

The various species tested so far, the initial and final conditions at the end of each experiment are indicated in table I. It may be observed that in most of the specimens tested in dry conditions, the moisture content remained more or less uniform throughout the experiment but the fibre stress has decreased in general with increasing reverses of stress, at a lower rate in the earlier stage and at a higher rate in the later stage. In the case of specimen initially under green condition (i. e. the moisture content above the fibre saturation point) there has been definitely a decrease in the moisture content by the time the final condition has reached. It is interesting to note that while in Terminalia tomentosa and Dalbergia latifolia there has been greater deterioration in fibre stress for lesser No. of reversals in the dry condition, the reverse is indicated in the case of Picea morinda, Shorea robusta, Morus laevigata, Parrotia jacquemontiana were tested on both radial and tangential pieces. It is observed that in the case of former two species the tangential pieces have failed much earlier than the corresponding radial pieces even though the initial conditions were similar for the two types of specimen in all the species. The contrary result in the case of Parrotia jacquemontiana is probably due to low initial fibre stress.

It is interesting to observe that in the case of Tectona grandis and Dalbergia latifolia with the initial fibre stresses nearly about one third of their Modulus of Rupture no failure has occurred even after large number of cycles but with only slight increase of the initial fibre stress to about 56% in both the cases a complete failure has occurred at considerably less number of reversals, lowering the fibre stress to 24.3% and 34.0% of their Modulus of Rupture respectively. In most of the cases where the initial stress has been more than $\frac{1}{3}$ of its nominal Modulus of Rupture the final fibre stress has come down to more or less $\frac{1}{3}$ of the same.

In conclusion it may be stated that in order to understand a complete fatigue behaviour of a material like timber it would be useful to obtain more information on these lines for other timbers of varying densities and varying initial conditions. The present investigations have however indicated the general trend of mechanical deterioration with increasing reversals.

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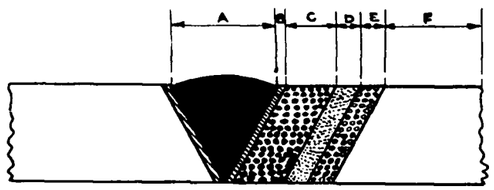
Weldability of Plain Carbon Steels

By S. V. Nadkarni, M. Sc., A. M. I. W.

A FUSION-WELDED joint in mild steel should not be regarded as a homogeneous body. From the metallurgical point of view, the weld metal together with the heat-affected area of the base metal can be divided into five distinct zones as shown in Fig. 1. The zone 'a' represents pure weld metal deposited from filler material such as an arc-welding electrode, or metal slightly contaminated by admixture with the base material. 'b' represents portion of the base metal which melted and resolidified. The portion marked 'c' did not melt, but reached a temperature approaching A4 point of the iron-carbon diagram. The result was recrystallisation to a coarse-grained structure followed by hardening. The next zone 'd' reached the temperature a little above A3 point of the iron-carbon diagram which resulted in the formation of fine-grained structure. The zone 'e' was not heated up sufficiently to cause a change in grain size, but it reached a temperature at which a structural change such as balling up of pearlite could be expected.



SCHEMATIC REPRESENTATION OF STRUCTURAL FORMATION IN WELDMENTS IN CARBON STEELS WITHOUT HEAT TREATMENTS

Fig. 1

Many of the important welded constructions are nowadays stress-relived, but temperatures in this treatment never exceed 700°C. Such a post-heat treatment redistributes the contraction and other residual stresses, and also reduces differences of hardness in the various zones. However, the temperature is not sufficient to cause recrystallisation and consequently the variations in grain-size as shown in Fig. 1 continue to be present. A normalising treatment which raises the temperature to anywhere between 800–900°C (i. e. above A3 point in the iron-carbon diagram) can cause recrystallisation and fair amount of equalisation of grain size in the various zones. However, such a treatment is hardly possible on grounds of economy and practicability, and, therefore, a welded joint still remains a heterogenous body.

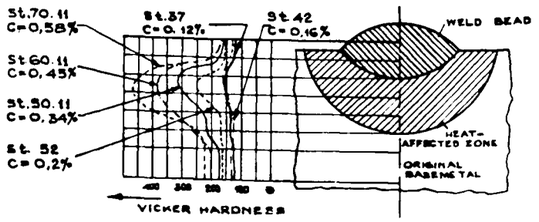


Fig. 2

Hardness surveys of heat-affected zones of carbon steels (0.4 in. thick) on which a weld run was made with 8 Swg. Electrodes.

The extent of changes in structural and mechanical properties such as described depends not only on the welding procedure (rate of heat input and final cooling) but also on the carbon content in the steel. K. Tewes has shown his findings graphically in Fig. 2. Here it is seen that while in the steel of grade St. 37 (German classification) with 0.12% carbon the Vickers hardness in the heat-affected zone rises from 125 to 160, in the steel of grade St. 70 with 0.58% carbon, it rises from 220 to about 470. This means that the heat-affected zone in St. 70 cannot be cold-worked and is very susceptible to cracking in service.

The coarse-grained structure in the heat-affected zone will affect, more or less, the toughness of the joint as a whole. More critical than the grain-size is the simultaneous increase in hardness in the zone which affects the joint toughness to a much larger extent. Tests and practice have shown that acceptable joints can be produced in carbon steels upto 0.3% carbon, but once this has been exceeded or alloying elements are present, suitable heat treatment procedures are necessary to keep the hardness of the heat-affected zone within permissible limit.

The point will become clearer by studying the graph shown below which represents changes in ultimate tensile strength, elongation and yield point of plain normalised carbon steels with changes in carbon content. It is seen that while ultimate tensile and yield point values rise with carbon content in the steel, the elongation values, which are a measure of ductility, decline gradually. The line at the top which rises steeply represents the variation in tensile strength of steels which are quenched. From this line, one can note that a

quenched steel with 0.3% carbon already reaches the limit at which it can be cold-worked. Since the heat-affected zone in a welded joint also undergoes a treatment as severe as quenching (the severity increasing with thickness and size of the base metal) one should expect that in steels with carbon content more than 0.3%, there will an area which will be unacceptable from the point of view of ductility and toughness, unless, of course, a suitable welding procedure is adopted.

Since alloying elements also have cumulative effect on hardness in the HAZ, one recognises the carbon equivalent (%) of a steel which is given by the formula :

$$C + \frac{Mo}{4} + \frac{Cr}{5} + \frac{Mn}{8} + \frac{Cn}{13} + \frac{Ni}{15}$$

It has been observed that hardness in the HAZ following welding can be pre-calculated fairly correctly with the help of the formula :—

Hardness (in Vicker's units) = 1200 × equivalent carbon in %–200

In case of an unalloyed steel, a simple formula $C + \frac{Mn}{6}$ gives a fairly correct carbon equivalent in %.

Besides the carbon equivalent, the welding procedure also determines the extent of changes taking place in the heat-affected zone. The following important factors determine the welding procedure, and these should be closely controlled to ensure that consistent weldments are being made :

(a) The kind and size of the heating source (electric arc, arc voltage, polarity & so on)
(b) The temperature of the heating source.
(c) The rate of travel of the „ „ .
(d) The dimensions of the base material.
(e) The heat conductivity of the material.
(f) The temperature of the base material (degree of preheat, if any.)
(g) The shape and position of the joint surfaces in which the filler material is being added.
(h) The stress configurations present in the joint.
(i) The class of electrode used in manual arc welding.

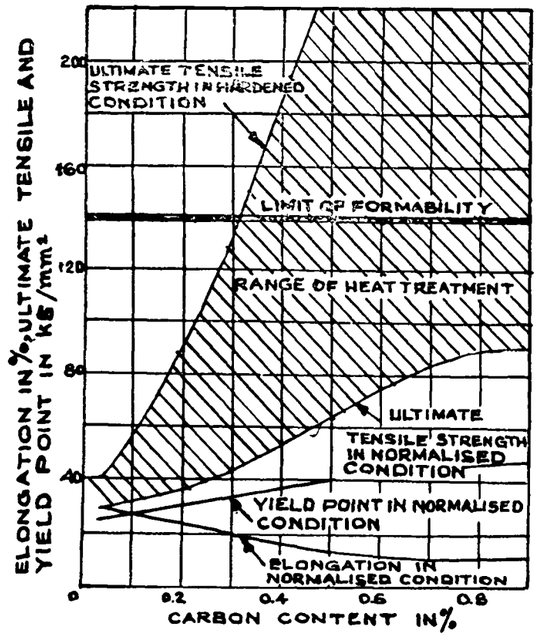


Fig. 3
Variations of tensile properties with carbon content of normalised and quenched carbon steels.

The above discussion helps us to recognise a new property of steel called "weldability" and its definition as given by the American Welding Research Council as follows :

The weldability of a steel is defined as the ease with which the required degree of joinability and performance can be obtained with a given welding process and procedure.

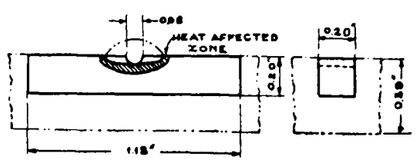
ARC WELDING ELECTRODES

Where arc-welding is used, electrodes play a very important role in determining the quality of the weld joint. Seven classes of electrodes are universally recognised, depending on their coating composition and performance characteristics. It is in every electrode user's interest to understand these classes, and apply them judiciously. The classification as recognised by three important countries is shown in the table below :

	German Norm DIN 1913	B. S. 1719 1951	AWS. A5. 1-55T (1955)
A = Sauer (acid)		E 4 —	E 6020-30
B = Basisch (basic)		E 6 —	E 6015-16
C = Cellulose (cellulosic)		E 1 —	E 6010-11
D = Oxydierend (oxidising)		E 5 —	E 4520
R = Rutil (Rutile)		E 2 —	E 6012
T = Titan (Titania)		E 3 —	E 6013
V = andere Typen (other types)		E 9 —	E 6024-27

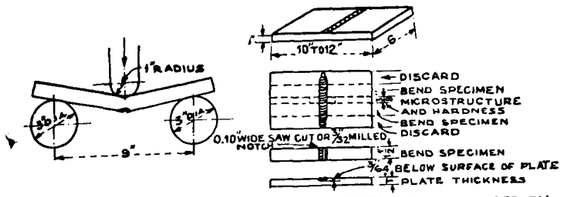
Rutile and titania type electrodes are very popular all over the world due to their easy performance characteristics in all positions and are excellent for all normal applications including shipbuilding, wagon construction, tanks, pipes and bridgework. Their shortcomings are felt only when thicker sections of over $\frac{3}{4}$" are to be welded and when attempts are made to use higher currents. Cellulosic electrodes give excellent welds in all positions, but give considerable spatter and a slag which is very difficult to dislodge from the weld metal. They are largely used on tanks and pipes. Acid types are usually heavy coated and can stand very high currents. They give a heavy, fluid slag which ensures thorough cleaning of the weld metal. They give radiographic welds on pressure vessels upto any large thicknesses, but they can only be used in flat and horizontal positions.

Basic or low-hydrogen electrodes deserve special mention. They give a thoroughly deoxidised and deslagged weld metal possessing exceptional mechanical properties. The exceptional notch-toughness is maintained to much lower temperatures. The electrode naturally finds extensive use on highly-stressed joints and those subjected to temperature fluctuations and dynamic loads. This type is the only one that can give satisfactory welds on steels high in sulphur or containing sulphur seggregations, and on steels with upto 0.5% carbon without causing cracks in the deposit of the heat-affected zone. Steels can often be welded at much lower preheats with basic electrodes. To cite an example, it has been found that welding of rimmed carbon steel boiler plates in thicknesses of 1 in. or less can be successfully accomplished with low-hydrogen electrodes with preheats as low as—12°C.



TRANSVERSE-BEAD-WELD NOTCH-BEND SPECIMEN PROPOSED BY CORNELIUS AND FAHSEL

Fig. 4



TRANSVERSE-BEAD-WELD NOTCH-BEND SPECIMEN AS PROPOSED BY JACKSON AND LUTHER.

Fig. 5

In contrast to this, preheats of 16°C are required for welding with cellulose-coated electrodes. Another example is that the Welding Research Council of America recommends a preheat and interpass temperature of 300°F for the welding of ASTM A7—50T steel (.26—0.30C) of 2-4 inch thicknesses when using electrodes other than basic, but only 100°F preheat temperature when basic electrodes are used.

TESTING FOR WELDABILITY

Besides microscopical examinations and hardness surveys, some conclusive tests are necessary to determine the effect of changes in the heat-affected zone on the ultimate behaviour of the weldment under load.

The transverse-bead-weld notch-bend test in many forms has been used in various countries. In 1939,

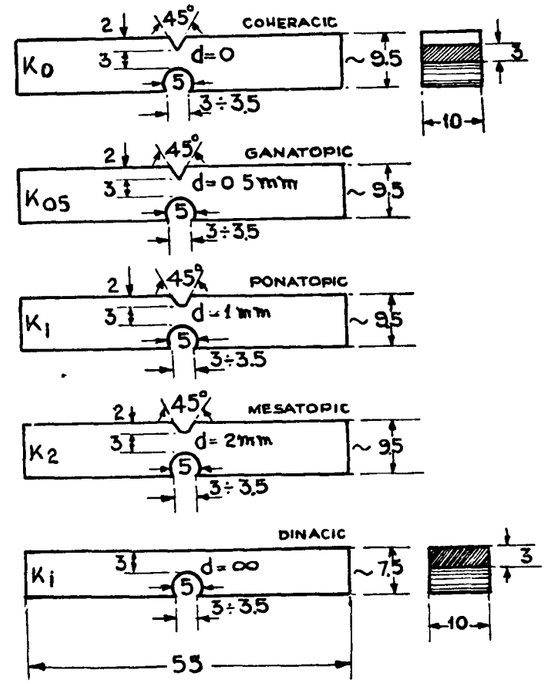
TYPE	SUB TYPE	DESCRIPTION	TYPICAL STRESS-STRAIN CURVES
A		PROGRESSIVE FAILURE UNTIL LOAD DROPS TO LESS THAN 50 PER CENT	
	1	GRADUAL DECREASE IN LOAD AS ANGLE IS INCREASED	LOAD, A1, A2, ANGLE OF BEND
	2	RAPID PROGRESSIVE FAILURE, LOAD DROPS AT LEAST 50 PER CENT BEFORE ANGLE HAS INCREASED 10 DEG. BEYOND MAXIMUM LOAD	
B		PROGRESSIVE FAILURE FOLLOWED BY INSTANTANEOUS* FAILURE BEFORE LOAD DROPS 50 PER CENT	
	1	INSTANTANEOUS* FAILURE CAUSES LOAD TO DROP TO NO LESS THAN 500 lb.	LOAD, B1, B2, ANGLE OF BEND
	2	INSTANTANEOUS* FAILURE CAUSES LOAD TO DROP TO LESS THAN 500 lb.	
C		INSTANTANEOUS* FAILURE AT MAXIMUM LOAD. LOAD DROPS AT LEAST 10 PER CENT	
	1	INSTANTANEOUS* FAILURE CAUSES LOAD TO DROP TO NO LESS THAN 500 lb.	LOAD*, C1, C2, ANGLE OF BEND
	2	INSTANTANEOUS* FAILURE CAUSES LOAD TO DROP TO LESS THAN 500 lb.	

*APPREGIABLE DROP IN LOAD WITH NEGLIGIBLE INCREASE IN ANGLE (USUALLY AUDIBLE)

CODE USED TO DESCRIBE TYPE OF FAILURE IN NOTCH-BEND TEST. LUTHER, JACKSON, AND HARTBOWER

Fig. 6

Cornelius and Fahsel in Germany described a notch-bend specimen comprising a bead weld with a parallel notch located at the bond as shown in Fig. 4. The specimen was bent about a 0.4 in. diameter pin until the first appearance of a crack at the root of the notch. However, in this specimen the full thickness of the plate was not tested. To overcome this objection, modifications were made which resulted in a test such as the one described in Fig. 5 which is the one adopted by the Naval Research Laboratory in the U. S. A. A single bead was deposited (3/16 inch E 6010 electrode, 175 amperes, 26 volts, and 6 inches per minute travel speed) transverse to the intended direction of bending of a plate and strips $1\frac{1}{2}$ inches wide were cut as shown. The bead weld was notched with a hack saw to a point just short of the heat-affected zone in order that initial deformation would occur, in the weld metal when the specimen was tested in bending. In these studies a 9 inch testing-jib span was used and the following three values were recorded during testing: the angle of bend at maximum load, the type of failure, and the load-deflection curve. The failure type was described by a code, illustrated in Fig. 6.



SIZE AND FORM OF FIVE STANDARD TEST PIECES

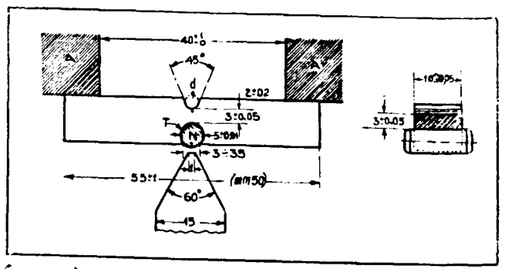
Fig. 7

A number of investigators have devised notched weld specimens to study the impact performance of welds. One of the simplest and most convincing tests is due to Mr. Henri M-Schnadt, which is being increasingly used on the Continent.

The new type of test piece introduced by M. Schnadt and protected by a patent is really a series of notched bending specimens to be broken in a Charpy machine.

The test pieces are 55 mm. long, 10 mm. wide and between 7.5 mm. and 9.5 mm. thick. There are five standard specimens with V-notches of varying root radii, that is, of varying severity. The five standard test pieces which have been given special names are shown in Fig. 7.

The *dinacic* test piece has no notch, that is, the root radius of the notch is infinity. The following three specimens with 45° Vee notches of 2 mm. depth, have root diameters of 2 mm. 1 mm. and 0.5 mm. and are called *mesatopic*, *ponatopic* and *ganatopic* test pieces respectively. These test pieces can all be notched with milling cutters of the requisite root radii. The last test piece with root radius zero, is called "*coheracic*" and its notch is made as is shown in Fig. 8, by milling a ponatopic prenotch first to a depth of 1.6 mm. into which a tungsten carbide knife is pressed afterwards to an additional depth of 0.4 mm. so that the total depth of the notch is again 2 mm. It is important that the notch is made with a very sharp knife and that the knife is placed centrally into a prenotch. For this and,

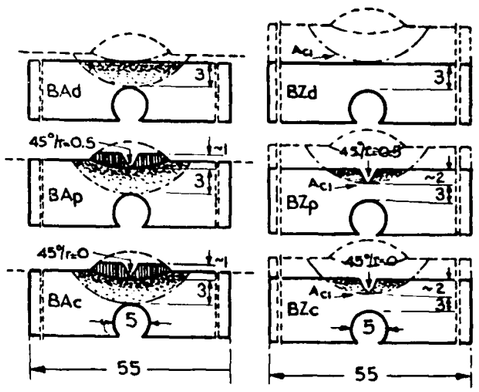


NOTCH IN COHERACIC TEST PIECE

Fig. 8

(SCHNADT) TEST PIECE SET UP IN CHARPY IMPACT TESTING MACHINE

Fig. 9



FORM OF TEST PIECE FOR TESTING HEAT AFFECTED ZONE. METAL HEATED TO ABOVE ACI POINT (BA-TEST) AND METAL HEATED TO BELOW ACI POINT (BZ-TEST).

Fig. 10

incidentally, the other operations necessary in the making of the test pieces, M. Schnadt has developed special jigs and tools. The position of the test pieces in the machine is shown schematically in Fig. 9

The compression zone in each specimen is drilled out and replaced by a tungsten carbide pin. This has the important result of preventing almost entirely the absorption of energy in the compression zone of the material. All test pieces, even the unnotched (dinacic) one, are broken in two in the test.

The time for making the test piece, starting off with material of the required thickness, is only about ten minutes, and if many test pieces are required from the same material, this time can be reduced still further.

The five test-pieces represent gradually increasing severity of stress configuration, increasing from the

dinacic to the *coheracic* test piece. The coheracic test piece represents the most severe conditions for propagation of cracks met with in service. A base metal or the weldment which gives coheracic test value of above 8 Kgm/cm² can be relied upon to be an excellent crack arrester. Coheracic steels and weld metals are already being produced by leading steel fabricators and electrode manufacturers on the Continent.

Results of tests are read out in energy absorbed in units Kgm/cm². A value of at least 8 Kgm/cm² is considered good, while a value of 2 Kgm/cm² is considered unacceptable leading to brittle failure. An intermediate value of 5 Kgm/cm² denotes fracture with some amount of plasticity.

Forms of test-pieces for testing heat-affected zone are shown in Fig. 10.

Acknowledgements are due to the following authors for data and illustrations presented in the article:

To Dr. K. L. Zeyen for reproducing Figures 1, 2, 3 from his article "Die Schweissbarkeit Von unlegierten Staehlen".

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To Ing. H. Schnadt, C/o Oerlikon Electrode Factory, Zurich, for Figures 7, 8, 9, 10 taken from the reprint of his paper read to Institute of Welding in November 1949.

THE HIGH SPEED STEEL SAW BAND

Until as recently, as three years ago, firms enterprising in production uses of the metal cutting band saw, had only hard edge carbon steel saw bands at their disposal while other machine tools had high speed steel cutting tools. Yet, so advantageous is the flexible cutting geometry of the band machine, that its production applications mushroomed in this period.

Several deterrents existed to prevent the development of the high speed steel saw band. These were (1) the well known brittleness of high speed steel which prohibited continuous flexing; (2) the inability of the steel mills to fabricate this metal in satisfactory strip form and (3) problems of joining and heat treating the band.

The breakthrough came several years ago when The DoALL Company introduced the "Demon" High Speed Steel Saw Band. Other high speed steel blades are now on the market at this present time. The introduction of a "practical" high speed steel saw band created a veritable revolution in metal band sawing because, now, the advantages of this tool steel were added to a highly adaptable cutting principle. The word "practical" was applied to this development because this blade was flexible; its weld held firm and it had "red heat" hardness!

High speed steel provided for the band machine, what it had for other machine tools years before. Work could be fed at considerably greater feed pressures, greater speeds, and yet the tools remained sharp much longer. Though greater in initial cost, its production per hour of labor was so much greater and the frequency of blade changes so much less, that the high speed steel blades soon proved its economic feasability. Between the flexibility of the band machine and the prowess of the high speed steel saw band, an unsurpassed combination was born.

Today, companies like National Acme have switched almost exclusively to Demon High Speed Steel Bands with considerably lower production costs resulting. Increasingly, more firms are switching to the high speed steel bands not only for production but for straight tool and die work !!!

* * * * * * * * *

PRODUCTION OF MACHINE TOOLS

As regards the Government of India's plans for increasing the production of machine tools in the country, it is now learnt that a recent investigation has revealed that against a total of 80,000 machine tools installed in the country at the end of December last, the number of machine tools that may be required by the end of the current plan period will approximate to about 170,000. It is estimated that by the end of 1960–61 imports are likely to be of the order of Rs. 15 crores to Rs. 17 crores. The Government is reported to be considering the question of production of machine tools as a side-line is well-established engineering works. According to a preliminary estimate, the industry needs an annual capital investment of about Rs. 1 crore to become self-sufficient.

The First Indigenous Firm to achieve success in the manufacture of Automotive Diesel Engines

The world famous *Perkins* P6 engines are now in full indigenous production at Madras.

ONE Hundred and Sixteen years are but a moment in the long history of the ancient land of India.

Travel along any of the shady roads of the mofussil and you may see how short these one Hundred and Sixteen years are, for in the space of an hour or so, the history of road transport in the century rolls before you.

Through the dappled light and shade of the dusty roadway comes the coolie, tramping along on his bare feet, his bundle on his head. Creaking past him in a covered wagon, the bullock driver sits his patient bullocks plodding along slowly with an occasional spasmodic effort at speed as the driver applies his stick or gives their tails a twist. Nearing a temple town, an elephant slouches along—the transport of the ancient and still used on occasions of ceremony and splendour. Passing these age old transporters comes the modern streamlined internal combustion engine powered motor coach, speeding along in safety with its passengers. Diesel Trucks also roll along, all these methods of transport linking up village to village.

And so, in a short hour, more than a century's progress in road transport is bridged over, and we see the ancient and modern side by side.

The firm of Simpsons, Madras, has had the proud privilege of living through these one Hundred and Sixteen years of India's life, beginning with the manufacture of the Howdah, Litter and Palanquin, then Travelling Vans, State Carriages, Pony Tongas, Landaus, Victorias, etc., always keeping abreast with improved methods of road transport.

The year 1903 ushered in a new era in road transport in India with the introduction of internal combustion engine propelled vehicles and since that time, the firm specialised in Automobile Engineering, including Motor Car, Motor Coach and Motor Truck body building, in which field they have achieved and maintained an excellent reputation throughout India.

The advent of the Diesel Engine for Road Transport Vehicles was one of the most important developments in recent years and as Simpsons realised the popularity diesel transport would quickly gain, they entered into an agreement with F. Perkins Limited, Peterborough, as Distributors for the whole of India for the famous Perkins "P" Series Diesel Engines. Subsequently, they entered into a manufacturing agreement with the approval of the Government of India, following which a Phased Manufacturing Programme was submitted to the Government of India and on June, 5, 1955, the Chairman of Simpson & Co., Ltd., Shri S. Anantharamakrishnan, the noted South Indian industrialist, gave an assurance to Government that by December 1956, i. e, in the remarkably short period of 18 months, Simpson & Co. would achieve complete indigenous manufacture of the Perkins P6 Automotive Diesel Engine to a capacity of 3,000 Engines per annum.

This was a tremendous task and under the able direction and control of the Company's Director & General Manager, Mr. A. J. Lund, a Chartered Engineer, possessing considerable administrative, organising and production ability, the programme was fully completed.

The utmost co-ordination and co-operation of all administrative staff, draughtsmen, jig & tool designers, other technical, managerial and general staff, Workers' Union, and every employee of the Company was most essential for such an undertaking, and it is undoubtedly a great credit to all that a project of such magnitude was accomplished in the very short space of 18 months.

Specifications and capacities of all plant and machinery had to be worked out to suit all machining operations for each and every component part of the Engine. Orders then had to be placed for deliveries Madras to suit the respective phased periods of the Manufacturing Programme. Complete factory layout plans for positioning of the machinery for flow-line production had to be prepared, excavations made and machinery foundations laid ready for installation of

machinery on arrival. Additional electric power supply had to be provided including purchase and installation of additional Transformers, new electric power cables and feeder lines together with distribution boards and switch gear. The entire lighting arrangements throughout the factory had to be re-planned.

Jigs, Fixtures and special Toolings had to be designed and manufactured at their Madras Works to the tune of nearly 3 lakhs of rupees value. Simultaneously, necessary labour force had to be trained, especially for the manufacture of high precision work involved in the production of Jigs and Fixtures. And high tribute should be paid to Indian labour for their remarkable adaptability and progress in this specialised sphere of engineering.

SIMPSONS' WORKS

A massive modern construction, double-storied building houses the Administrative Offices, Financial and Cost Accounts, Drawing and Design Office, Sales Department, Central Stores, Purchasing Department, Material Control and Planning Office. And behind this building is the spacious and most modern Workshop. The factory area covers approximately 250,000 sq. ft.

THE PERKINS P6 AUTOMOTIVE DIESEL ENGINE

This is a 6-cylinder unit, having cylinder bore 3.1/2" and stroke of 5". Swept volume is 4.73 Litres (288.6 cu. inches) and develops a maximum commercial vehicle rating of 83 b. h. p. at 2,400 r. p. m. Maximum torque is 202 lbs. ft. (27.9 Kgms.) The weight of the Engine with electrical starting equipment but without flywheel and starter ring is 696 lbs. In its power range, Perkins P6 is unquestionably the most popular diesel transport engine in the World and in India alone about 40,000 of these engines are operating with extreme reliability and efficiency.

THE MANUFACTURING PLANT

The Perkins P6 Diesel Engine consists of nearly 1,800 component parts, and, of these, 20-odd items are still not manufactured in the country, viz., Proprietary items consisting of Motor Starter, Dynamo, Fuse Box, Venturi, Timing Chain, Starter and Heater Switch Assembly, Etc.

PLANNING FOR PRODUCTION

The organization of the Planning Department has been done on the modern lines, using very extensively the Graphdex Board Charting System and with this the day-to-day stock position of the various engine components and also the flow of the manufacturing programme can be gauged at a glance.

Job Control Boards are operated by the Loading Section of the Planning Office and this method ensures very proper loading of the various production machines and also helps to keep an effective eye on the planned and actual production hours for doing various machining operations. The efficient organization of the Planning Department and co-ordination with the Works and the Cost Office facilitate accuracy in determining the manufactured cost of the component parts day to day.

PLANNING OF CUTTING TOOLS

The various cutting tools required by the Machine Shop are planned and procured, taking into consideration the tool life and the monthly tool consumption. The tools are properly numbered and as per the Operation Sheet, these are stocked in the Tool Stores for easy delivery. The procurement of tools has become a very important function to keep the Machine Shop running uninterruptedly, especially in view of the country-wide shortage of and import restrictions for various cutting tools. In the selection of various cutting tools, factors governing maximum production and tool life, and also the materials to be machined are taken into consideration.

MATERIAL CONTROL DEPARTMENT

The different types of raw materials required for the production of P6 Engines are procured through the Material Control Department. This Department is responsible for the location of suitable materials and ordering them as required. They take very suitable steps to contact various suppliers and ensure that only the right type of material as specified in the designs are procured. All raw materials received at the Works are bonded until material and chemical analyses as required have been taken. This procedure is rigidly followed to ensure that only approved materials to specification are used for the production of the Engine.

This Department also looks after the procurement of various purchased components and also maintains a close liaison with Messrs. F. Perkins Ltd., Peterborough, England, and their Resident Chief Inspector, for obtaining their approval for these item. In the case of completely machined purchase items, a rigorous inspection is instituted in our inward goods

section and these goods, like parts manufactured in Simpsons' Works, are constantly under review by F. Perkins Ltd.'s Resident Chief Inspector and his assistants.

MACHINE SHOP

The Machine Shop is broadly divided into two sections: one section manufacturing miscellaneous component parts and the other is laid out for flow-line machining of Cylinder Blocks with Main Bearing Caps, Cylinder Heads, Connecting Rods, Camshafts, Crankshafts, Lubricating Oil Pumps, Water Circulating Pumps, etc. The arrangement of Plant and Equipment has been carried out with a view to obtain a good deal of flexibility in production. Various Capstan Lathes and Automatics have been grouped in one section and several Radial and Pillar Type Drilling Machines in another and in this manner general purpose Milling Machines including Gear Hobbing Machine and SS & SC Lathes have been arranged in different groups.

Four of the Machine Shop bays extend lengthwise within the buildings and this arrangement enables very effective supervision and easy flow of components from machine to machine to be achieved. Manual handling of the components is minimized by necessary mechanization and goods, wherever possible, are palletised and the movement of components at various stages of machining is carried out by the employment of a large variety of specially designed pallets.

CYLINDER BLOCK BAY

The rough castings are delivered at one end of the bay and these are first washed with paraffin in a cleansing tank.

Gravity Roller Conveyors are arranged all along the bay and the castings travel on these from machine to machine, thus reducing to the minimum physical handling. This also helps to avoid 'stock piling' of components on the floor at the various machine stations.

After fettling and washing, the castings are inspected with necessary inspection fixtures to ensure the correct locations of cores, jig location points and machining allowance, and placed on the roller conveyor.

From these the work is loaded directly into the fixture on the first machine, this being a Duplex Miller provided with 2 Nos. 16" dia. inserted tooth carbide cutters. After this operation the work is moved on the roller conveyor to the next operation, i. e., drilling of sump and head faces. In this operation two locating holes are drilled and reamed on the same face for jig location purposes for subsequent operations.

In the Cylinder Block Bay there are several special purpose machines of the modern type such as 6-spindle Snout Borer specially designed for the rough boring of all the cylinder bores, Special Horizontal Drilling Machine for drilling the pressure rail hole in one setting and the wide base Miller for straddle gang milling the Crankshaft bearing sides and also for form milling the Crankshaft bore. 2 Nos. specially tooled Boremetics are stationed for finish boring the parent bore of the Block and the Linears with hydraulically-operated 3 station fixtures. The Honing Machines are positioned next to the Boremetics for rough and finish honing the Cylinder bores after finish machining of the Linears.

Most of the other operations are carried out on general purpose machines including Radial Drilling Machines, Vertical and Horizontal Milling Machines, Radial Arm Tappers, etc. All machines have been tooled up for doing particular operations through suitably designed jigs and fixtures.

The Crankshaft and Camshaft bores are finish bored in a Horizontal Boring Machine after fitting the main bearing caps which are processed alongside the Block and brought over to a fitting station. When the machining operations on the Block are completed, the Main Bearings are fitted and line bored.

At every stage of machining, strict inspection is maintained by well trained stage Inspectors to ensure that only correctly machined Blocks are allowed to move forward to their next operations.

Before line boring the Blocks these are water tested and also the pressure rail paraffin tested to ensure that the Blocks are leakproof in every respect.

Completely machined Cylinder Blocks before delivery for assembly are inspected by Final Inspection Department, although rigid stage inspection has already been done at different stages of production.

CYLINDER HEAD BAY

The various machines for processing this component are arranged operation-wise. The rough castings are fed from one end and the completely machined heads

are delivered to assembly from the other end. The work travels on roller conveyors and arrangements have been provided for lifting the work from machine to conveyor and conveyor to machine with the help of overhead lifting gear. For the machining of Cylinder Heads Vertical Milling Machines, Radial Drills, Radial Arm Tapping Machines, etc., are used, all of which are specially tooled and jigged for rapid production and interchangeability of the component. As in the case of Cylinder Block, rigid stage inspection is maintained and the completely machined Heads are delivered to Assembly only after passing 100% final inspection.

Before commencing the first machining operation, the castings are thoroughly inspected on the production line itself for jig location points, machining allowance and to detect any casting defects.

After completing the machining operation, the Heads are also hydraulically tested and steam-cleaned.

CONNECTING ROD AND CAMSHAFT BAY

The Connecting Rod stampings, made out of Nickel Chrome Molybdenum steel, are first inspected very thoroughly in the materials inspecting wing of the Inspection Department to detect twists and other stamping flaws. Only approved stampings are then released to the production line and before the commencement of the first machining operation, the stampings are fettled and crack detected on a Magnetic Crack Detector.

In this bay also the machines are stationed on operation basis and, therefore, the Connecting Rods move from one machine to the other in perfect sequence resulting in the least amount of handling.

Specially designed pallets are used for this bay instead of roller conveyors and the components are placed vertically on these pallets by the operative after completion of each operation.

The various milling operations are done by employing negative rake milling cutters as the material has over 65 tons tensile strength.

After the rods are completely machined, steel backed small end bush is press fitted and then finish bored to size on a precision specially-tooled Fine Borer. On completion of all operations the rods are again crack detected and demagnetised before delivery to final inspection where these are individually weighed and matched. Specially trained Stage Inspectors vigilantly watch for any process variation at different stages of production.

P6 Engine Camshafts are machined on journals which are ground to micro-finish. The Cam Lifts are profile ground and a specially designed Cam-o-matic Grinding Machine, specially tooled, give correct profile of all cam lifts. Cam contour and respective cam lifts are checked on a specially designed fixture during process of manufacture.

CRANKSHAFT

The P6 Crankshaft is machined from high tensile Nickel Chrome Molybdenum steel drop forgings. This most important component has been tooled up with utmost care as the efficient performance of the P6 Engine depends to a very great extent on the precision of the Crankshaft.

Most modern equipment is installed for the production of Crankshafts, the general sequence being crack detection of Crankshafts before passing into Machine Shop, centering for turning operations, rough and finish turning main bearing journals and crank pin journals, rough grinding all journals, drilling lubrication oil holes, induction hardening all journals by a special induction hardening plant, tempering after hardening, finish-grinding, balancing the Crankshafts and final crack-detection before being passed for assembly. Very rigid inspection is employed throughout the various machining and grinding stages and 100% inspection is carried out after all the operations have been completed.

GENERAL SECTION

In the General Section in the Machine Shop, various component parts such as Water Pump, Fuel Pump Drive, Lubricating Oil Pump, Starter Ring, Timing Case, Exhaust and Induction Manifold, Sprockets, etc. are manufactured. The Starter Rings are electrically butt-welded and passed through the Crack Detector before going forward for machining and cutting of teeth. The Starter Rings are again crack detected before 100% final inspection and utilisation in assembly.

Two special Hobbing Machines are utilised for cutting teeth in all Chain Sprockets, Spiral Gears, and all gears are tested by means of a Goulder Gear Testing Machine fitted with chromium plated master gears.

(Continued on page 97)

RESEARCHES ON CARBONIZATION OF INDIAN COALS

By N. N. Das Gupta,

Central Fuel Research Institute, Jealgora, India.

CARBONIZATION of coal in externally heated, slot type, tall ovens of large capacity is undoubtedly the most economic method so far developed for the production of metallurgical coke.

The expansion of the iron and steel industries makes a persistent demand for more and more metallurgical coke, which can ordinarily be produced only from high grades of metallurgical coals.

This class of coals has to satisfy certain essential requirements. For example, the ash, sulphur, and phosphorus contents have to be within certain stipulated limits. The volatile matter of the best class of coking coals is also found to lie within certain optimum limits. In general, coals lying on either side of these limits often fail to produce sufficiently hard and strong coke. In addition, the metallurgical coals must have sufficient caking, agglutinating, and agglomerating properties in order to yield strongly coherent hard coke.

Between the two extreme ranges of non-coking coals, i. e. those which on carbonization do not yield coherent mass at all and good coking coals i. e. those which give hard metallurgical coke, there exists a large variety of coals which are designated as poor coking, weakly coking, medium coking etc., etc.

Visualising the vital need for the conservation of the scanty reserves of the better grades of metallurgical coal, researches have been carried out during the last decade at the Central Fuel Research Institute of India, in close collaboration and co-ordination with the Coal Blending and Coking Research Organisation at Jamshedpur.

While the principal objective of the work so far done has been to utilise substandard grades of coals for coking in normal coke ovens (as distinct from other known techniques employing special types of carbonising equipment and appliances), various other aspects of coal carbonization have been studied with a view to improve

(Continued from page 96)

TOOL ROOM

The Tool Room is equipped with excellent high precision machinery, including a Jig Borer. Special grinding machines are used for maintaining necessary supplies of correctly ground milling cutters, reamers, drills, taps and other small tools. All jigs and fixtures are periodically checked for wear and are carefully maintained to ensure absolute interchangeability and maintenance of very close machining tolerances.

ASSEMBLY OF ENGINES AND TESTING OF ENGINES

The Engines are assembled in the well laid out Assembly Section on a line assembly basis and every Engine, after complete assembly, is subjected to very rigorous functional tests utilising Hydraulic Dynamometers. Fuel and Lubricating Oil Consumption figures are checked to ensure that each and every Engine complies with the very rigid standards laid down. Each engine averages 5 to 6 hours of actual functional test. After test, each and every Engine is very carefully examined, after finish painting and packing prior to despatch from the Works.

The production of an automotive type diesel engine of the Perkins P6 type calls for very efficient technical planning, extreme skill and supervision and also the adoption of modern production methods. The Perkins P6 Engine is world famous for its simplicity, rigidity, accessibility, economy and high quality, and Simpsons have taken every care to ensure that each and every component fitted into the Madras-manufactured Engine is, in every respect, equal to, if not better than, the previously imported product. From the manner in which the various machining operations on the several components of the Engine are produced in Madras and the excellent administrative co-ordination, one can very boldly state that the Perkins Engine being produced in Madras is not, in any way, inferior to the foreign product.

the coke quality in general and to increase the oven throughput etc. Some tests have also been done in commercial ovens to confirm the results. The coals tested cover zero to XVIII Seam of the Jharia field and various coal seams of the Raniganj, Madhya & Vindhya Pradesh, Assam, Orissa and Hyderabad Coalfields.

The work done includes investigations carried out for finding out suitable coking mixtures for various State and Central Government projects. This paper gives a resume of some of this work.

Plate I
(A) Coke from 100% High volatile coal.

Plate I
(B) Coke from Blend Containing
85 High Volatile Coal &
15 L. T. Char

BLENDING

Blending is one of the most commonly employed means for stretching the reserves of metallurgical coals. As applied to the carbonization industry the term blending means the intimate mixing of two or more components resulting finally in a coking mixture of uniform chemical and physical composition. Besides coals of different types and ranks, a variety of other substances has been used as blending agents.

Coal with coal :

Normally the best grade of coking coals, which make hard metallurgical coke when carbonised by themselves, occur in the upper seams of the Jharia coalfield and some of the coal seams in the Raniganj and Madhya Pradesh area.

Among other things the percentage of ash in the coals also plays an important role. Acting as a diluent for the essentially needed coking constituents, a high percentage of ash in a coal often results in coke of substandard physical properties besides raising the percentage of ash in the coke beyond the maximum accepted limits for metallurgical use. Washing of coals often improves matters ; the strength indices of the coke are raised and the ash is reduced. This is, however, not universally true particularly when the parent coal is inherently deficient in the coking constituents.

It has been found that depending on the nature of the parent (standard) coking coal, 10—15% of non-coking or poorly coking coals can be utilised in blends to produce hard metallurgical coke. A still higher proportion (30—50%) of the weakly to medium coking coals can be utilised.

In the case of blending also, washing of all or some of the constituent coals of the blends may enable a higher percentage of the deficiently coking coals to be used.

Fig. 1 shows the gradual deterioration in the physical properties of the coke with an increase in the proportion of the non-coking or poorer coking coals in the blends. Fig. 2 compares the properties of coke obtained from raw and washed coals.

While the above statement is generally true, recent findings of the Central Fuel Research Institute indicate the possibility of using as high as 80% of the weakly coking, high volatile Raniganj coals for the production of metallurgical coke. These high volatile coals

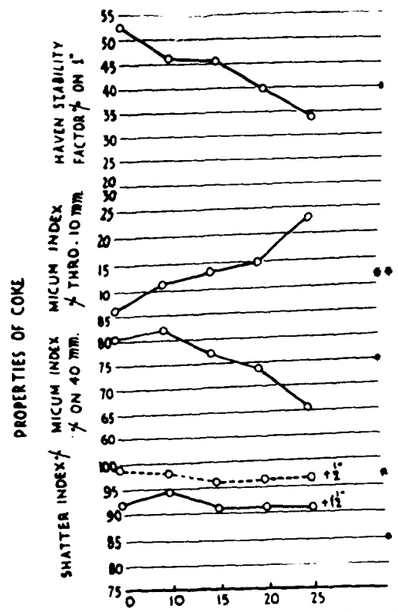

FIG.1. EFFECT OF ADDITION OF NONCOKING COAL.
* MINIMUM REQUIREMENT FOR METALLURGICAL COKE.
** MAXIMUM ALLOWABLE LIMIT FOR METALLURGICAL COKE.

produce, spiky, porous and brittle coke when carbonised by themselves. The coke obtained is smaller in size and does not satisfy any of the requirement of physical properties of metallurgical coke. But in blends with specially selected low volatile coals from the Jharia field, both the size and shape of the coke improve the fingery and porous coke becomes blocky and denser and fulfils the stringent specifications of metallurgical coke. Fig. 3 and Plate I show the improvement brought about in the structure and strength of the coke by blending.

Blending with low temperature coke dust :

The technique of adding low temperature coke or char to high volatile coals has been employed for economic reasons in different countries where the sources of low volatile coal, (essentially needed for blending with high volatile coals for the production of strong coke), are distantly located. Recent investigations have revealed the possibility of obtaining metallurgical coke by blending 15—20% of crushed low temperature coke or char with 80—85% of the weakly coking high volatile Raniganj coals, the effect being similar to the addition of specially selected low volatile

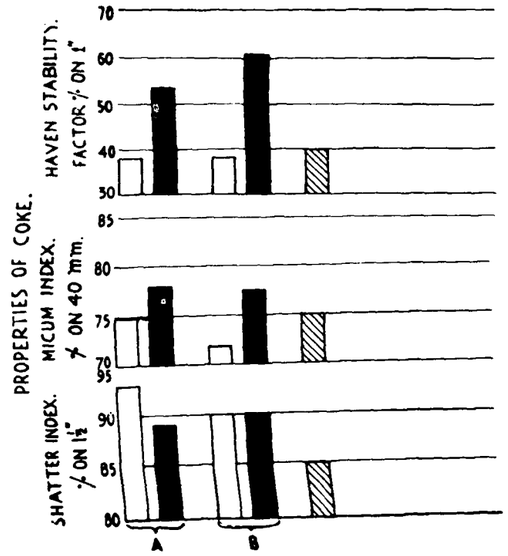

FIG.2. EFFECT OF WASHING ON COKE QUALITY.
100% RAW COAL.
100% WASHED COAL.
MINIMUM REQUIREMENT FOR METALLURGICAL COKE.

coal referred to earlier. Fig. 3 and plate I also illustrate this effect.

The fineness of crushing of the I. t. c. coke, the manner of its production, its volatile content, etc. have been found to influence considerably the final results.

Blending with high temperature coke dust :

The production of coke breeze or coke fines amounting of 5% or more of the total production of coke is unavoidable in all cokeries. This material is often difficult to dispose off and normally constitutes a dreg on the market. It has been observed from recent researches that depending on the nature of the carbonising coals, 3 to 5% of the finely crushed coke dust can easily be blended back with the coking mixture with no detrimental effect on the coke quality. The coke yield per ton of the charge increases often with beneficial effect even on the by-product yields. The use of coarsely ground coke dust or higher percentage (over 5%) of the material produces abradable coke. Fig. 4 shows the effect of the coke dust addition on the quality of the coke.

Blends for producing low ash and low phosphorus coke :

The specification of coke for the production of ferromanganese is rigorous. Besides satisfying the requirement of mechanical strength the coke should have low ash and low phosphorus.

Though Indian coals are in general low in sulphur compared to most foreign coals, their phosphorus content is rather high and is indeed a handicap in some of its industrial uses. Of all Indian coals, the coals of the Giridih field are known to contain consistently low phoshorus. The percentage of ash in these coals is also fairly low. The reserve of these coals is however, not large enough to enable the use of these coals for carbonization by themselves for long. Coking tests carried out with ternary blends of Laikdih and Dishergarh seam coals from Raniganj and Giridih coal produce coke suitable for ferromanganese manufacture. Specially selected low phosphorus coal from the Jharia field (after washing if so required) could as well be used in replacement of the Giridih coals.

Selective crushing :

Coal is a heterogeneous material composed essentially of a number of discrete petrographic constituents besides various amount of mineral matter with which it is invariably associated in the course of its formation. In order that coke of uniform texture and composition be made from coal, it is essential that it is given an optimum degree of crushing. When subjected to an indiscriminate process of crushing, as done in some conventional mills the more fusible, softer vitrainous constituents of the coal get more finely crushed while the harder and less fusible or non-fusible durainous parts and the shaley impurities predominate in the coarser size. This is quite contrary to what is derived for the production of the best coke. Improved coal crushing technique has been evolved whereby the objective of fine crushing of the harder constituents can be achieved, avoiding the crushing of the brights of the coal to an unduely fine size. Such methods of crushing are further advantageous in giving a higher bulk density in the coal charge compared to what can be obtained by crushing coal in the conventional manner.

Fig. 5 shows the improvement effected in the quality of coke by selective crushing i. e. crushing the coal initially to a fineness of about 70—80% through $\frac{1}{2}$ in. screening the crushed material and recrushing

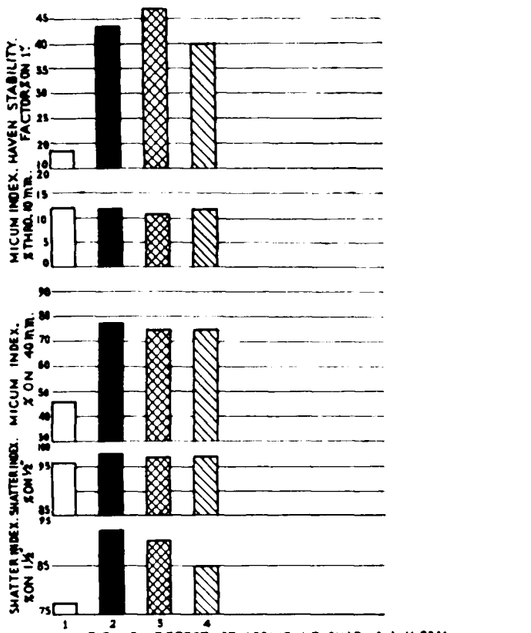

FIG. - 3. EFFECT OF ADDING L.T. CHAR & L.V. COAL TO DISHERGARH SEAM COAL.

1. □ - 100 % HIGH VOLATILE DISHERGARH SEAM (RANIGANG) COAL
2. ■ BLEND WITH LOW TEMPERATURE CHAR
3. ▨ " " LOW VOLATILE JHARIA COAL
4. ▧ MINIMUM REQUIREMENT FOR METALLURGICAL COKE

the plus $\frac{1}{8}$ in. fraction to a fineness of 1/16 in. (or even lower). In the case of the Indian coals which have comparatively high ash, such methods of coal preparation are essential for the production of hard and non-abradable coke.

Addition of oil to the coking mixture :

The bulk density of coals as charged to an oven depends on various factors and plays an important part in the carbonization process. While too high a bulk density of certain types of coal is often destructive to coke ovens due to development of high swelling pressures, an optimum bulk density is stated to be essential for all coals for the production of coke of the required quality. Finer crushing and the presence of an excess of moisture, lower the bulk density of the charge. It has been found that for most of the Indian coals which have comparatively high ash and less of the fusible, bright constituents, finer crushing is not only useful but often essential to obtain best grades of coke. In current Indian coking practice the

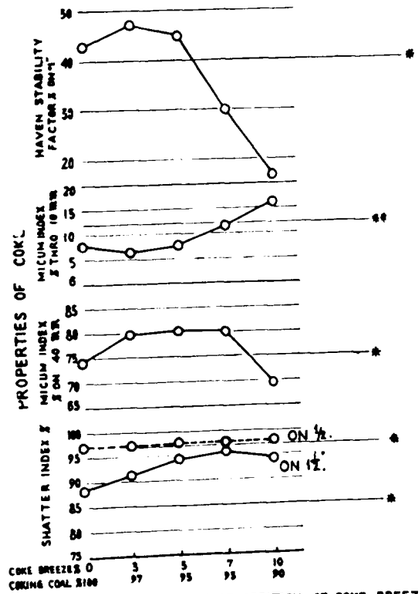

FIG. - 4. EFFECT OF ADDITION OF COKE BREEZE.

* MINIMUM REQUIREMENT FOR METALLURGICAL COKE
** MAXIMUM ALLOWABLE LIMIT FOR METALLURGICAL COKE

coal charge is carbonised with a moisture content of 5—6%. Strangely enough this moisture content corresponds to the minimum bulk density of the crushed coal. Recent tests have shown that by adding 0.5% of oil and raising the moisture in the coal to about 10% the bulk density can be increased by about 9%. Oil addition to coals straight away means an increase in the carbonising capacity by 8—10% besides producing an evening effect on the bulk density thus, improving the coke quality.

Industrial significance of the work done :

The work enumerated in the paper is of the highest significance to national planning. In fact, some of the findings have proved to be of great help to some of the industries already existing or coming into being.

Not only does the work done so far point to the possibility of utilising substantial amounts of the locally available coals in the projected iron and steel plants (for example the Orissa and M. P. coals) but enables, for the first time, the location of carbonization and iron and steel industries as well as chemical industries in the Raniganj areas independent of coal supplies from other sources. Based on the findings of the Central Fuel Research Institute the Durgapur Coke Oven Project of the West Bengal Government and the Hindusthan Steel Ltd., Rourkela have already decided to adopt the technique of selective crushing in their coke plants.

Projects are under way to establish l. t. c. industries in different regions to produce domestic coke and tar for hydrogenation. The coke fines produced, which will normally be unsuitable for domestic use, could profitably be blended with high volatile, weakly coking coals to produce metallurgical coke. Blending back h. t. c. coke dust with the coking mixture offers an easy outlet for the obnoxious breeze which causes great concern to most coke plants, with concurrent saving in coal consumption.

The future coking mixtures in Indian coke plants will consist essentially of a high percentage of washed but durainous coals. The high moisture in these coals and the greater degree of fineness that will be required to obtain coke of the best quality will considerably lower down the bulk density of the charge. The

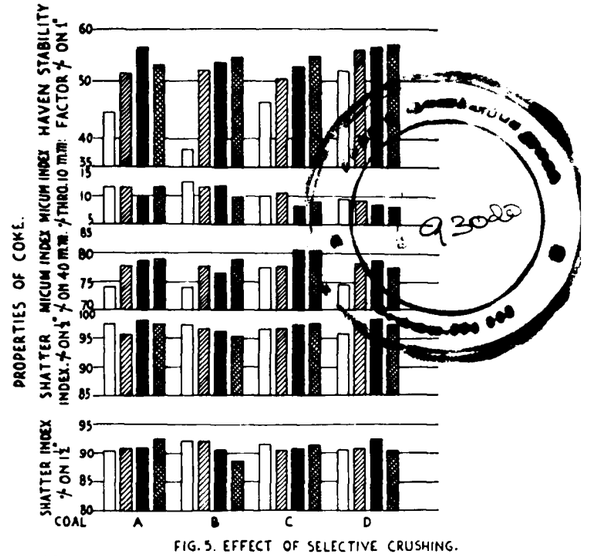

FIG. 5. EFFECT OF SELECTIVE CRUSHING.

LEGEND:-
- □ 80% THROUGH ½"
- ▨ 100% THROUGH ½"
- ▩ 100% THROUGH ½" SELECTIVELY CRUSHED (¼" TO PASS THRO. ¼")
- ▩ 100% THROUGH ½" SELECTIVELY CRUSHED (⅛" TO PASS THRO. 30 MESH)

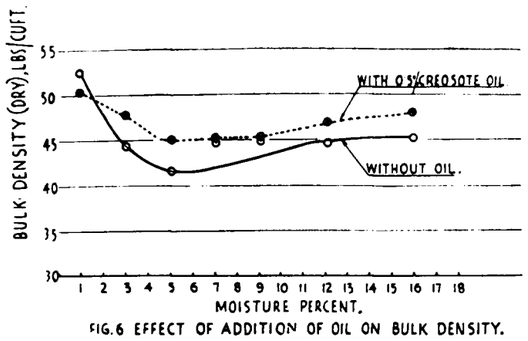

FIG.6 EFFECT OF ADDITION OF OIL ON BULK DENSITY.

addition of oil to the coal charge would counteract this adverse effect and result in an increased oven throughput, which can otherwise only be achieved by incurring heavy capital outlay for additional plant installation. The subject of addition of oil to coal charge is receiving consideration in some of the new coke plants.

There can be a net annual saving of 12 million tons of raw coal or 25 million tons of coal in situ by blending 5% coke breeze and about 30% non-coking or weakly coking coal for the production of metallurgical coke for which an estimated 30 million tons of raw coal will be required in the third Five Year Plan. Though approximate, these figures show the magnitude of savings that can be effected even by partial implementation of the results of investigations carried out by the Central Fuel Research Institute.

ACKNOWLEDGEMENT

The author is deeply indebted to the Director, Central Fuel Research Institute for valuable guidance in the preparation of the paper and for permission to publish the data embodied in the paper.

STAINLESS STEEL TRADE & INDUSTRY—A CASE FOR IMPORT

In a memorandum submitted by Messrs. Devidayal Stainless Steel Industries Private Ltd., Bombay to the Indian Tariff Commission during its public enquiry on 21st ultimo at Bombay had dealt with in details the steady increase in the import of and utility of stainless steel in India. The state that the stainless steel which the common man in India came to know only after the Second World War has now crossed the mark of 4,000-tons in annual imports and is likely to reach at least 10,000 tons per year within the next few years.

They have elaborately dealt with the immense uses to which the stainless steel is applied in diverse walks of life ranging from hospital furniture and motor parts to that of kitchenwares and yet the list is being steadily enlarged. The important reason for this rapid expansion and popular application of this scientific metal is its properties of non-corrosive, acid resisting and less wear and tear nature, which are very important factors, apart altogether from the fact of its elegance and comparatively light nature, coupled with cheapness in cost, which is said to be 1/15th of the cost of silver. They have further maintained that it will not be correct to say that stainless steel offers competition to brass and copper.

According to a recent disclosure in the Lok Sabha by the Minister for Steel, Mines & Fuel, Shri Sardar Swaran Singh, the Government of India is contemplating setting up a huge plant for the manufacture of specific metallic alloys and stainless steel in the country. Such a unit will doubtless offer further encouragement for the Industry to thrive on local supplies and will doubtless serve a very useful need of the community.

*** *** ***

SALEM PIG IRON PLANT

It is reported that a low-shaft furnace unit with a capacity to produce 15,000 tons of pig iron per annum is likely to be shortly set up in Salem. The Government of India, it is learnt, have granted a licence to a private firm to start the low-shaft furnace to make pig iron from the iron ore available in Salem. The capital outlay of this unit will be about Rs. 40 lakhs. Salem district, has an enormous reserve of iron ore, the iron content of which is 35 to 40 per cent. Limestone of high grade required for extracting pig iron is available in plentiful in the district. One of the advantages of the low-shaft furnace is that it replaces coke of high quality by fuel of inferior quality. Another advantage is that it does not need the enormous outlay that a modern blast furnace requires. Foundry pig iron requirements of the country are estimated at 8,00,000 tons per annum. At present they are being produced by the two iron and steel companies. If the requirements of the country can be met through these low-shaft furnaces, there will be a corresponding increase in the production of steel.

EPOXY RESINS

(Contributed by : CIBA Dyes Private Ltd., Bombay)

THE epoxide resins which are available from CIBA under the name of 'Araldite' have, by reason of their many outstanding properties, become well known during the comparatively few years in which they have been available. This is particularly true in the electrical engineering industries where these materials, in the form of adhesives and casting resins, have made possible the development of electrical equipment along lines not previously possible. Since their introduction, however, the resins which were originally available have themselves been developed to a considerable degree. Furthermore, in the years since their introduction, much has been learned of their behaviour, their properties and techniques of use. Originally there was only one type of casting resin, this being known as casting resin B, and this is still the type most widely used.

CASTING RESIN B

This is supplied in the form of lumps, golden yellow in colour, which are used with hardener 901, a white powder, both of which can be stored under normal conditions for periods up to two years. In use, the resin is heated to 120°–140°C., at which temperature it can be kept for several days without any deleterious effect. While at this temperature, 25–30 parts by weight of hardener 901 per 100 parts of resin are added to the resin and stirred in until it has melted. As soon as the hardener is added and providing that the temperature remains above 100°C., the process of curing begins and at 120°C. the pot life of the resin-hardener mix is between 1 and 1½ hours. Curing can be carried out at any temperature between 100°C. and 200°C., the times and temperatures being as follows :—

Temperature	(°F.)	392	346	310	274	238	212
	(°C.)	200	180	160	140	120	100
Curing Times	(hours)	1-2	2-3	5-7	7-10	10-14	14-20

The most suitable temperature for curing casting resin B is dependent upon the materials of the component which is being treated. In some instances, the maximum curing temperature will be dictated by one or more of the materials which are being encased, as several materials and pieces of equipment used in the electrical industries are not able to withstand very high temperatures. Apart from such considerations it is usually an advantage to cure at the lowest economic curing temperature. This particularly applies to very large castings where it is advisable to keep the temperature down in order to minimize the shrinkage due to the thermal linear co-efficient of contraction. As will be seen from the properties listed in Table 2, the coefficient of expansion and contraction of casting resin B is about 60 parts per million but this may be reduced to about 25 parts per million by use of suitable inert fillers.

FILLERS

There is a large number of materials which may be used as fillers but these are not all equally suitable, as the percentage which the resin plus hardener will tolerate varies from 25 per cent to as high as 350 per cent. Among materials which have been tested are slate powder, mica dust, glass powder, quartz meal, sand and ground porcelain. Of these, it is found that sand of a

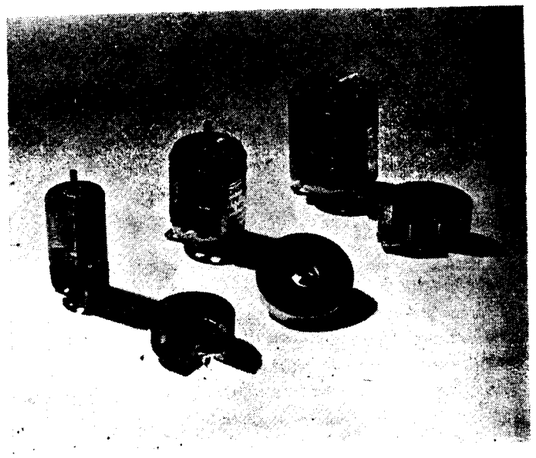

Fig. 1. Servo motors. Laminations bonded with 'Araldite' 15, potted in 'Araldite' casting resin B.
(By courtesy of Kearfott Co., U. S. A.)

type similar to that used in foundries can be used in the largest quantity but it is not necessarily the most suitable filler, as there is a tendency towards settling out during the curing process. The filler which offers the best all-round properties seems to be quartz meal of a particle size smaller than that which passes a 120 B.S.S. mesh sieve. Apart from reducing the thermal linear coefficient of expansion, the addition of fillers also provides the means of increasing the heat-conducting properties (see Table 2) and considerably reducing the cost of the resin mix, as these fillers are usually cheap.

MIXING OF FILLERS

When fillers are being used they have the effect of raising the viscosity of the mixture, and with most fillers it is the viscosity at pouring temperature which limits the amount of filler which may be added. The increase in viscosity means that there is a much greater possibility of any air which is entrapped in the mould being unable to escape, thus causing blow-holes in the final casting. In order to obviate this possibility, it is advisable to subject the resin and filler to heat (120°-140°C.) under vacuum before the hardener is added. The most satisfactory way is to treat these before mixing in order to pull off any moisture which may be present in the filler, and also any which may be on the surface of the casting resin. When these are then mixed together (which may be done out of the vacuum chamber) all that is left to pull off is any air which may be included in the mixing operation. For this purpose, about 20 minutes in vacuum of 1-2 mm. of mercury is recommended. The time may be easily judged, however, from the fact that when the vacuum reaches this level a rather violent movement may be observed in the resin-filler mix which will cause the mixture to rise to a height equal to about twice its normal depth in the container. When this has died down and the surface has become more or less still, the mixture may be removed from the vacuum chamber. If the mixture is not required for immediate use, it may be run off into trays and allowed to solidify, being subsequently broken up and stored. If required immediately, however, the correct quantity of hardener 901 should be added and, after stirring until the hardener has dissolved, the whole may again be subjected to a vacuum treatment. For this operation, a vacuum of 10 mm. is sufficient and this should be held for about ten minutes. Again a small movement occurs in the mixture but not as violent as that which takes place when the resin and filler are first subjected to vacuum.

CASTING

The mixture may then be removed from the vacuum chamber and poured into the moulds which have been previously prepared. Unless the shape of the mould is very complicated, further vacuum treatment should not be necessary, but where the conditions demand it, the filled mould should also be placed in the vacuum chamber at a temperature of about 120 C. and maintained under vacuum for about five minutes. The mould may then be transferred to an oven to complete the cure, or it may be allowed to cool and the resin cured at a later time.

Such would be the technique used if curing were to be carried out overnight at a temperature of 100 C. which appears to be favoured by most manufacturers. As already mentioned, there are advantages in keeping the curing temperature down to 100 C., but in addition, electric power is sometimes cheaper during the night-time.

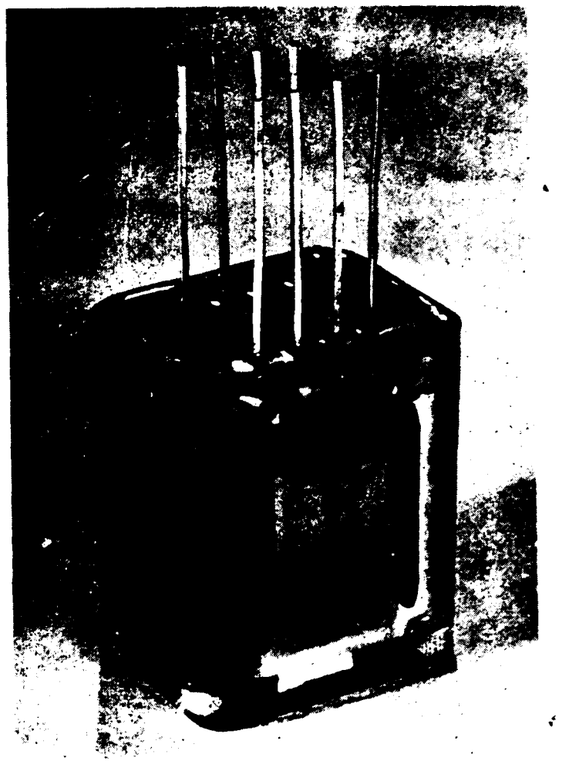

Fig. 2. Transformer potted in "Araldite" D. (By courtesy of Eversbed & Vignoles Ltd.)

TABLE 1

COMPARISON BETWEEN AVERAGE PHYSICAL PROPERTIES OF PORCELAIN AND CASTING RESIN B WITH 200 PER CENT. FILLER

	Porcelain.	*Casting Resin B+ 200% Quartz Meal*
Specific gravity ..	2.6–2.8	1.7–1.8
Tensile strength ..	4,300–7,000 lb./sq. in.	10,500–12,000 lb./sq. in.
Compressive strength ..	57,000–64,000 ,,	28,000–31,000 ,,
Fatigue strength ..	8,500–11,000 ,,	17,000–20,000 ,,
Modulus of elasticity ..	$9–10\times10^6$	$1.7–2.0\times10^6$

MOULDS

A wide variety of materials may be used for manufacturing moulds suitable for use with casting resins but, in general, it may be said that the simplest form of mould is usually the best. The design of a mould will obviously be dictated by the nature of the component being treated, but wherever possible sharp corners or sudden changes of section should be avoided. It has been found that aluminium alloys appear to be the most suitable materials from which to fabricate moulds, although steel is quite satisfactory and brass (sometimes chromium plated) is also used. 'Araldite' casting resins have excellent properties of adhesion to metals and it is necessary to use a parting compound to prevent the cured resin from adhering to the mould; the use of curing temperatures in excess of 100 C. rules out the use of most waxes. The parting agents recommended are those belonging to the silicone groups.

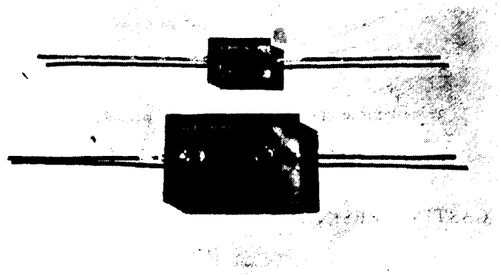

Fig. 3. Silver mica capacitors cast in "Araldite" casting resin "B". (By courtesy of London Electric Mfg. Co., Ltd.)

With a new mould it quite often happens that, when silicone greases are used, the first two or three castings produced in it do not free themselves very easily and it is therefore suggested that, before casting into a new mould, the process of applying the parting agent and curing is carried out with the mould empty. After this treatment it is usually found that separation of the mould and casting does not present any difficulty. It should be remembered, however, that the fact that the resin has a higher shrinkage rate than the mould material means that if cores are used when casting, they must be removed while the casting is still hot, otherwise their removal will be impossible due to the shrinkage of the resin on to the core.

If the mould is itself large, this should be heated to a temperature slightly higher than that of curing before the resin mix is poured. This prevents the resin mix from cooling, thus making the removal of any air bubbles present more difficult owing to the increase in viscosity of the mix. With sheet metal moulds, however, this is not necessary.

It sometimes happens that the number of castings of any particular shape which is required is very limited, and the cost of metal moulds is not justified. In such instances the use of moulds made from sand offers a convenient and economic method of producing the required casting. To produce sand moulds a wooden pattern is first made and around this is moulded the sand mixture. This is made by adding three parts by weight of resin 285 (CIBA), to 100 parts by weight of sand, mixing these, and stirring in four parts of water. It is sometimes an advantage to add one or two parts of Dextrine. This mixture, after moulding round the pattern, is baked for one or two hours at a temperature of 150°C. with the wooden pattern removed. In order to seal the pores of the sand mix, one and three parts of water and water glass respectively are brushed over the moulding surfaces a drying period being allowed between each coat.

USES OF CASTING RESIN B

The most extensive uses of casting resins are found in the electrical industries where the combined properties of adhesion, moisture resistance, mechanical strength, temperature and ageing resistance, combined with excellent electrical properties are employed to produce equipment which was not practicable until comparatively recent years. The properties of casting resin B are shown in Table 3 and it will be seen that the high strength of adhesion,

coupled with good electrical insulation value, means that components may be satisfactorily joined together but at the same time be adequately insulated one from the other. This is particularly useful when it is desired to embed the windings of electric motors in which the encasing of the whole after winding prevents movements of the wires in subsequent use and at the same time insulates the windings. Among the types of component which are being manufactured with the aid of casting resins may be listed: transformers, bushings, capacitors, insulators, terminal blocks with cast-in terminals, resistors, bobbins, servo motors, transistors, relays and potentiometers.

One development which appears to be gaining ground rapidly is the production of insulators from casting resin B plus silica, as a substitute for porcelain insulators. Table 1 gives a direct comparison between the properties of each type of insulator and it will be seen that the advantages generally lie with the insulator made from casting resin.

Any metal fittings required, which normally have to be attached to the porcelain, may be cast *in situ*, and due to the adhesion of the casting resin to the metal, freedom from electrical interference is obtained. Furthermore, the dimensional accuracy possible with casting resin is of the order of 0.1-0.2 per cent as compared with the normal variation of five per cent which is found in ceramics. Possibly the greatest advantage, however, is the resistance of the casting resin insulator to thermal and physical shock. Filled resin castings may be repeatedly dropped on to a concrete or stone floor without causing any damage other than possibly chipping the outside surface, whenever a protrusion or edge hits the floor at an awkward angle. Such castings may also be heated to temperatures of 100 C. or more and plunged straight into cold water many times before showing any signs of cracks. The dielectric constant of the cast insulator is usually better than that of the ceramic insulator and the electrical breakdown strength is practically the same.

The largest users of casting resin B are transformer manufacturers and it has been found that a potted transformer offers many advantages over the conventional oil-immersed transformer. Among these advantages is the facility it affords for designing a transformer of a given capacity which is considerably smaller in bulk and consequently lighter in weight. Insulation resistance is also higher than that of a taped transformer and heat transfer compares very favourably with that of an oil-filled transformer. Possibly the most important factor, however, is that transformers potted in resin will satisfactorily withstand the full tropical tests laid down by Service standards and are not likely to catch fire if overheated. Many other items of electrical equipment are also being encased in resin in order to meet the requirements of tropical conditions.

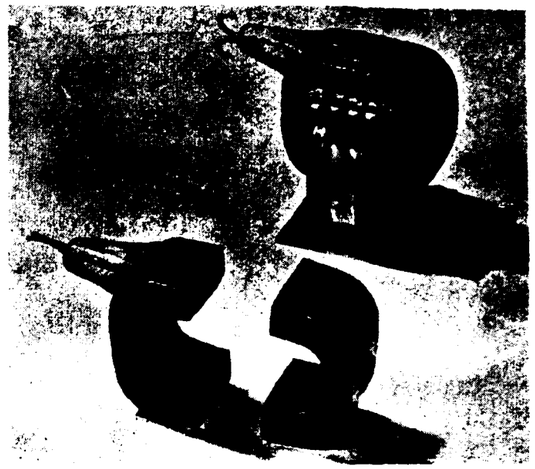

Fig. 4. Pulse Transformer embedded in 'Araldite' casting resin 'B'. (By courtesy of Aircraft Transformer Co., U.S.A.)

NEW CASTING RESINS

As mentioned earlier, since casting resin B was introduced, much development work has taken place and several other types of 'Araldite' resins are now offered which are of particular interest to the electrical engineer. These new products all adhere strongly to metals and may be listed as follows:

1. Casting resin D
2. Casting resin F
3. Flexible casting resin
4. Impregnating resin

CASTING RESIN D

This is a cold-setting resin used in conjunction with hardener 951, both of which are solvent-free liquids. In use, ten parts by weight of resin D are mixed with

TABLE 2

PHYSICAL PROPERTIES OF CASTING RESIN B, WITH AND WITHOUT FILLERS

	Test Method.	*Resin Mix 1.*	*Resin Mix 2.*	*Resin Mix 3.*	*Resin Mix 4.*	*Unit.*
Approx. adhesive strength (bonding Avianel M)	—	2,900–3,750	2,000–2,700	2,550–2,900	1,150–2,500	lb./ sq. in.
Ash content	—	0.02–0.03	15–16	60–61	69–70	per cent
Combustibility	—	5–10	8–10	8–10	8–10	seconds
Compressive strength	ASTM D695-49T	15,500–18,500	17,000–18,500	28,000–31,000	206,000–220,000	lb./sq. in.
Decomposition	—	340–360	335–345	340–345	345–350	°C
Fatigue strength	VM77103	12,700–17,000	9,000–11,300	17,000–20,000	7,100–8,500	lb./sq. in.
Flexural strength	ASTM D790-49T Schopper test bar 120×15×10 mm.	12,800–17,000	9,300–11,400	10,000–14,000	7,000–8,500	lb./sq. in.
Heat resistance (Marten's test)	Federal L-P-406a-2011	105–115	110–120	120–125	125–130	°C
Modulus of elasticity	ASTM D638-46T	0.42–0.57×10⁶	0.64–0.78×10⁶	1.7–2.0×10⁶	2.1–2.6×10⁶	lb./sq. in.
Shrinkage (depending on curing temperature)	—	0.5–2.5	—	—	—	per cent
Specific gravity	—	1.2–1.3	1.25–1.35	1.7–1.8	1.9–2.0	—
Tensile strength	ASTM D651-48	8,500–11,000	9,000–11,000	10,500–12,000	5,000–5,600	lb./sq. in.
Thermal conductivity	—	approx. 0.17	—	approx. 0.54	approx. 0.73	kcal/m² h°C.
		,, 0.008		,, 0.036	,, 0.036	watts/ich²/°C.in.
Thermal coefficient of linear expansion	ASTM D696-44	60–65×10⁻⁶	60×10⁻⁶	30–35×10⁻⁶	25–30×10⁻⁶	parts per million per °C.
Water absorption, 10 days at 20°C	ASTM D570-42	0.25–0.35	0.25–0.35	0.25–0.3	0.15–0.2	per cent weight
1 hour at 100°C	—	0.3–0.45	0.3 –0.4	0.3 –0.45	0.2 –0.3	,, ,,
Composition of Resin Mix						
'Araldite' Casting Resin B	—	100	100	100	100	parts by weight
Hardener 901	—	25–30	30	30	30	,, ,,
Filler	—	—	25 slate powder	200 quartz or porcelain flour	300 quartz sand	,, ,,

one part by weight of hardener 951 (nine parts by volume of resin D with one part by volume of hardener 951) and thoroughly mixed together. The mixing is of great importance, as, unless this is complete, free hardener will remain in the resin with the result that complete hardening will not take place; there is the further danger that free hardener may cause corrosion of copper or brass. When mixed correctly there is no danger of corrosive action and should this occur it is a sign of faulty mixing. It has been found that the most suitable and possibly the easiest way of mixing these materials is by means of an electric-vibrator mixer working at a frequency of 60 cycles per second. By such means it is possible to mix about 2 lb. of resin and hardener in about two minutes (by other means at least 15 minutes would be required for this amount) and with this method of mixing, air is not added to the mixture. When the hardener has been added an exothermic reaction occurs and for this reason it is recommended that the quantity mixed should be kept to a minimum and that the container used for mixing should be made of a material which will enable the heat generated to be dispersed as quickly as possible. It is helpful if the container is of such dimensions that the depth of resin is small. It is possible to control the exotherm by maintaining the

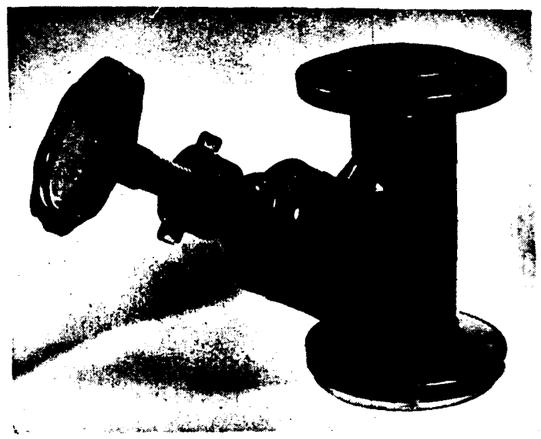

Fig. 5. Valve for chemical plant cast in 'Araldite' casting resin B. The bore of the valve is 4 in.

resin and hardener at a low temperature, say 5°C., before mixing. They should also be kept at this temperature immediately after mixing and poured into a cold mould. By regulating the rate of temperature rise of the mould and resin the exotherm may be

TABLE 3

ELECTRICAL PROPERTIES OF ARALDITE CASTING RESINS

	Test Method	*Casting Resin B*	*Casting Resin D*	*Unit*
Permitivity or dielectric constant	ASTM D150-47T			
60 c/s		3.8		
10^2 c/s		3.65		
10^3 c/s		3.62	3.76	
$2\sqrt{}10^3$ c/s		3.09		
10^4 c/s		3.01		
Loss angle tan δ	ASTM D150-47T			
60 c/s		0.0017	0.015	
10^2 c/s		0.0024		
10^3 c/s		0.019		
$3\sqrt{}10^3$ c/s		0.027		
10^4 c/s		0.022		
Dielectric strength ($\frac{1}{8}$ in.)	ASTM D149-44	400		volts/mil
Diffusion constant	ASTM D697-42T	1.0	1.1	
Surface resistivity	ASTM D257-49T	$>3.8\times10^{13}$		ohms
Volume resistivity	ASTM D257-49T	$>10^{15}$	6×10^{14}	ohms
Arc resistance time	ASTM D495-8T	50-180		seconds

controlled. After such treatment it is essential to post-cure at a temperature of between 80° and 100°C. for about two hours in order to develop fully the properties of the resin.

After the hardener is added the mixture remains pourable for 1½ hours at normal room temperatures (or considerably longer at lower temperatures) after which time setting takes place. Full curing, however, takes at least 24—36 hours at room temperatures but after about five hours the resin has set sufficiently to enable the casting to be removed from the mould. Although this is essentially a cold-setting resin, the curing process may be accelerated by means of heating, which also has the advantage of improving the physical properties of the cured resin.

TABLE 4

CHEMICAL RESISTANCE OF 'ARALDITE' CASTING RESIN B

Test Medium	*Concentration*	*Temp. °C.*	*Resistance*	*Duration of Test*
Acetone ..	100%	20	N.R.	
Benzene ..	100	20	R	6 months
	100	80	R	6 months
Distilled water ..	—	20	R	12 months
		100	L.R.	3 months
Ethyl alcohol ..	100	20	R	6 months
	100	80	N.R.	
Formic acid ..	100	20	R	6 months
Glacial acetic acid ..	100	20	R	6 months
Hydrofluoric acid ..	100	20	R	
Hydrochloric acid ..	10	20	R	6 months
	10	100	R	6 months
	100	20	R	6 months
Nitric acid ..	100	20	N.R.	
Potassium permanganate ..	6g/100g water	20	R	3 months
Oil (mineral) ..	100	20	R	12 months
Sodium chloride ..	1	20	R	6 months
Sulphuric acid ..	10	20	R	6 months
	50	20	R	6 months
	96	20	N.R.	6 months
Trichlorethylene ..	100	20	N.R.	

N.R. Not resistant. R. Resistant. L.R. Limited resistance.

The electrical characteristics of type D are similar to those of casting resin B up to about 60°C. but its heat resistance is lower and it softens at temperatures above 50°—60°C. It is less water resistant, but samples have satisfactorily withstood tropical tests.

CASTING RESIN F

Casting resin F, which is a solvent-free liquid resin of fairly high viscosity, may, unlike the casting resins already mentioned, be employed as a cold-setting resin using hardener 951, or as a hot-setting resin using hardener 901.

When used with hardener 951, 10—12 parts by weight of hardener are added to 100 parts by weight of casting resin F. As with casting resin D, there is an

Fig. 6. Fly-back transformer, potted in 'Araldite' casting resin B. (By courtesy of Todd-Tran. Corporation, U.S.A.)

exothermic reaction and large amounts should not be mixed. At normal temperatures the pot life of the resin hardener mix is about 45 minutes and setting time is about 24 hours at 20 C. As with casting resin D, the application of heat will shorten the setting time, the times and temperatures being as for casting resin D.

As a hot setting casting resin using 40—45 parts by weight of hardener 901 to 100 parts by weight of casting resin F, a liquid of low viscosity at 100 C. is produced. At this temperature the pot life is over four hours. Due to the very low viscosity of this mixture and the fact that it does not contain any solvents, it is particularly suitable for the embedding and impregnation of very fine windings. A double process is recommended for the potting of finely wound parts, consisting of an initial impregnation using casting resin F with hardener 901, and after curing, the impregnated winding is potted in casting resin B and silica sand. This technique permits the use of the most suitable resin for each purpose.

FLEXIBLE CASTING RESIN

Although casting resin B meets the requirements of most users and is in fact used for potting current transformers which embody as much as 2600 lb. of resin, it was felt that there was a need for a flexible casting resin which would retain its flexibility throughout the recommended temperature range of the resin. Furthermore, as it is not practicable for the resin manufacturer to know the degree of flexibility required for each component, it seemed advisable that the resin should be so made that the user could vary the degree of flexibility by varying the proportions of the component which imparts the flexibility.

IMPREGNATING RESIN

Although casting resin F, when used with hardener 901, is of such a viscosity that it is suitable as an impregnating resin, it suffers from the disadvantage of a relatively short pot life and must be handled at an elevated temperature. In order to overcome these difficulties new impregnating resin, which have a long pot life, have now been developed.

It should be noted that 'Araldite' resins, particularly casting resins, possess properties which are of great interest to the chemical engineer as well as the electrical engineer.

Table 4 shows the chemical resistance of casting resin B, which is already being used very extensively for making valves, taps, etc.; the fact that it machines very easily increases its usefulness.

From these notes it will be seen that the development of the range of epoxy resins is now taking place at a fairly rapid rate. In addition to the materials already mentioned several other products are now undergoing tests before being offered to industry.

EDUCATION OF WORKERS—TEACHERS' TRAINING TO START SOON

Immediate steps are to be taken to train a cadre of teacher administrators who would train teachers to carry out a programme of education for workers. Candidates for this training would be selected from trade unions, universities and other organisations. This was decided by the Workers' Education Committee at its first meeting held in New Delhi recently. Comprising representatives of the Government, employers' and workers' organisations and educational institutions, the committee has been set up to complete certain preliminaries necessary to give effect to the recommendations of the team of experts on workers' education, which recently submitted its report to the Government. The recommendations, which included the setting up of a semi-autonomous central board to administer the workers' education programme, were generally approved at the last session of the Indian Labour Conference. The committee agreed that the training programme for teacher administrators, should be undertaken in a place like Bombay or Calcutta, which are both industrial and educational centres. It was, however, left to the Government to decide the exact location of the training centre. A provision of Rs. 50 lakhs to Rs. 60 lakhs has been made in the second Plan for workers' education.

Safe Applications of Electricity in Industries

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I—INTRODUCTION

ELECTRICITY is the greatest and most easily applied labour-saving resource at the service of mankind. By its use, industry has been expanding at an unprecedented rate. Electrification in industry means the provision of more congenial environments for workers, elimination of drudgery and long working hours, more pay justified by increased output and more goods of better quality at lower prices for the consumer. The applications of electricity in industries in India are, however, quite small compared to those in other countries. This may be judged from the fact that in England in the year ended 31st March 1954, about 22,400 million units of electricity were used by the industries as against 4,076 million units consumed by our industries in 1954. With the tempo of rapid industrialisation of the country, the use of electricity in industries is bound to increase considerably. Continued vigilance is, however, necessary against electrical hazards because every user of an electrical equipment, appliance or device supplied at mains voltage or above, runs the risk of electrical accidents. It is therefore appropriate to consider at this juncture the safety measures which would be generally effective in minimising both fatal and non-fatal accidents due to electrical causes in the industries.

II—CAUSES OF ELECTRICAL ACCIDENTS

Electricity can be dangerous in three ways, viz., (1) electric shocks, (2) fire risk, (3) public ignorance. The dangers under items (1) and (2) are much less than the dangers from other forms of power and can be easily guarded against. The third and greatest danger is that electrical accidents happen as a result of carelessness, generally due to ignorance of the existence of a known hazard or non-observance of certain fundamental safety measures. People who take proper care in the handling and use of electricity are, however, quite safe.

Generally, legal enactments, rules and regulations are not clearly understood by persons using electrical appliances and the best way of reducing electrical accidents is to educate the public to realise that under certain conditions and in certain circumstances, electricity can be dangerous, so that the user of electricity can take necessary commonsense precautions to avoid a shock.

In this connection, it may be of interest to briefly review the information given in the annual publication by the Factory Department of the Ministry of Labour and National Service in England, entitled "Electrical Accidents and their Causes, 1955". During 1955, the number of electrical accidents reported under the Factories Acts, was 739, of which 42 were fatal. In addition, 59 fatalities occurred in other industrial or similar premises not falling under the provisions of the Acts, and 41 in domestic and similar premises. There were 232 accidents to electrical personnel and 65 accidents to mechanical fitters and similar craftsmen compared with 227 accidents to all other men. There were 56 accidents, including 4 fatalities, to boys and young men under 21.

Of the 611 accidents, 193 (19 fatal) were caused by portable electrical equipment with its cables, etc. This is the type of accident which chiefly concerns people without electrical skill or knowledge. The proportion of accidents caused by portable apparatus in 1954 was 45.5% of the total reportable fatal accidents and 35.1% of the total accidents. Either the lack of, or the failure of, earthing systems accounted for 26.6% of the 302 accidents involving electric shock. The analysis of accidents in relation to voltage showed that 19 of the reportable fatalities occurred at 250 volts or below.

There were 200 accidents (6 fatal) associated with transformers, switchgear and fuses, to which electricians are primarily exposed. Another important group was 42 accidents (6 fatal) on crane trolley wires and collectors, 14 accidents (5 fatal) arising from the use of cranes and contractors' equipment, etc., near overhead transmission and distribution lines.

Of the 341 accidents involving electric shock, 100 caused injuries from falling, and this is frequently the most serious result of a shock. 401 accidents caused burns of which 131 were accompanied by shock.

Of 60 persons who were known to have become unconscious 5 had fractured skulls as a result of falling and 15 of the rest received no artificial respiration and died. Of those who received artificial respiration, 19

recovered and 21 died. Some of these would no doubt have died in any event, but as artificial respiration was continued for half an hour or more in only one case, it is at least probable that one or two others could have been rescued. There must, of course, have been other cases in which persons were unconscious who recovered without assistance, but as recovery is usually complete with little or no physical after-effects, and victims were not disabled for over three days, such accidents are not reportable.

The report states that 275 accidents were the result of someone's ignorance, carelessness or neglect, and in 95 of these cases, the neglect was not that of the injured man. Among 18 typical incidents quoted are those in which a worker used a metal bound paint brush which shorted live contacts of a switchboard; another shorted live terminals while tightening up a nut; and a third dusted live 11 kV cable bus-bar spouts, thinking his mate in another substation would cut off the supply.

Descriptions are given of a number of electrical failures, including switchgear and transformer failures, which resulted in fires and explosions and caused serious injuries to persons employed. Attention is also drawn to the number of serious accidents which arose from faulty planning and supervision of work in high tension substations where it was either not made clear to men what they had to do, or insufficient care was taken that they did not exceed their instructions. In some instances, the trouble arose from over-enthusiastic young men starting work before the engineers in charge had had time to tell them what the job was and what safety measures were necessary. Serious accidents in electricity stations and on heavy plants in factories not infrequently occur because of momentary mental lapse of memory or aberration on the part of fully competent personnel, often the engineer immediately in charge. This may arise if he is harassed, or his attention is distracted. Sometimes, men become so interested in the technical aspect of the job in hand that they momentarily forget they are dealing with live gear.

Many men seem to have not the least idea of the risks they are running, and the greatest care must be taken to prevent men and plant approaching live overhead conductors and to allow a very adequate margin of safety. Particular care must be taken to protect the wiring and especially temporary installations while building work and alterations are in progress, and attention paid to the construction and application of safety devices, such as limit switches, alarm devices, etc. which would be valuable in preventing accidents.

III—SAFETY MEASURES IN INDUSTRIES

It is impossible to deal adequately, in a brief article, with the various safety measures which are necessary or desirable for protection against electrical hazards commonly met with in connection with the utilisation of electrical equipments and appliances in industries. However, some of the important points affecting the industrial undertakings, excluding electric supply undertakings, are briefly reviewed here.

IV—SELECTION OF ELECTRICAL APPARATUS AND EQUIPMENT

Most of the electrical equipments and appliances used in industries are designed and built for special types of service. They will operate with efficiency and safety only when they are used for the specific purposes and under the particular service conditions for which they are intended. It would be a short-sighted policy to select inferior equipments merely on considerations of cheapness. It would always be a wise policy to purchase equipments of reliable manufacture and which are liberally rated so that they will operate satisfactorily under the most severe conditions met with in service. The best is not only the cheapest in the long run but it is also the safest.

In the selection and use of electrical equipments and appliances, it is advisable to follow the recommendations of the various established Codes and Standards, such as the Indian Standards Specifications, the British Standards Specifications, the Regulations for the electrical equipment of buildings published by the Institution of Electrical Engineers, London, etc. and the statutory provisions, such as the Indian Factories Act and the Indian Electricity Act and Rules. The employer and all supervisory staff have a statutory as well as a moral duty in complying with all the safety regulations which have been laid down for the safety of the personnel employed in factories.

The following notes on Electrical Safety in Factories, if studied and followed carefully, would be of assistance in minimising electrical accidents in the use of electrical appliances and equipment in Factories.

V—INSTALLATION OF ELECTRICAL EQUIPMENT

Electrical apparatus should, as far as possible, be placed in less congested areas of the factory and, where practicable, in special rooms to which only authorised persons have access. If the equipment must be located in the plant area, enclosures should be built round those parts of equipment having exposed conductors.

When transformers, switchboards, switches, motors, starters and other electrical apparatus are installed in a factory, the equipment should be laid out in an efficient and safe manner so that the possibility of accidental contact with live conductors will be reduced to a minimum.

Frequent inspection of equipment, competent supervision and preventive maintenance, are extremely important in the case of electrical equipments. It is recommended that every factory should have a Plant Safety Department and the personnel of this Department should familiarise themselves with the Codes and Standards which apply to the various equipments in operation. The electrical maintenance staff should consist of qualified engineers, supervisors, electricians, foremen and other technically-trained personnel according to the type of electrical equipment installed, who should ensure that the safety requirements are always kept in the forefront and strictly observed at all times by all the employees of the factory.

VI—GENERAL WIRING

The general wiring in industrial undertakings should be adequately insulated and be further protected, where necessary, by metallic sheathing or by sheathing of heavy rubber or other suitable material or the wiring run in screwed conduits. Cleated wiring may be permitted if out of reach and not subject to damage. Flexible metallic tubing may be used at entries to adjustable motors. The use of temporary wiring should be discouraged even though it may be reasonably safe when put in. The general standard and method of wiring should comply with the requirements of I. E. Rules and the Factory Regulations and, as far as possible, conform to the requirements laid down in the Institution of Electrical Engineers Regulations for the electrical equipment of buildings (13th Edition, 1955).

VII—EARTHING

The earthing of metal casings which might be touched is obligatory except for fixed apparatus operating at not more than 250 volts D. C. or 125 volts A. C. and for portable apparatus operating at not more than 150 volts D. C.

In earthing electrical circuits, the requirements of the various Statutory Regulations and Codes should be observed. In particular, effective earthing should be provided for such equipments as motor controller cases, frames, tracks and motors of electrically-operated cranes, electrical equipment of elevators and metal enclosures around high voltage equipment.

To earth electrical equipment effectively, either of two methods may be employed. One method is to utilise the water pipe, metal framework of building or other metal structures with a low resistance path in direct contact with the earth. The other system is to use a group of electrodes driven into the ground, buried parts and strips or other arrangements in direct contact with the ground. In D. C. circuits, it is important that the negative side be earthed on to the water pipe in order to prevent the deterioration of the pipes and nearby metal structures through electrolysis. For effective maintenance of the earthing system, the electrical conductivity of the soil should be determined by its contact with the earth conductor and by its chemical ingredients, and this should be checked periodically by taking earth readings with an earth tester.

VIII—PROTECTION

The following hints are given as general guidance for the protection of electrical plant and equipments and safety of personnel in industries:—

(i) *Isolating Switches* Electrical equipments must be provided with suitable isolating switches or other devices so that every equipment or part of an electrical system can be readily isolated to avoid danger. In addition, suitable protective equipment, such as fuses, circuit breakers and other automatic devices should be provided so as to isolate the overloaded or faulty electrical equipment or circuit in the case of danger.

(ii) *Fuses* Fuses should be installed in every circuit and they should be of a size and type that will interrupt the current flow when it exceeds the capacity of the conductor to be protected. Protection of this kind, both for the personnel and for the equipment, is one of the important features of an electrical installation. They should be designed to clear both over-current and short circuit faults without danger or damage. Bus-bar short circuit values of 25 MVA at 230 volts to earth are common in factories. The severity of short circuit is lessened at the remote sub circuit but in all instances fuses should be of adequate rating and guaranteed

performance. Blown fuses should be replaced by others of the same type and size. Substitution of copper wire or other conductors for fuses should never be permitted. Fuse distribution boxes should be placed so as to be within easy reach and not at such a height that a ladder is needed.

(iii) *Circuit Breakers* Circuit breakers are designed to open the circuits automatically in the event of excessive current from accidental earth, short circuit or overload. They are available in a variety of types and sizes. They must be reliable in their operation and equipped with timing devices. In large installations, for the protection of important equipments or circuits, protective relays are installed to trip the circuit breakers. Circuit breakers have long been used in high voltage circuits. They should be selected for the specific installation by qualified engineers and checked regularly to see that the moving parts do not stick.

(iv) *Switchgear interlocks* Interlocks are provided for the specific purpose of preventing errors in switching in and switching out operations and only under exceptional circumstances should steps be taken to defeat the purpose of interlocks. Because of grave risk to life from uncontrolled maintenance, lockout routines should be drilled into every Maintenance man and the Supervisor should see that the routine is implemented with the necessary keys, locks and arrangements.

IX—MOTORS

Motors should be mounted on machines, floors or other locations, so that they do not interfere with the normal movement of personnel or materials. Non-enclosed motors should be in areas free from dust, moisture or corrosive vapours. Accidental contact with motors should be prevented by installation of enclosures or barriers around moving parts, such as pulleys, projecting shaft ends, gears, chains or belts.

Before starting a motor, the operator must personally see that all is clear and stand away from the rotating elements, running belts or pulleys. He should dress properly as torn parts of overalls or loose straps are liable to catch in rotating elements. Gloves must not be used while working on parts of a machine which is running, as fingers may be lost in so doing.

X—ELECTRIC WELDING

The welding area should be enclosed as far as possible, either as a permanent cubicle or by portable screens so as to protect people moving nearby. Suitable gloves, protective eye and face shields and an insulated holder are essential for the operators. Persons assisting welders should also wear goggles with opaque side screens. A robust low resistance return circuit must be provided for the return current to the generator or transformer. In a confined compartment, the welder would have difficulty in avoiding contact with the live parts of the electrode holder. The use of D. C. for welding or a device for reducing the open circuit voltage to 20 volts in A. C. welding is to be preferred.

XI—PORTABLE APPARATUS

All portable electrical apparatus should be regularly examined, tested and maintained to ensure that the apparatus and leads are in good order. The metallic casing of portable apparatus should be effectively earthed by the use of three-pin plug and socket connections.

The best insurance against risk of shock from portable apparatus is the use of D. C. When A. C. is to be used, safety may be increased by reducing the voltage, to say 25 or 50 volts for portable lamps and to 100 or 110 volts for portable tools. The step-down transformer should be double wound, the two windings being separated, so that the main supply cannot, by bad insulation, leak through the low voltage winding. For 110 volts outlets, the mid-point of the secondary winding should be earthed so that when using a portable apparatus with motor wound for 110 volts and its casing earthed, the maximum possible shock voltage to earth will be only 55 volts.

Handles of portable lamps should be made of non-conductive material and there should be no metallic connection between the lamp guard and the socket shelf. In dangerous situations, the shock hazard of portable lamps may be eliminated by the use of small portable transformers which step the lamp voltage down to 6 volts and special lamps rated at 15 watts capacity at 6 volts give sufficient working light.

All loose wiring such as flexible cables for portable lamps, tools, trailing cables for lifts, cranes, hoists and other portable and transportable apparatus should be tested regularly at frequent intervals to ensure safety.

XII—H. T. EQUIPMENTS

Only authorised persons should be permitted to enter high voltage enclosures. Whenever other employees are given authority to enter, they shall first be warned by the authorised person permitting access of the dangers which may be present. The warning shall include the instructions not to go near or beyond barriers and how to carry an object (which he may require to handle) so as to prevent such other object coming into contact or within close proximity of the exposed apparatus. Danger notices shall be attached to all high voltage apparatus.

XIII—PERMIT-TO-WORK SYSTEM

Permit-to-Work System should be adopted in factories which possess their own power station, H. T. distribution and substations. The object of the Permit-to-Work System is to ensure that the care which the Charge Engineer must exercise is directed along pre-determined lines of safety, because a mistake in isolation or earthing can lead to disastrous consequences in respect of life and damage to electrical plant. This Permit is a certificate from the Charge Engineer to the Supervisor in charge of the men selected to carry out the work on high voltage or other electrical equipment. It should state which apparatus is dead, isolated, earthed and available to be worked on with safety and the work which must be done. The Charge Engineer should sign the Permit and the Supervisor in charge of the work should sign a declaration of his responsibility to see that his men do not carry out any other work.

An important matter is the method of cancelling the Permit by a Clearance Certificate printed on the back of the Permit. In this, the Supervisor in charge of the work signs a statement that his men have been withdrawn and warned and that work has ceased and that all tools and temporary earthing connections have been removed. The Charge Engineer then accepts responsibility for the operation of the gear by signing a cancellation of the Permit which is filed for record.

XIV—WORKMEN'S SAFETY DEVICES

Rubber gauntlets, gloves, mats, boots and galoshes, insulated platforms and stools, safety belts, handlines, tower wagons and other special insulated devices should be used, as required, by employees working on electrical apparatus, and ærial lines as a precaution against accidental electric shock. The supervisor in charge of the work should be responsible to test and ensure proper safety of the equipment supplied to the gangs of workmen under him and to see that they are maintained at all times in efficient condition. Any equipment which is liable to be broken in use should be replaced at once.

XV—FIRE PRECAUTIONS

In every factory, adequate precautions should be taken to guard against electric fires which may be the result of insulation failure, dangerous earthing conditions, switch explosions and oil fires and ignition of materials by open sparking or by electro-static discharge and the use of incorrect fuses.

In the event of fire on electrical equipment, the affected part should be immediately and completely isolated from its source of supply of electrical energy.

Fire extinguishers, liquids or containers which are not insulated, should never be employed in fighting fires near exposed live parts. Only such fire extinguishers should be used on electrical apparatus which are marked as suitable for the purpose. When using fire hose, it should be ensured that the jet of water does not come in contact with live conductors.

It is dangerous to throw on live apparatus a stream of water, a wet blanket or stream from an ordinary carbonate of soda extinguisher. When found necessary to use them, all neighbouring apparatus must be made dead. Carbon dioxide, carbon tetrachloride and other special types of extinguishers, sand or dry blanket may be used on live static apparatus and conductors. Sand or dry blanket should not be used on rotary apparatus.

XVI—FIRST AID

First aid boxes should be provided in all factories as per the regulations in force. A periodical check should be made on the contents by a responsible supervisor and deficiencies should be immediately made good. Stretchers should also be kept in the factories in good condition for use in an emergency.

XVII—REPORTING OF ACCIDENTS

All accidents to persons, whether minor or major, non-fatal and fatal, including slight injuries, when the injured person is capable of performing his duties, should be immediately reported as per the rules in force. First aid shall be rendered where necessary, the injured persons shall be sent to the doctor for medical inspection or the doctor sent for to attend on the

patient. Section 33 of the Indian Electricity Act, 1910, requires that electrical accidents which result, or are likely to have resulted, in loss of life or personal injury, actually occasioned by the accident, shall be reported in such form and within such time and to such authorities as the State Government may direct.

All accidents to factory employees, irrespective whether electrical or non-electrical, including temporary or partial disablements exceeding 48 hours, should also be reported to the Chief Inspector of Factories and the Commissioner of Workmen's Compensation Act.

XVIII—ACCIDENT REGISTERS

Each factory should maintain an Accident Register in which all accidents are to be recorded. The record should show the date and time of accident, name of person or persons involved, nature of injury, whether fatal or non-fatal, name of the investigating official or officials, reference to accident report submitted, compensation paid, if any, and the final action taken to prevent a recurrence of such accidents.

XIX—EMPLOYEES' TRAINING

It is the duty and responsibility of the Managers, Engineers and Supervisors in every industry to so train the men under them that they understand their duties thoroughly and carry out the work entrusted to them in an efficient and safe manner. Every industrial undertaking should, therefore, have a suitable training programme to give safety instructions to their employees on the hazards of electricity. Such training should consist of not merely generalisations and indefinite recommendations, but should be based upon demonstrations and training in the correct operation and maintenance of electrical equipments and appliances. The supervising official should maintain a close supervision over all operation and maintenance works and defective or careless handling of equipments or deviation from safe practices should, under no circumstances, be permitted or tolerated.

The employees should also be trained in first aid, fire fighting, use of warning signs, guards and other protective devices and safety operational procedure. In addition, senior workmen should be trained to understand and apply the Schafer's Prone Pressure Method and other alternative methods of artificial respiration and resuscitation from electrical shocks. Safety Codes, General Safety Precautions and 'DO' and 'DONT' Instructions and other forms of propaganda to instil the sense of safety in the workmen should be prepared and distributed among workmen and also displayed in various parts of the factory.

XX—CONCLUSION

It is hoped that the implementation of the recommendations made above and the cultivation by all persons of safety habits in the use of electricity, would go a long way in minimising electrical accidents in industries.

HEAVY MACHINERY PLANT NEAR RANCHI

It is reported that the Union Government have finally decided to locate the Rs. 150-crore heavy machinery plant proposed to be set up with Soviet aid, at Hatia village near Ranchi. The plant, the first of its kind in India, will employ about 17,000 workers of different categories. Preliminary work such as land acquisition and survey have already been started.

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MICANITE FACTORY IN BIHAR INAUGURATED

The Chief Minister of Bihar inaugurated recently at Jhumritilaiya, in the heart of the mica belt of Bihar, a micanite factory which is claimed to be the first of its kind in Asia. It may be mentioned that the factory set up with the help of German experts is expected to produce 300 tons of micanite per year initially, out of which one-tenth is to be consumed in India and the rest are likely to be exported.

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COAL DEPOSITS IN GARO HILLS

Sardar Swaran Singh, Union Minister for Steel, Mines and Fuel is reported to have announced the steps taken by the Government to exploit the coal deposits of Garo Hills in Assam. According to him, drilling operations have been started by the Geological Survey of India to find out the potentialities of the deposits. The manner and method of operation would be determined by the drilling data which would be compiled and analysed as soon as drilling operations are completed.

NAMES IN THE NEWS

TOP PRIORITY TO MACHINE TOOL INDUSTRY URGED

American Machine Tool Experts' suggestions to the Government of India.

THE United States Machine Tool Industry Team to India composed of Mr. George E. Merryweather of Cleveland, Ohio, Vice-President of the Motch and Merryweather Machinery Co., Mr. Paul F. Hawkins, Export Sales Manager of the Monarch Machine Tool Co. of Sidney, Ohio, Mr. Roy A. Jacobs, Manager of Industrial Engineering for the Jones & Lamson Machine Co., of Portland, Oregon and Mr. Robert Fleming of the U. S. Department of Commerce, which toured the country last month, has recommended to the Union Government to give top priority to the development of machine tool industry and making the necessary technical assistance and raw material available to the manufacturers in this country.

The team which came to India at the invitation of the Ministry of Commerce and Industry and under the joint sponsorship of the U. S. Department of Commerce and Industry and the International Technical Co-operation Administration, consists of six specialists and experts, with Mr. George E. Merryweather as its leader.

Arriving in New Delhi on June 14 last, the team spent a week in meeting officials of the Government of India, the American Embassy and the T.C.M. It was assigned the task of preparing a report on some of the following points :—

1. The various sectors of the Indian Machine tool industry including recommendation for improvements and expanded production.
2. The possibilities of the U. S. machine tool industry participating in the development of India's machine tool industry through investment, licensing and other appropriate arrangements.
3. Recommendations on methods of improving the productivity of India's machine tool industry.
4. An estimate of the potential demand for Indian machine tools, present and future, domestic and export.
5. The types of machine tools to be produced by the Indian machine tool industry in which plant expansion is recommended and recommendations on a goal or goals for such expansion.
6. The availability of Indian small shops to produce complete machines and component parts for the machine tool industry.
7. An evaluation of the availability of steel based on the existing and proposed capacity of the industry in India, to the requirements for such steel in the machine tool industry and the availability of raw materials for the maximum utilisation of increased capacity of the machine tool industry.

The U. S. Machine Tool Team left New Delhi on June 24 for Bangalore to attend the conference of the Machine Tool Development Council. After inspections and consultations there, it toured various cities and towns in the country, accompanied by Mr. R. L. Kirloskar, Managing Director of Messrs. Mysore Kirloskar Ltd., Harihar, Mysore State and Mr. Frank S. Wilson, T. C. M. Industrial Adviser to the Government of India.

Returning to New Delhi on July 30, it began a series of consultations with the Government of India officials and started work on the preliminary draft of the final report. During its informal consultations with some of the Ministers, the team has recommended, said Mr. Merryweather at a press conference on 3rd August, 57 that with a view to giving incentive to small manufacturers to produce more machine tools, the Government of India should buy machinery and other equipment and give the same on lease to various manufacturers at a nominal rate of one per cent. per month of the total cost. At a later date, the Government might sell the plant at original cost after deducting the amount of lease money already realised,

Mr. Merryweather added that the team had also recommended that the Government should place bulk orders for machine tools with small manufacturers. In case they could not sell their products in the open market, this would encourage them to produce more machine tools.

This recommendation was particularly made for the Punjab manufacturers who were now doing a very good

The U. S. Machine Tool Experts who visited the country recently: Left to right are: Shri R. L. Kirloskar, Managing Director of Mysore Kirloskar Ltd., Harihar who accompanied the team on the tour, Mr. Robert Fleming of the U. S. Department of Commerce, Mr. George E. Merryweather, Vice-President of the Motch and Merryweather Machinery Co. of Cleveland, Shri S. L. Kirloskar, President of IMTMA, Mr. Paul F. Hawkins, Export Sales Manager of the Monarch Machine Tool Co. of Sidney, Ohio and Mr. Roy A. Jacobs, Manager of Industrial Engineering for the Jones and Lamson Machine Co. of Portland, Oregon.

job and deserved all possible encouragement from the Government. Big manufacturers, he said, did not need this assistance. Mr. Merryweather praised the Punjab manufacturers for producing machine tools at a considerably low cost.

About the prospects of American investment and other assistance, Mr. Merryweather said that the team had recommended to the Government of India to request the U. S. Government for technical assistance to help in the development of India's machine tool industry in design, maintenance tool engineering and other methods. Licensing arrangements could also be worked out by which the U. S. machine tool industry could participate in the development of the industry here.

Mr. Merryweather also suggested that the Ambernath Ordnance factory should be used to design and develop this industry and the wonderful laboratory and the beautiful equipment of the Hindustan Machine Tool Factory be utilised to improve the quality of tools. The capacity of the various technical training schools should be increased, he said.

Mr. Merryweather graduated from the Massachusetts Institute of Technology in 1934 and served some time with the Cincinnati-Bickford Machine Tool Co. Later he joined the Motch & Merryweather Machinery Co. of which he is now a Director, Secretary and Vice-President. He is also a Director of several other industrial firms, and a member of the Executive Committee of the American Machine Tool Distributors' Association.

Mr. Hawkins has been with the Monarch Machine Tool Company for nearly 18 years, having served in numerous capacities in many divisions of the Company. In 1948 he became Export Sales Manager in charge of Overseas Sales and Service operations. In this capacity, he has visited several European and South American countries.

Mr. Jacobs had been with the Jones & Lamson Machine Co. since 1928 and is now its Manager of Industrial Engineering. He was in France in 1939, serving as Field Engineer for the company on various installations. For 8 months in 1945 he served with the Donald Nelson Mission in China. In 1952 for several months he worked with the National Production Authority in Washington.

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AMERICAN FOUNDRY EXPERT HELPS MODERNISE INDIAN FOUNDRIES

Mr. John F. Schnur's outstanding contribution to foundry practices.

Mr. John F. Schnur, Foundry Technologist working in India under the Indo-U. S. Technical Co-operation Programme since 1952 has helped several Industrial firms to redesign furnaces and improve performances by the introduction of new moulding techniques. This has resulted in considerable savings and increased production in dozens of foundries in the State. Economy in fuel and time was achieved in a score of foundries after Mr. Schnur introduced new mixtures of sands and clays, making it possible to use moulds while still damp. Before his visit these foundries used only dry moulds.

Among the outstanding examples of his services is a big foundry in South India employing 100 persons, where within 60 days Mr. Schnur doubled the output with the same personnel. At another small factory, his redesigning and new methods resulted in pushing output from 20 to 100 moulds per man each day.

In addition to visiting and working with scores of factories all over India, Mr. Schnur has spent two and a half years as Foundry Instructor at the Indian Institute of Technology at Kharagpur, West Bengal, and two months at Roorkee University in Uttar Pradesh. At Kharagpur he conducted seven three-month intensive training courses for more than 140 foundrymen from throughout India, who have returned to their home states with new knowledge of moulding and casting practices. Participating in these courses were foundry instructors from several colleges and technical institutions throughout India.

Mr. Schnur has also been answering thousands of

Mr. & Mrs. John F. Schnur, American Foundry Expert now working in India, under Indo-U. S. Technical Co-operation Programme.

queries on foundry problems through correspondence during the last five years. Perhaps his unique contribution to the foundry industry in India is the preparation of four manuals on "Modern Practical Foundry Training", which have been translated into several Indian languages. These manuals, prepared to suit raw materials and conditions in India, are an invaluable guide for training new foundrymen.

"Indian foundrymen are as good as any in the world, given the proper know-how and facilities", said Mr. Schnur at several technical conferences and discussions. He also speaks highly of the competence of Indian Metallurgists.

Sixty-nine-year-old Schnur has spent more than 20 of the 50 years of his professional career abroad. For 14 years he worked as foundry foreman and superintendent in several places in Central and South America. During 1944 and 1945 he was Foundry Consultant to the Chinese War Production Board.

He is accompanied in India by his charming wife, who goes with him every place and helps him in preparing reports and in his social life.

Mr. Schnur is expected to leave India by about March 1958 and by this time he would have left behind him a concrete contribution to the foundry industry in this country. Back home and away from the heat and blast of furnaces one might find Mr. Schnur playing any of these wind instruments; the trumpet, the saxophone,

the trombone, the bass or the French horn. He has also conducted a number of civilian and army brass bands. Mr. Schnur loves classical and dance music and plays almost all mouth instruments.

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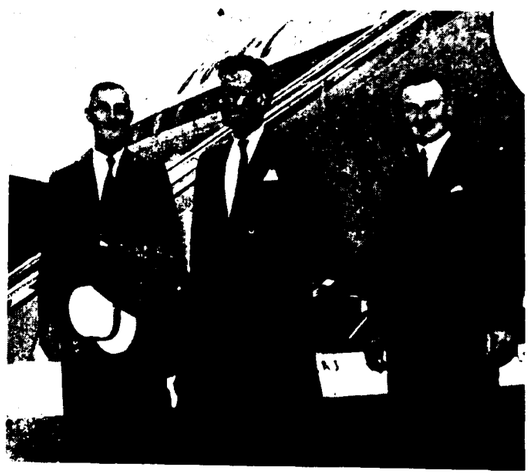
BRITISH SHIPYARD EXPERTS' VISIT TO INDIA—PRELIMINARY SURVEY COMPLETED

As a result of the recent discussions with the Government of India, an Advance Party of the British Shipyard Mission under the joint auspices of the Colombo Plan and the United Kingdom Shipbuilding Conference visited India in July and inspected nine sites in various parts of the country.

The Advance Party consisted of Mr. J. Milne of Lithgows Ltd., Shipbuilders and Dr. F. W. Blythe of Costain-John Brown Ltd., Contracting Engineers, with Mr. R. M. C English as Secretary. The Main Mission will visit India this autumn. The Advance Party visited Gonkhali in West Bengal, Paradip in Orissa, Tuticorin in Madras, Cochin in Kerala, Mangalore, Bhatkal and Karwar in Mysore and Trombay & Kandla in Bombay.

Before leaving for United Kingdom the Members of the Advance Party met senior officials of the Government of India in New Delhi and are expected to submit their preliminary report to the Main Mission.

Speaking on behalf of the Advance Party Mr. Milne said that everywhere the members went they were impressed by the arrangements made and the facilities provided to enable them to complete their on-the-spot studies.



BRITISH SHIPYARD MISSION TO INDIA. The advance party of the British mission which will advise the Government of India on the site and layout of a new shipyard has just completed an inspection tour of probable sites for the shipyard. The party consists of Mr. J. Milne of Lithgows Ltd., shipbuilders, and Dr. F. W. Blythe of Costain-John Brown Ltd., contracting engineers, with Mr. R. M. C. English as Secretary. The main mission, visiting under the joint auspices of the Colombo Plan and the United Kingdom Shipbuilding Conference, will come out to India this autumn.

The Main Mission after visiting the various sites will advise in detail the Government of India the final site and layout of a new shipyard and the equipment which would be required to establish it and provide estimates of the capital costs of the shipyard.

PRODUCTION SCHEDULES OF NEW STEEL PLANTS TO BE ACHIEVED

It is learnt from an unconfirmed report that although some fears have been expressed in certain quarters about the maintenance of schedules of production of the three steel plants in the public sector, it is believed in government circles that not only production targets will be achieved but the schedules of production will be maintained. Further, as at present envisaged, there is likely to remain no surplus steel for export after meeting the internal demands here. The Government, however, is likely to set apart about half a million tons of steel for export by 1961 with a view to earn foreign exchange by selling iron and steel in the export market.

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PROMOTION OF EXPORTS

A Directorate of Export Promotion has been created in the Ministry of Commerce and Industry to pursue specific measures of export promotion and assist businessmen in increasing exports. The Directorate reportedly will be the executive agency for the policies and decisions formulated by the Foreign Trade Board which was recently set up to co-ordinate all work relating to the development of Indian foreign trade, particularly promotion of exports. It will also be an agency to which all exporters in the country could look for guidance, information and assistance.

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IMPORTS OF INDIAN CYCLES BY BURMA

Burma is reported to be considering the question of allowing imports of a sizable quantity of Indian cycles. It may be mentioned that since January last, the Government of Burma has not issued any licence for the import of cycles from sterling area countries including, India.

COMPANY NEWS

INDIAN COPPER CORPORATION LTD.

Speech Of The Chairman, Mr. Patrick E. G. W. Parish

THE following is the speech of the Chairman, Mr. Patrick E. G. W. Parish delivered at the Thirtythird Annual General Meeting of the Indian Copper Corporation Ltd.

Gentlemen,

I have purposely departed from precedent this year in producing my Statement on the Corporation's affairs, now at the Annual General Meeting, rather than to send it out with the Accounts which were published some two months ago, as was the practice in the past. The reason which has prompted me to make this change is my desire to give you the very latest position in the light of changing World prices of Copper.

GENERAL REVIEW

You will recall that your Chairman, in his statement last year, was somewhat cautious concerning the possible results for the year now under review. He was perfectly right for the World price of Copper had reached its peak of £434/- per ton in March and a rapid decline was already in evidence. The price in September last year was £307/- and this decline continued until the end of the year when the price of Copper stood at £267/-. Last week it was £191/-.

Despite this heavy fall in price the selling prices of your Company's products averaged over the year 1956 were maintained above the previous year. These average prices were: Copper Ingots £330/- per ton against £309/- per ton last year, Rolled Brass £273/- against £245/-, Yellow Metal Circles £305/- against £266/- and Rolled Copper £388/- per ton as against £357/- per ton last year.

The annual consumption of copper of various grades in India is approximately 40,000 tons, of which your Company produces about 7,800 tons. The balance 32,200 tons has, therefore, to be imported at current world prices. Despite foreign exchange difficulties, it is understood that the Government of India intend to grant import licences to cover the country's requirements of this metal.

The price structure of your Company's products must bear a close relationship to that of imported Copper and with prices as they are today it is obvious that the spectacular results achieved during the past two years will not be repeated in the current year.

It is an impossible task to forecast the future trend of the world price of Copper. Obviously when the price of Copper was over £400/- some mines, which in ordinary circumstances are uneconomic, were able to resume production, with the result that eventually the supply caught up with and then surpassed demand. The decline in price since the peak in March 1956 is the consequence. At what stage uneconomic mines will go out of production to the extent that supply and demand are again in balance is difficult to say. Experts have said that £230/- per ton might be a reasonably economic price, but as I have already said, the price today is well below that.

So far as your Company's mine is concerned, the cost of production is somewhere about mid-way between the highest and lowest costs of Copper producing Companies in other parts of the World and at present prices we can expect to show a reasonable return, but if the world price continues to fall, either owing to over production or to a recession in demand by consumers, there must come a point where profits end and losses begin. My own view, for what it is worth, is that the world price will not fall below our cost of production, but this, of course, presupposes that our cost of production will not be further inflated by wage demands. As you will see from the Directors' Report, the settlement reached in January this year with the two Unions representing our employees will increase the direct cost of wages by about 13 per cent. It is to be hoped that their leaders will realise the simple economics of the matter and not press their demands to such an extent as to put our Mine among the uneconomic producers.

You may have seen references recently in the press to a renewed dispute with the Union at Mosaboni. As

the matter is now in the hands of the Conciliation Officer I think it is better for me to say no more at the moment. In fact the Union at the Mine did call the workers out on a one day's token strike last month—in our opinion quite unjustifiably.

WORKING REVIEW

You will observe from the Profit and Loss Account and your Directors' Report that the financial and working results are a record in the annals of the Company. These results have been achieved by the increase in the selling prices, together with an increase in production of ore and copper.

The record of ore milled, amounting to 421,131 short tons, is a direct result of the policy commenced a few years ago for an extensive prospecting and development programme with the object of opening up all the workable areas of the Company's leasehold to maintain and, if possible, to increase production. This included the sinking of a circular shaft to a depth of 2,200 feet completed in 1954 at a cost of £370,000/-.

You will observe from your Directors' Report that this policy has not only increased production but, what is so important for the non-ferrous metal deep-mining industry, built up further ore reserves which now stand at 3,424,594 short tons.

The new prospecting and development of all the remaining areas of the leasehold, despite the fall in Copper prices, continues on an extensive and uninterrupted scale, but although it is premature to forecast results it is necessary for me to issue a caution that the results so far obtained, although not unsatisfactory, are not conducive to any spectacular large increase in production in the near future. It is, however, I repeat, our policy even at lower Copper prices to exploit the deposits on our leasehold, with our very highly skilled and experienced technical mining staff, to the full to the ultimate benefit of the country.

The production of Copper was a further record and in order to achieve this it was necessary to increase the productive capacity of the Works, which is still being continued according to the requirements necessitated by the increasing production of ore.

ACCOUNTS

The Accounts disclose that the profit before providing for taxation, depreciation and reserves amounts to £1,507,184/-.

Depreciation at £175,000 -, the same as last year, has been provided for in view of the large capital expenditure required for prospecting, development and the increasing production programme planned. You will observe from the Balance Sheet that the addition to fixed assets during 1956 was £220,747 -.

Your Directors have transferred £175,000 - to General Reserve.

As regards Taxation, £932,689/- has been reserved in the Balance Sheet. Of this £676,315/- is for Income Tax and Super Tax, £99,355 - is additional Super Tax on the 1955 final dividend and Bonus, and the Interim and Final Dividends for 1956, £137,130/- is tax on the Bonus Share Issue and £19,889/- is reserved against Wealth Tax under the new Budget.

Although costs increase as mining operations get deeper, these were partly offset last year by the increased production and the actual overall increase of cost per ton as compared with the previous year was directly attributable to the large increase in Profit Sharing Bonus paid out to the employees.

Your Directors' Report outlines details of the year's operations as compared to the previous year, but further details are given in your General Manager's report, which may be seen during office hours at the Company's Head Office.

KYANITE

The mining, benefication and despatch of kyanite ore from the Company's leasehold property continued uninterrupted throughout the year. The export of this ore remains unrestricted and despatches amounted to 16,617 tons being 2,617 tons less than in the previous year due to shortage of wagons to carry the ore from the mines to Calcutta Docks. Our main world markets continued to be the North American continent and Europe, and prices were maintained at approximately £23 - per ton F. O. B. Calcutta as compared to £20/- per ton in the previous year.

The civil suit brought by the Bihar Government against the Company and the civil suit brought against the Bihar Government by the Company for specific performance to renew their lease, as reported by your Chairman at the last Annual General Meeting, were both decreed in favour of the Company; but the Bihar Government has appealed to the Patna High Court where the suits are now pending.

STAFF

On behalf of you all I extend our thanks to the General Manager, Mr. N. A. B. Hill, to the Staff both at the Mine and at the Works and to the workers and congratulate them on the fine results achieved.

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THE INDIAN IRON & STEEL CO., LTD.

Speech of the Chairman, Sir Biren Mookerjee

The following is the text of the speech of Chairman, Sir Biren Mookerjee delivered at the Annual General Meeting of the shareholders of the Indian Iron and Steel Co. Ltd.

Gentlemen,

It is my privilege to address you this year as Chairman of the Board of Directors in the absence of very well-earned leave of Mr. Leslie Martin. It is, however, the intention of the Managing Agents that on his return to India, Mr. Martin should resume his former position as Chairman, and to this end I commend to you the resolution that will be proposed at a later stage of this Meeting to provide for his re-appointment.

PRODUCTION & DESPATCHES

The total production of iron at 695,156 tons showed a decrease of 11,830 tons from that of the previous year due to the reduced output of the Blast Furnaces at Kulti. These Furnaces with their ancillary plant are now very old and uneconomical and subject to frequent shut-downs for repairs. Under the 1953 Extensions Programme it had originally been the intention that heavy capital expenditure should be incurred in effecting their complete modernisation and rehabilitation, but on a later examination of the position in connection with the Company's 1955 Extensions Programme and the overall Second Five Year Plan of Government, the conclusion was reached with the concurrence both of Government and the World Bank that such expenditure would not now be warranted having regard (a) to the surplus pig iron that would be available from the new Blast Furnaces at Burnpur and from the other new or expanded plants and (b) to the inevitable higher cost of production at Kulti owing to inherent operational difficulties. It was accordingly decided that the Kulti iron plant should be closed down when the new Blast Furnaces at Burnpur came into operation.

In consequence of this decision, Government withdrew as from the 1st January 1956 the special depreciation element of Rs. 6—8 per ton included in the sale retention price of iron to the Company despite protest that the resultant price was quite uneconomical. Possibly in view of feared delay in the bringing into operation of the new plants, Government have recently requested that the Company should examine the possibility of the Kulti Blast Furnaces being maintained in production for a period of about four years. This position would be capable of achievement only by the incurring of considerable expenditure on the plant and our Consulting Engineers are now examining the matter. In the meantime it has been indicated to Government that the Company would expect all such emergent expenditure to be met by Government and the retention price of iron to be adjusted in relation to the actual cost of production.

Production of the Burnpur Blast Furnaces was 476,336 tons against 473,172 tons for the previous year, the slight increase being due to the fact that the relining of No. 1 Furnace during 1956—57 was effected in a still shorter period than that of No. 2 Furnace in 1955—56, thus constituting a fresh record for the Company.

As regards the out-turn and despatches of steel, you will have realised from the particulars given in your Directors' Report that a number of special factors operated to inflate the position for the year 1955—56. These factors did not recur during the year under review which accounts for the decrease shown.

PROFIT

In view of the reduction of 31,114 tons in the despatches of steel there is naturally a fall to a more normal level in the gross profit earned for the year under review and the effect on net profits of this fall has been greatly accentuated by the severe increase in the rates of corporate taxation imposed under the Finance Act 1957. The severity of this increase will be realised when I tell you that had the Reserve for Taxation been calculated at the rates previously prevailing, the charge would have amounted to Rs. 269 lakhs as compared with the sum of Rs. 315 lakhs that has had to be provided to cover liability at the new rates. The incidence of the increase of taxation on the profits of the year under review accordingly amounts to no less a sum than Rs. 50 lakhs.

In face of this position it was decided that the time had now come to commence adjustment of the large balance standing on the Reserve for Taxation Contingencies and an initial write back to Profit & Loss Account of a sum of Rs. 47 lakhs has accordingly been made in the Accounts now before you. The Reserve in

question is maintained to offset the increased incidence of taxation in subsequent years as a result of the special depreciation allowances granted in earlier years in the case of plant and buildings. The major part of the Reserve is attributable to the initial depreciation granted in previous years which has the effect of cutting off any further depreciation allowance for taxation purposes once the value of the asset has been written down to a certain level, and write back from the Reserve on this account will, in consequence, operate only as and when that level is reached. In addition, further special depreciation is allowable on plant and buildings during the first five years of their life which has the effect or reducing the allowance for each subsequent year with a consequent increase in the liability for taxation. It is to offset the position in this latter respect that the write back of Rs. 47 lakhs, which is not an arbitrary figure, but a calculated amount covering the position up to the 31st March 1957, has now been made. It is the intention periodically to examine the position so that the balance of the Reserve may gradually be adjusted.

Initial depreciation now no longer applies having been replaced in the case of plant and machinery by the grant of Development Rebate giving an outright exemption from taxation of 25% of the cost of new plant and machinery installed. The approximate tax saving on this account for the year under review amounts to Rs. 9,50,000 which sum has accordingly been transferred to General Development Reserve raising the balance of this Reserve to Rs. 16,50,000. As and when the major items of the extensions plant are commissioned the Development Rebate and the consequent saving in taxation will be substantial and, as was explained last year, we count to a large extent on the continuance of the Rebate for finance of the 1953 and 1955 Extensions Programmes, which apart from the pure capital cost of the added plant will involve a very considerable increase in the working capital requirements of the Company for the finance of rolls, spare parts, stores, raw materials stocks and the generally increased financial requirements of the expanded undertaking.

DIVIDEND

The fullest representation was again made to Government for admission of the Ordinary shareholders to some added participation for the year under review in the continuing prosperity of the Company, it being urged that with the limitation of dividend imposed in the past, the financial position of the Company had been strengthened to such an extent that the stage had now been passed where it could be validly contended that a small increase in the dividend distribution would in any way prejudice the finance of the cost of the Expansion Programmes or the due repayment of the indebtedness that is being incurred. It is a matter of regret to your Directors that Government have been unable to accept the views of the Board in this matter and in their letter dated the 29th July 1957, a copy of which has been appended to the Directors' Report, have notified that restriction of the dividend must continue until the Expansion Programmes have been completed. This reply is a slight improvement on the earlier attitude of the Government. As the 1953 Extensions are expected to be completed next year, whilst one of the two batteries of coke ovens and one of the two blast furnaces will be ready for commissioning this year, I trust it may be possible for the Government to relax their control in the near future. In the meanwhile, your Directors would again point out that the decision of Government cannot be challenged without serious detriment to the interests of the Company and would urge that the position be accepted with good grace in the hope and expectation that the justness of the claim of the shareholders to a reasonable participation in the improved and continuing prosperity of the Company must ultimately be recognised.

FUTURE PROSPECTS

I should perhaps sound to note of warning as regards the present year. We are now feeling the full effect of the disruption of current operations that is inescapable when a plant is being expanded and constructional and operational work has to go on side by side. In these circumstances there has inevitably been a drop in production and whether this can be made up will depend entirely upon the date when it will be possible to bring into operation the first of the new blast furnaces at Burnpur, a matter with which I will deal in more detail at a later stage.

As to the future in general, I have no hesitation in saying that if it depended entirely on the efficiency, diligence and enthusiasm of all of us alone, your prospects would appear to be bright. However, in the day to day changing moods of the workers, not only in the industries but in all those departments whether in the Government or outside, who have to make their contribution towards the national effort, nothing can be said even with reasonable certainty as to what we may expect in future. Extreme lack of discipline has manifested itself particularly during the last few months amongst all classes of workers in many essential Government or other services, the Ports, etc., accompanied by

actual or threatened strikes and by violence. Political agitation, sometimes accompanied by violence, has also played its part in interrupting industrial production and disturbing the public peace. This state of affairs may, if it continues, entirely upset not only our own expectations as regards the future operations of our plants, but the entire economy of the country. I would, therefore, with all the emphasis I can command, urge upon Government the vital necessity that violence be severely dealt with and punishment meted out with promptitude not only to those by whom the overt act is committed but also to those to whose subversive background activities this violence is directly attributable.

In our own works, in spite of an almost continuous improvement during the last few years in the conditions of service and emoluments, to which I shall refer later, it is regrettable that the workers allow themselves to be influenced by a minority affiliated to a certain political party and activated by the motive of supplanting the recognised Labour Union. This unfortunate position has been evidenced during the year by sporadic illegal strikes of short duration in the essential services sections, which have been particularly serious in the case of the Gua Ore Mines where even murder has been resorted to in an endeavour to terrorise workers belonging to the recognised Union and to disrupt normal operations. I cannot too strongly condemn this manifestation of an influence which for the gaining of its own party ends can contemplate with equanimity the disruption of all planned progress towards the achievement of the country's social advancement and industrial self-sufficiency. As you must have noticed similar troubles have been reported also from Jamshedpur in the speeches of the Chairman of the Tata Locomotive and Engineering Co. Ltd., and the Tata Iron & Steel Co. Ltd., at their recent annual meetings.

Mere condemnation, however, is of little use unless it is coupled with some suggestion as to how the position may be met. My personal opinion, based on a study of similar situations in other industrial countries, is that the evil can best be countered by the building up of really strong and representative labour unions having the full support of the workers and capable of restraining the subversive influence of those few who for their own ends attempt to cause disruption to the detriment of the general welfare and that no other unions should merit Government's recognition. I would in fact go further and say that what affects one section of an industry must have repercussions upon the whole of that industry and therefore the ultimate solution may lie in the building up on an industry-wise or craft-wise basis, of unions under the leadership of responsible bodies of men who have the interest of the country and the workers genuinely at heart and who are not swayed by political influences or the desire for self-aggrandisement.

We have progressed a long way since the days when an employer could contemplate with equanimity, as reducing the bargaining power of the workers, dissension within a single union or the formation of a number of rival unions. It is now the desire, I am inclined to believe, of all enlightened employers that they should be able to deal with one strong labour union enjoying the support and truly representing the interest of its members. Given such strong and representative unions, employers and workers could readily resolve the difficulties that must from time to time arise between them and could act together in full co-operation and mutual trust, thereby enabling the country to advance to new fields of prosperity and social security.

There are, however, other difficulties which will discourage any prudent man from trying to peep into the future. The solution of these difficulties almost exclusively depends upon the success of the more than Herculean tasks to be performed by the Government according to schedule for the implementation of what has been lately described as the "hard core" of the Second Five Year Plan, particularly in respect of the supply of good quality coking coal and the transport of this and all other raw materials and ultimately the finished products. This "core" consists of the development of iron and steel, coal, transport and ancillary power and necessarily includes the two major units in the private sector of the steel industry. I shall try and explain to you briefly how the success or the failure of the Government's efforts in this respect is likely to affect the operations of our extensions with which your future is naturally linked up.

EXPANSION SCHEMES

In your Directors' Report and in the report by our Consulting Engineers that was issued therewith, a full description has been given of the stage which the schemes have already reached. We have, as you are aware, two programmes of expansion in hand, the earlier of which is described as the 1953 Extensions and the later one as the 1955 Extensions. The later scheme was undertaken by us at the request of Government to form part of the Second Five Year Plan. It is intended to enable us to produce more finished and expensive products by reducing the excessive output of the semi-finished ones and of the saleable pig

iron contemplated in the 1953 Extensions. The total production after the completion of the 1955 scheme will be 1,000,000 tons of ingot steel or 800,000 tons of saleable steel instead of 700,000 tons of saleable steel as planned under the 1953 Extensions.

The 1953 Extensions, which you may remember suffered an initial delay of nineteen months, are expected to be completed by the end of 1958 if no unforeseen difficulties arise in the meanwhile, in which case we shall have made up seven months of the delay. Towards the end of the current year we expect to bring into operation one of the two batteries of coke ovens and one of the two blast furnaces included in the scheme, and the conversion of the old 600 ton active mixer into a 300 ton steel-making furnace, whilst the second coke oven battery and blast furnace are expected to be completed and function towards the end of 1958 along with the completion of the new Open Hearth melting shop.

In order to work the first battery of coke ovens we shall require an extra 54,000 tons of coking coal per month. This will bring the total monthly requirements of coking coal for Burnpur to 146,000 tons and we have been advised, and very rightly, by our Consulting Engineers and by the plant manufacturers that the new coke oven battery should not be lighted unless we have built up and can expect to maintain a stock of at least 100,000 tons in our works.

At the moment I can only say that the attainment of this stock position by the time the new coke oven battery is ready appears to be remote and in fact even the maintenance of supplies of coal for existing operations causes no little concern. As an indication of the seriousness of the position I would say that during the current year we have literally been living from hand to mouth and that recently orders had to be given to reduce the throughput of the coke ovens owing to the dangerously low level of the coal stocks which in turn has meant a reduction in the production of steel. The fullest representation has all along been made in official quarters and it has been somewhat disheartening to be referred from one department to another, each in turn refusing to acknowledge responsibility for this sad state of affairs. I am hopeful, however, that as a result of intervention at ministerial level lately, the position may improve.

Similarly, we shall require a further 60,000 tons of iron ore per month to work the first new blast furnace. Owing to the late delivery of mining plant and machinery, caused by the strikes in America and the closing of the Suez Canal, the full mechanisation of our Gua Ore Mines will be delayed by about five to six months. For this reason, we have been advised by our Consultants to stock pile about 225,000 tons of iron ore at Burnpur. Although the target has not been reached yet, we have every hope that this position will be achieved by the end of November next.

Each of the new blast furnaces is designed to produce about 1,200 tons of pig iron per day which can be converted into about 1,000 tons of steel. Taking the present average import price of foreign steel at Rs. 700 per ton, which is perhaps Rs. 150 per ton lower than the price at which steel is being imported at present, the bringing into operation of the first blast furnace will mean a saving in foreign exchange to the country of more than Rs. 2 crores per month. The completion of the second blast furnace will double this advantage.

The second battery of coke ovens and the second blast furnace will also need about 54,000 tons more of coking coal and about 60,000 tons more of iron ore per month. Our total requirements including our present consumption will, when the 1953 Extensions are completed, be about 200,000 tons of coking coal and about 185,000 tons of iron ore per month, which means the transport of more than 4 million tons per annum in addition to considerable quantities of limestone, stores and other essential materials for our Burnpur Works equal to another one and a half million tons. In addition there will be 800,000 tons of saleable steel per annum to be moved. Allowing only four days turn round for the wagons, the Railways will have to provide for us carrying capacity for about 24 million tons or so per annum, about one third of which will have to consist of specially built hopper wagons for iron ore. These, I would emphasise, are the transport requirements for Burnpur only and take no account of the requirements of your Kulti Works.

In this connection it may not be out of place for me to observe that when the three Government plants and the extensions of the Tata Iron & Steel Co. Ltd., come into operation, the problem of transport may prove to be very difficult as most of the steel works will have to draw their principal raw materials from more or less the same area or neighbourhood which will cause a considerable amount of congestion on the railway lines and consequential delay. In such circumstances it is natural on the part of the private sector to apprehend that in the distribution of the transport facilities some discrimination may be made between it and the public sector. We are quite certain that at the ministerial level any discrimination between the private and the

public sectors is unthinkable. We cannot, however, be certain that unless strict control is observed at the ministerial level or by some other high authorities, the administrative staff in charge of the transport or supply of the raw materials, particularly coking coal, may not exercise some discrimination between the two sectors. They may naturally imagine that their primary duty is to enable the Government projects to function before those in the private sector. Some public assurance, therefore, that continuous priority will be given in respect of this matter to meet regularly the requirements of the private sector, both for stock piling and normal use, is highly desirable if the two producers in the private sector are to meet punctually their obligations in respect of the heavy foreign loans contracted by them to finance their extensions.

EMPLOYEES WELFARE AND EMOLUMENTS

In previous years we did not think it necessary to give an account of the wages and other emoluments of our employees and of the many amenities provided by us. But all those employed in industries in whatever capacity have in recent years attained what is now described as the status of partners in the fortunes of the industry concerned. It is desirable, therefore, that I should place before you briefly what we have so far done and plan to do in the future, as well as give you some idea of their wages and other emoluments and the amenities provided for them.

From past experience and statistics it is found that whenever an increase in wages has been given, the prices of food and other commodities have moved up almost simultaneously to the extent of 80% of the rise and in order to combat this evil we firmly believe in providing permanent benefit by increasing amenities for employees. It will perhaps be of interest if I give an indication of the lines on which we are progressing. We have always taken pride in the medical facilities that are made available free of cost to our entire staff and workers and to their families. These facilities are now being enlarged by the considerable extensions that are being made to the hospitals at Burnpur and Gua where an augmented staff of medical specialists and general practitioners are equipped to give the fullest and most careful attention to all cases that may arise.

With the expansion of the Gua Ore Mines we have been able to plan on up-to-date and enlightened lines a model township which will provide an improved standard of living accommodation for all classes of workers. This position applies equally in the case of Burnpur where a large area of land adjacent to the steel works has been acquired for construction of a new township of the most modern design to provide more accommodation and amenities for our workers.

At Burnpur also, enlarged training facilities are being provided which will include four hostels for the accommodation of those undergoing instruction for their future positions as artisans and supervisors; a new cinema has been built to provide film shows at concessional rates and plans have been drawn up for the construction of a building to form the headquarters of a social and welfare centre called the Mahila Mangal Sabha for all the womenfolk of the station. We are now building a large and modern canteen in the works for the workers in place of the older ones and at Kulti have a large construction programme for additional housing for the workers, of which much has already been completed.

We have up to March 1957 already spent large sums on the town including housing and the provision of many amenities. Our present programme which I have just explained involves an immediate expenditure in the region of one and a half crores of rupees and will be followed by further developments and expenditure in accordance with our plans for the progressive improvement of the standard of living of all employees. This is a matter to which I personally attach great importance. In order that shareholders may have knowledge of what is being done, I have had a small booklet prepared showing the designs of some of the amenities for issue to shareholders with the print of this speech.

EMOLUMENTS

We have given a great deal of thought to building up the structure of the wages and other emoluments of our employees on lines which on the whole have been generally acceptable to them. The total emoluments take the form of monthly cash payments or deferred payments and the provision of various kinds of amenities. The principal items constituting the total earnings or emoluments include a basic daily or monthly wage, a dearness allowance, free housing or grant of rent allowance in lieu thereof, a production or incentive bonus, a profit sharing bonus, Provident Fund benefits, leave allowances of various kinds, free medical service for all employees and their families and free or aided educational and training facilities.

It is not possible for me in a speech such as this to enter into any great detail, and I must therefore restrict myself to giving you in outline the position for the year 1956—57 in regard to remuneration as it concerns

our entire Burnpur staff who are members of the Labour Union. Our First Staff, who form but a small percentage of the total number of employees and occupy the higher technical managerial and administrative jobs are not members of the Labour Union and therefore nothing that I say now will have any application to them.

The largest proportion of our employees are unskilled or semiskilled workers on daily wages as distinct from the monthly paid workers who are mostly skilled men employed in the productive departments. The wages rates in both cases vary from department to department according to the nature of the work done and the ability of the worker. The semiskilled and skilled workers naturally get higher wages and have higher earnings than the unskilled. The minimum daily wage varies between Rs. 1.00 and Rs. 1.94 per day according to the department concerned. At the former figure the total earnings, comprising basic wages, dearness allowance, quarters allowance and production bonus only, ranged between Rs. 73 and Rs. 90 per month again according to the department concerned. At the latter figure of Rs. 1.94 per day, the total earnings were Rs. 132 per month. The maximum departmental daily wage varies between Rs. 2.87 and Rs 7.37 per day, the total monthly earnings aggregating Rs. 176 and Rs. 463 respectively, which latter amount was the maximum a daily rated worker in the Melting Shop earned.

In the case of the monthly paid workers the basic salaries vary similarly from department to department. The minimum basic salary is Rs. 60 per month, the total earnings in such case ranging between Rs. 144 and Rs. 183 per month, while the maximum basic salary is Rs. 460 per month resulting in total earnings of Rs. 1,042 per month.

In the case of most of the employees in question there is provision for the granting of annual increments.

Taking all the factors into account, I think you will agree that we are giving our employees emoluments, amenities and opportunities for advancement that compare favourably with other similar major organisations.

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TATA LOCOMOTIVE AND ENGINEERING COMPANY LIMITED

Speech of the Chairman, Mr. J. R. D. Tata

The following is the text of the speech of the Chairman, Mr. J. R. D. Tata delivered at the Annual General Meeting of the shareholders of the Company.

Ladies and Gentlemen,

As you will have seen from the Directors' Report, the Company has made excellent progress during the year in all its activities. The programme of production has been achieved, construction has proceeded apace, and efficiency is increasing steadily. The all round progress made and the satisfactory profits earned during the year have enabled your Directors to recommend an increase in the dividend to 8%.

2. While it may reasonably be expected that, as the projects on which substantial capital expenditure has been and is being incurred come into operation, the Company's earnings will progressively increase, so will its financial needs. In fact, the provision of adequate funds to finance our growing operations is today one of our main problems By the nature of the industries in which we are engaged and the circumstances peculiar to this country in the matter of essential supplies and bought-out items, it is necessary for us to maintain substantial stocks of raw materials and bought-out components. This locks up large funds as can be seen from the considerable amount of borrowings shown in the balance sheet. In addition, we still have a large amount of capital expenditure to incur in the next few years as we proceed with our current manufacturing and expansion programmes Although, in the long run, the funds provided from year to year out of allocations to depreciation and various reserves will substantially cover the total amount of capital expenditure so incurred, the heavy commitments during this year and the next make it necessary for us to raise additional finance in the very near future. While no decision has as yet been made, the possibility of an additional issue of equity shares, possibly in the form of debentures convertible into ordinary shares cannot be ruled out. I shall not say more at this stage than to assure you that the Directors are fully conscious of the long period the shareholders have had to wait for a return on their original investment and of the fact that even at the increased rate of dividend paid this year, the average return over the whole period is still much below what they are entitled to expect. Any proposal therefore that the Directors may put forward later will bear in mind the shareholders' legitimate claims for an adequate return on their investment from the time the new funds are provided.

3. As mentioned in the report, the output of locomotives and boilers has exceeded targets by 30%. There has been some improvement in efficiency, which, together with a concerted drive to utilise surplus capacity available in some of the sections for outside jobs has resulted in a lowering of costs. The progress of construction work on the expansion project has been satisfactory and the Company's commitments to deliver locomotives at the rate of 100 complete units per year from the beginning of 1958 will be fulfilled and possibly improved upon. With the increase in output, further improvement in efficiency and fuller utilisation of available capacity, it is expected that costs will come down to a satisfactory level despite the recent steep increase in the cost of steel and the upward trend of the costs of other materials and wages.

4. With the gradual contraction of steam locomotive building capacity throughout the world in line with the disappearing demand for such locomotives, the downward trend of prices on the world market, which had reached an unrealistically low level, seems to have been checked. In fact, with the exception of countries, which give direct or indirect subsidies for their exports of locomotives and boilers, an upward trend is visible. This has further narrowed the gap between the prices of the Company's products and those, exclusive of subsidies, of similar imported products.

5. In my speech last year, I had referred to the trend in other countries towards the conversion from steam traction to diesel and / or electric traction. Today, there are virtually only two large railway systems in the world which still purchase new steam locomotives, India's being one of them. Here, as elsewhere, a gradual but inevitable movement towards the "dieselisation" of rail transport is taking shape, retarded only by financial and foreign exchange considerations. As and when oil in adequate quantities is discovered within the country, the process is bound to be accelerated. As mentioned in my speech last year, our works are exceptionally well equipped to undertake the manufacture of diesel locomotives. The Railway Board have recently issued enquiries for a fairly substantial number of such locomotives and we propose to respond to this enquiry in collaboration with our technical associates, Messrs. Krauss-Maffei A.G., and Messrs. Daimler-Benz A G. We are in this regard fortunate in our association with both these firms, for Krauss-Maffei are leaders in the field of main line diesel hydraulic locomotives, while the Daimler-Benz range of high efficiency diesel engines are ideally suited to rail traction. If our expectations fructify, we can look forward to a long period of continued collaboration with, and service to, the Indian Railways, even after the cessation of steam locomotive manufacture.

6. The Automobile Division has kept to schedule in its programme of indigenous manufacture despite several adverse factors including shortages of steel, transport difficulties, congestion at docks and delays in the receipt of machinery and materials.

7. The automobile industry was the subject of a price enquiry by the Tariff Commission who submitted their recommendations at the end of 1956. Since then we have made considerable progress. We are today nearing the end of the second stage of development strictly according to schedule and, despite the many complicated problems affecting supplies and operations, we are confident that our manufacturing programme will be maintained.

8. The Tata-Mercedes-Benz commercial vehicles continue to enjoy the popularity and dominant position in the market which their quality and performance has deservedly earned for them, and we have no doubt of their ability to withstand any competition they may have to face.

9. The unexpected situation created by the heavy drain on the country's foreign exchange resources has been a source of anxiety to your Directors during the year. I am glad to say, however, that the Government of India have recently informed the Company that its reasonable requirements of foreign exchange for plant and equipment to implement its approved manufacturing programme will be sanctioned. We are grateful to Government for this decision. It will enable us to proceed rapidly with our plans and complete them according to schedule by the end of 1959 when we expect to be in a position to produce almost entirely Indian-made diesel truck and bus chassis in the Automobile Division.

10. When our present development programme is completed, we shall be saving through indigenous production of truck and bus chassis a larger amount of foreign exchange each year than the aggregate amount of foreign exchange spent for the purchase of plant, machinery and equipment for the Automobile Division.

11. On the recommendation of the Tariff Commission, the Government of India have decided to leave the automobile manufacturers in the country a reasonably free hand to fix their prices within the overall limits of a return of 10% on cost, subject to general supervision and check by the Government of India. We welcome this decision which will go a long way towards providing an effective incentive for the rapid development of the industry.

12. The Tariff Commission have observed that in the automobile industry the first priority should be accorded to commercial vehicles. The annual requirements of commercial vehicles are expected to be as high as 40,000 by the year 1960—61. Further, from the strategic point of view, the speedy attainment of self-sufficiency is of far greater importance in the case of commercial vehicles than in the case of passenger cars. The Tariff Commission have further advocated the manufacture of diesel vehicles in preference to petrol driven vehicles. In conformity with this view, we have submitted to Government a scheme framed in consultation with our technical associates for doubling once again the capacity of our Automobile Division and bringing it up to 12,000 vehicles per year. The Government of India have informed the Company that the scheme will find acceptance provided suitable credit arrangements can be made to stretch out the foreign exchange expenditure over a period of years.

13. While we are anxious to collaborate with Government to expand output of trucks and buses, we trust that the Government of India will in due course enable us also to diversify the output of our Automobile Division by the manufacture of other types of vehicles within the range of output of our technical associates, Messrs. Daimler-Benz A. G., such as light commercial vehicles, cars and diesel engines for various uses. Such diversification will promote more intensive use of our available capacity and experience. It will promote efficiency and reduce costs. The best warranty that we can offer to Government for the fulfilment of these objectives in due time is our actual performance in the fulfilment of the initial programme of manufacture of trucks and buses on which we are now engaged.

14. On the recommendation of the Tariff Commission, the Government of India have decided to grant protection to the automobile industry for a period of ten years. Our present manufacturing programme will have been completed long before the end of this period. We hope also, before that time, to be well on the way to completing the proposed plans for expansion as well as diversification. In effect, it is our intention to build up in this country, as rapidly as circumstances and the authorities concerned will permit, a self-contained and highly efficient automobile industry.

15. We have also taken steps to implement other recommendations of the Tariff Commission, so far as they relate to us, amongst which is the extension of hire-purchase facilities, with the collaboration of our bankers and insurers, to the buyers of Tata-Mercedes-Benz vehicles.

16. The construction of the steel foundry is almost complete. Since the close of the year some of the sections have commenced work and this department will be in full operation by the end of this year. This foundry is unquestionably the most up-to-date in the country and with the growing importance of the part played by steel castings in the engineering industry, it will be the source of a substantial accretion of strength to our Company.

17. In view of the increase in the output of the Automobile Division and the further expansion now proposed, the plans for the alloy iron foundry were revised early in the year to take care of the additional requirements of castings and include provision for further expansion in future. This revision involved some initial delay, but subsequent progress has been rapid. The construction of all buildings is virtually completed. Orders for all the necessary equipment have been placed and plant and equipment has started to arrive at the Works. Production of castings for the Automobile Division is expected to meet the requirements of the approved manufacturing programme.

18. The coming into operation of the Foundries Division will result in significant economies not only through the reduction in the cost of the castings, but also through the elimination of the costly hold-ups and loss of productive time, through delays in delivery and defects in the quality of castings, which constituted one of the most serious problems encountered by the Company in the past.

19. It is disappointing to note that, whereas in the preceding two or three years there were hopeful signs of a growing sense of responsibility and discipline on the part of our workers, there has been in the year under review a tendency on the part of certain sections of workmen to take matters in their own hands in preference to following proper constitutional methods for representing their views and grievances. Our men are amongst the highest paid in the engineering industry. They enjoy excellent conditions of work in a fine integrated factory equipped with the best machinery and equipment to which we are continuously adding. The Company has done and will continue to do all it can to provide, in addition to more than fair wages, a high standard of such amenities as housing, medical benefits, training and the like. The capital investment per employee in our Company is probably the largest in the industry. Our employees have a fine and safe future before them, but it is time they realised that the Company's continued ability to pay high wages and provide the maximum of amenities and job security depends on high productivity which, in turn requires that the workers put in a reasonable day's work.

20. Although some progress has been made, we are not satisfied with our present standards of productivity which, in the case of the Locomotive Division, have been criticised in the past by the Tariff Commission as comparing unfavourably with those at Chittaranjan. We are pursuing our efforts to achieve a satisfactory labour output but these will be in vain unless our employees and their Union co-operate with us. I am sorry that such co-operation has shown signs of weakening in recent months rather than the opposite, and I particularly regret that, in spite of its responsible and mature leadership, the Union has recently aggravated the lack of discipline by instigating the workers to down tools for a few hours in each shift mainly, it seems, as a protest against their not having been consulted in regard to the quantum of bonus declared this year. This action was, I feel, particularly unfair as the figure of bonus proposed to be declared was in fact disclosed to the Union sometime before the publication of the Report and Accounts and the total amount distributed is twice that of last year and proportionately much in excess of the corresponding increase in dividends.

21. It does not seem to have been realised that our progress in the last year or two and the improvement in our profits have been due largely to the support both in the form of technical assistance and the sustained supply of high quality components which we have received from our foreign associates. As our manufacturing programme develops and an increasing proportion of the contents of our products are made in our own Works, our results will depend increasingly on the work and productivity of our own men. Nothing could bring greater benefit to them as well as to the Company and its shareholders than a sound and cordial relationship between Management and Labour based on mutual understanding, respect and co-operation. I sincerely hope, therefore, that our workers and their Union with both of whom we are anxious to maintain the most cordial relations, view of the situation and will cooperate with the Management in their own long-range interests as well as those of the nation.

22. The Company's Apprentice Training Scheme, which attracted the favourable attention of the Tariff Commission, continues to make satisfactory progress.

23. The arrangements with our technical associates for imparting higher practical training in their factories abroad to the Company's personnel have yielded very satisfactory results. A large number of our Indian technicians have received invaluable training and experience.

24. We attach the greatest importance to the efficient recruitment and training of young engineers which we consider as a vital part of our programme of development. We are trying to make every young man who comes to us feel he is well looked after, his worth recognised and every chance given to him to equip himself, at our expense, for a successful, imaginative and rewarding career.

25. One of your Directors, Mr. Y. N. Sukthankar, has been elevated recently to the high office of Governor of Orissa and has resigned from the Board of Directors of the Company. In felicitating him on behalf of the shareholders, the management and staff of the Company, I wish to record the keen appreciation of your Directors for the valuable services rendered by Mr. Sukthankar to the Company during the period he held office as one of the Directors.

26. I am sure you would like to join me also in expressing our appreciation of the valuable services rendered to the Company by your Director, Mr. V. T. Dehejia, who retires today and has informed the Company that he does not wish to seek reappointment.

27. Dr. Heinrich Korschan who had been the General Manager of your Company since October 1951 retired at the end of April 1957, for reasons of health. His tenure as General Manager of the Company was marked by very rapid and extensive developments in the various activities of the Company. On your behalf and that of the Directors and the management, I would like to record our appreciation of the valuable services rendered by him as General Manager of the Company.

28. I would like also to record thanks and appreciation, on your behalf and on behalf of the Directors and management of the Company, of the very valuable advice and assistance given to the Company by Mr. F. G. S. Martin who has been associated with the Company almost since its inception. As Technical Adviser of the Company in London, Mr. Martin has been intimately concerned with the operations as well as the development programmes of the Locomotive and Foundries Divisions of the Company. Despite personal inconvenience, Mr. Martin has readily acceded to the management's request to take over again temporarily the responsibilities of the post of General Manager on the retirement of Dr. Korschan. By the

(Continued on page 132)

ALL ABOUT STANDARDS

CODE OF PRACTICE FOR USE OF COLD FORMED LIGHT GAUGE STEEL STRUCTURAL MEMBERS IN GENERAL BUILDING CONSTRUCTION

THE Indian Standards Institution has issued for comments draft Indian Standard Code of Practice for Use of Cold Formed Light Gauge Steel Structural Members in General Building Construction. This standard lays down the provisions as are of special application to constructions using light gauge steel structural members and is complementary to IS : 800—1956 Code of Practice for Use of Structural Steel in General Building Construction.

Cold formed, light gauge steel structural members are—produced from strip or sheet steel less than 4.5 mm. (or 3/16 in.) thick. For repetitive mass production they are formed most economically by cold-rolling; while smaller quantities of special shapes are most economically produced on press-brakes. The latter process, with its great versatility of shape variation, makes this type of construction as adaptable to special requirements as reinforced concrete is in its field of use. Members are connected by spot, fillet, plug and slot welds, by screws, bolts, cold rivets and other special devices.

This type of construction is appropriate and economical under one or more of the following conditions :

a where moderate loads and spans make the thicker, hot-rolled shapes uneconomical (e. g. joists, purlins, girts, roof trusses, complete framing for one and two-storey residential, commercial and industrial structures ;

(b) where it is desired that load carrying members also provide useful surfaces (e. g. floor panels and roof decks, mostly installed without any shorting, and wall panels ;

(c) where sub-assemblies of such members can be prefabricated in the plant, reducing site erection to a minimum of simple operations (e. g. sub-assembly of panel framing up to 3×4 meters and more for structures listed in a) above, standardized, package shed-type utility buildings, etc.)

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EXTRUDED ROUND TUBE AND HOLLOW SECTIONS

The Indian Standards Institution has circulated for eliciting comments the draft Indian Standard Specification for Wrought Aluminium and Aluminium Alloys, Extruded Round Tube and Hollow Sections (for General Engineering Purposes).

This standard, which forms part of a comprehensive series of ten Indian Standards for Wrought Aluminium and Aluminium Alloys in various forms for general engineering purposes, covers the requirements of three grades of aluminium and ten aluminium alloys in the form of Extruded round tube and hollow sections. The standard is divided in two sections, Section I contains clauses on general requirements ; while Section II covers specific requirements, such as chemical composition, condition and mechanical properties applicable to each grade of the material.

Comments on this draft standard are invited by 13 November 1957 and all interested can obtain its copies from the Indian Standards Institution, 19 University Road, Delhi-8 or its branch offices at 40/40A Cawasji Patel Street, Fort, Bombay and P-11 Mission Row Extension, Calcutta and 23 Nungambakkam High Road, Madras—6.

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METHODS OF CHEMICAL ANALYSIS OF MANGANESE ORE

The Indian Standards Institution has circulated for eliciting comments, draft Indian Standard Methods of Chemical Analysis of Manganese Ore.

This standard specifies the methods of determination of moisture, silica, barium, manganese, manganese dioxide, iron, alumina, titanium oxide, phosphorus, sulphur, lead, copper and arsenic.

While preparing this draft due consideration has been given to the work being done on the international level and the facilities available in the country for analysis.

Comments are invited on this draft by 8 November 1957 and all interested parties can obtain its copies from the Indian Standards Institution, 19 University Road, Civil Lines, Delhi-8 or its Branch offices at 40/40A Cawasji Patel Street, Fort, Bombay-1, P-11 Mission Row Extension, Calcutta and 23 Nungambakkam High Road, Madras.

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CLASSIFICATION AND CODING OF COVERED ELECTRODES FOR METAL ARC WELDING

The Indian Standards Institution has published Indian Standard Classification and Coding of Covered Electrodes for Metal Arc Welding of Mild Steel and Low Alloy High-Tensile Steels (IS : 815—1956).

Classification of electrodes is meant to assist in specifying and selecting the correct electrodes. This

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end of the year, the post of the General Manager of your Company will be filled for the first time by an Indian officer who brings to it long and varied experience in the field of engineering.

In conclusion it is my privilege once again to express my thanks and those of my colleagues to all members of our staff, from the General Manager downwards, for the year's excellent work. Their initiative and the hard work they have put in have been principally responsible for the Company's progress reflected in the Report and Accounts before you.

standard prescribes a systematic classification of covered electrodes for welding of mild steel and of low Alloy high-tensile steels of welding quality. The use of a standard form of marking provides a direct indication of the characteristics of the electrode, while the Indian Standard coding provides a simple form of reference.

Due consideration has been given in the preparation of this standard to the trade practices followed in the country in this field.

Copies of the standard can be purchased at Rs. 2.00 from the Indian Standards Institution, 19 University Road, Civil Lines, Delhi-8, and also from ISI Branch Offices at 40 40A Cawasji Patel Street, Fort, Bombay; P-11 Mission Row Extension, Calcutta and 23 Nungambakkam High Road, Madras-6.

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REAGENT BOTTLES

The Indian Standards Institution has issued a Draft Indian Standard Specification for Reagent Bottles to all interests concerned to elicit comments.

This draft standard prescribes the requirements and methods of test for reagent bottles used for storing and stocking of pure chemicals. It is hoped that this standard will assist the consumers to procure reagent bottles of accepted quality.

The draft Standard deals with two types of reagent bottles, narrow mouthed and wide mouthed with any of the stoppers of the three types, namely, flat, dustproof and upright grip. It also lays down requirements in respect of capacity, material, pattern, dimensions, workmanship, finish, etc.

Copies of the draft Standard can be had from the ISI Office at 19, University Road, Delhi-8 as also from ISI Branch Offices at (i) 40 40A Cawasji Patel Street, Bombay-1, (ii) P-11 Mission Row extension, Calcutta, and (iii) 23, Nungambakkam High Road, Madras-6.

The ISI will entertain comments on this draft standard up to 12 November 1957.

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ANTI-CORROSIVE AND ANTI-FOULING PAINTS FOR SHIPS' BOTTOM

The Indian Standards Institution has circulated Draft Indian Standard Specifications on the following subjects for eliciting comments from all interests concerned:

(i) Anti-Corrosive Paint, Brushing, for Ships' Bottom and Hulls, Red Chocolate or Black as required.

(ii) Anti-Fouling Paint, Brushing, for Ships' Bottoms and Hulls, Red or Black as Required, Type A & Type B.

Anti-corrosive and anti-fouling paints for ships' bottoms offered by the trade are of varying compositions. Government requirements of the material have all along been met by DGS&D Specification Nos. G/P 307 273 and G.P-307/274 respectively. But with the building up of naval vessels in the country, it has been felt that adequate and improved Indian Standards have to be prescribed covering both the requirements of performance and composition. The modern naval practice of making the boot-topping area of the hull with anti-corrosive paint followed by anti-fouling paint has been taken into consideration whereas the necessity of a separate boot-topping paint for ships' hulls, covered hitherto by DGS&D Specification No. G P-307 275, has been dropped.

The first draft standard prescribes the requirements and methods of test for the material commercially known as Anti-Corrosive Paint for Ships' Bottoms. The material is normally used as a primer over Ships' steel hulls and overpainted with a compatible anti-fouling finishing paint.

The second draft standard prescribes the requirements and methods of test for the material commercially known as Anti-fouling paint for Ships' Bottoms and Hulls. The material is used for the protection of ships' hulls including boot-topping area against the settling of marine fouling organisms. It shall be applied as a finishing coat on compatible anti-corrosive paint conforming to the draft standard on anti-corrosive paint.

The ISI will entertain comments on these draft standards up to 8 November 1957.

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GREASE S. No. 2

The Indian Standards Institution has recently issued Draft Indian Standard Specification for Grease, S. No. 2 to all interests concerned with a view to eliciting comments.

This standard prescribes the requirements such as consistency, drop point, evaporation loss, stability, resistance to mechanical breakdown, etc. It is hoped that the material conforming to this standard will be suitable for lubrication of high speed ball and roller bearings

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ENGINEERING NOTES & NEWS

EXHIBITS AT THE ENGINEERING, MARINE, WELDING AND NUCLEAR ENERGY EXHIBITION, 1957

Stand No. 2, Row W, Empire Hall, Olympia.

MANY new products of outstanding interest are shown on the stand of Murex Welding Processes Ltd., Waltham Cross, Herts. Among these are new welding electrodes, a new automatic welding machine, new welding transformers and new welding accessories. The exhibit of Murex welding electrodes covers more than 70 types for the welding of all classes of ferrous and non-ferrous metals and the welding equipments and accessories on view are representative of a very wide range.

NEW ELECTRODES

One of the most important of the new Murex electrodes is the new "Fastex 100" electrode which has been specially developed for the rapid welding of pipe joints in situ using the "stovepipe" or vertical downwards technique. An extremely fast deposition rate can be obtained with this electrode which produces smooth and regular welds with an absence of undercut. The slag is of the inflated type and is very easily removed. The "Fastex 100" electrode can also be used as a general purpose electrode for downhand, overhand and vertical welding using either the vertical downwards or upwards technique.

The "Fortrex 35A" electrode is another new and important Murex electrode. This electrode has been specially designed for the welding of the extra thick plate which is being increasingly used for nuclear energy vessels and similar applications. The main feature of this new electrode is that the weld metal provides extremely high impact properties throughout the whole section of the welded joint at sub-zero temperatures. The electrode also has all the advantages of the standard "Fortrex 35" type. It is an all position

(Continued from page 134)

The ISI will entertain comments on this draft standard up to 13 November 1957.

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BLEACHING POWDER, STABLE

The Indian Standards Institution has just published an Indian Standard Specification for Bleaching Powder, Stable (IS: 1065—1957)

The manufacture of stabilized bleaching powder has been started recently in this country even though the production of unstabilized bleaching powder was well-established after World War II. Unstabilized bleaching powder is covered by IS: 295-1951.

The Indian Standard Specification for Bleaching powder, Stable prescribes requirements for available chlorine, stability and method of manufacture. It is hoped that this standard will give impetus to the indigenous industry to manufacture stabilized bleaching powder of acceptable quality.

This Indian Standard has been prepared by the ISI's Heavy Chemicals (Inorganic) Sectional Committee under the Chairmanship of Shri Madhav B. Bhagvat of Tata Chemicals Ltd., Bombay with the assistance of representatives from various government and private interests.

electrode; it is simple to use, slag removal is easy and the radiographic quality of the weld metal is sound.

Since the last welding exhibition at Olympia, the Murex "Suprex" range of electrodes has been introduced. These electrodes are specially designed to produce welds of high radiographic quality in creep-resisting and low alloy steels and they can be used in all positions.

It is also of interest to note that certain types in the comprehensive range of Murex stainless steel electrodes have been modified to meet the latest requirements of nuclear fission and other high temperature requirements.

NEW AUTOMATIC EQUIPMENT

The new Murex "Muramatic" automatic arc welding equipment is of particular interest as it has been specially designed for use either with the open arc process using continuous coated electrodes or with the submerged arc process using powder flux.

The most important part of the equipment is the welding head which can be supplied either as a separate unit or it can be mounted on a self-propelled carriage. This carriage is designed to operate at speeds which are infinitely variable between 8 in. and 80 in. per minute and it has provision for free steering or running on tracks.

The equipment is designed for use with either A. C. or D. C. welding power supplies and it is suitable for use with welding currents of up to 1200 amps. All the operator's controls are conveniently grouped in a small cabinet close to the welding head and they include a multi-purpose instrument for checking the arc volts and welding current and also facilities for remote control. A main control box is also provided and this neatly houses the necessary relays, contactors and timing devices etc.

The "Muramatic" equipment can also be supplied with a separate power pack consisting essentially of a Murex transformer for A. C. welding or a Murex "Dynex" generator for D. C. welding. The current is infinitely adjustable within the range of the equipment in all cases. Other types of ancilliary apparatus such as gantries, tracks, positioners, jigs and flux recovery units can be supplied with the equipment.

NEW WELDING TRANSFORMERS

The Murex Type 210 single operator self-contained air-cooled welding transformer is of an entirely new design and it is an ideal welding set for small engineering shops, garages and agricultural workshops. The current range is 20–210 amps. and adjustments are made by means of two self-locating switches on the top of the equipment. The housing of the set combines pleasing appearance with robust construction.

The latest version of the very popular Murex Type 330/S single operator transformer equipment is on view and this has a current range of 15—250 amps. for continuous hand welding and up to 330 amps. for intermittent work. The set is mobile and is completely self-contained. It is designed for connection to any standard voltage between 380 and 550 volts and similar Murex models are available with primary windings suitable for connection to any standard supply between 200 and 550 volts.

NEW MULTI-OPERATOR TRANSFORMERS

A new range of Murex multi-operator welding transformers has been introduced for 3, 6, 9, 12 and 15 operators at 250 amps. each; for 3, 6, 9, 12 and 15 operators at 350 amps. each; for 3, 6, 9 and 12 operators at 450 amps. each and for 3 and 6 operators at 600 amps. each. The primary windings are suitable for connection to 380/440 volt 3 phase 50 cycle supplies and all these new transformers comply with B. S. 638 : 1954 Part 4. The transformers are housed in boiler plate tanks with elliptical tube cooling. The model on the stand is suitable for 6 operators at 350 amps. per operator.

A new type of Murex regulator has also been introduced and the model on view is rated at 35–350 amps. for continuous hand welding and it is of the tapped type giving 49 current adjustments. It is calibrated for use with long leads and is housed in a round tank for ease of movement. Regulators for 250, 450 and 600 amps. are also available.

Other types of Murex multi-operator transformers are available complete with suitable regulators and power factor correcting capacitors, switch fuses, bus-bar chambers etc. can also be supplied

MOTOR GENERATOR ARC WELDING EQUIPMENT

All Murex rotary equipments now incorporate the highly successful Murex "Dynex" welding generator which by using a new and unique principle makes possible infinite current adjustment over a single current range. This adjustment can be carried out irrespective of the open circuit voltage which can also be infinitely adjusted within the range of the equipment. The single operator Murex motor generator equipment exhibited on the stand incorporates a 300/450 amp. "Dynex" generator and a 380/440 volt 3 phase 50 cycle squirrel cage motor. A voltage regulator, polarity change-over switch and motor starter are fitted as standard.

NEW ENGINE-DRIVEN EQUIPMENTS

Among the engine-driven equipments on the stand is the latest version of the Murex "Overlander" 300/400 amp. mobile diesel engine driven equipment which has been specially designed for oilfield pipeline and similar site work. The set is powered by a Perkins P4 industrial diesel engine coupled to a Murex "Dynex" generator and in addition to the excellent facilities which it offers for welding purposes, the equipment is mounted on a special "Flexitor" type undercarriage giving independent springing to each wheel. The centre of gravity of the equipment is exceptionally low, while the track and wheel base are relatively wide and thus great stability is provided for work carried out in rough terrain.

A new Murex stationary 300/400 amp. single-operator welding equipment powered by an Armstrong Siddeley 3 cylinder air cooled engine is on view. The set incorporates the "Dynex" generator and the equipment has the special advantage of not requiring a radiator and water cooling system thus eliminating the possibility of a freeze up in low temperatures. The diesel engine is air cooled and is amply rated for driving the generator at maximum current.

Another new Murex 300/400 amp. single operator equipment is driven by a Ford Type 592E industrial diesel engine and this set again incorporates the "Dynex" generator. Originally designed as a stationary equipment, it can now be supplied in a variety of forms for mobile work.

NEW ACCESSORIES

Among a number of new welding accessories on view are new Murex fibre welding helmets and hand-shields. The helmets have an automatic locking device to hold the helmet in the "up" position when required. The new hand-shields are a special light-weight type with shallow wings. New leather jackets on view include a chest length type for completely protecting the arms and shoulders of the welder and a waist length type for protection down to the hips.

Practical demonstrations of Murex electrodes are being given and the exhibits include displays of weld samples and welding literature.

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A NEW SLIDE RULE

Specially designed for calculating the flow of water through pipes and circular sewers as well as in open channels is a new slide rule which should prove of great use to all engineers engaged in hydraulic calculations. The slide rule has been designed by Mr. J. Tarrant, a London engineer.

In appearance much like the standard slide rule, this new version provides two distinct sets of calculations. One side of the rule is used for flow in pipes up to 100 in. in diameter with the water running full. Scales are provided for flow, diameter of pipe, head lost and length of pipe, and when any three of these factors are known, the fourth can be found rapidly with the minimum of calculation. There is also a scale for determining the velocity of flow.

By means of a set of proportional scales on the lower edge of the rule, the same information can be calculated for pipes and sewers running partly full and a scale is also provided for ordinary multiplication and division. Calculations on this side of the slide rule are based on the Hazen-Williams formula for flow of water in pipes.

The other side of the rule is used for calculations of flow in open channels. The scales on this side are for velocity, hydraulic radius, slope of channel and Kutter's constant "n". The hydraulic radius for channels bounded by straight lines can easily be determined, and for half round channels having a depth of flow up to half the diameter, the hydraulic radius and area of flow can be calculated in conjunction with a set of additional scales provided on the lower right hand part of the rule. The Manning formula is used for calculations on this side.

On both sides of the slide rule the scales are printed in black and in red, the former reading in cubic feet per second and the latter in metric units. The use of this new rule should help considerably to reduce the time spent in calculating special problems in pipe flow, such as branching pipes, parallel pipes and compound pipes.

Firm: The Paterson Engineering Company Ltd., Windsor House, Kingsway, London, W. C. 2, England.

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LABORATORY PUMP

From Britain comes a laboratory pump developed for use with highly corrosive chemicals. All parts which come into contact with the fluid being pumped are made from Fluon (polytetrafluoroethylene) which means that all known chemicals and solvents except fluorine and the molten alkali metals can safely be handled. Though the pump is basically designed for handling clear fluids, it can also function successfully with liquids which have solids in suspension so long as they are not by nature likely to silt up the convolutions of the bellows or prevent the valves operating.

The Crane Pump, as it is called, has been designed mainly for use in laboratories on short-term experiments, to provide highly corrosive liquids or gases at a predetermined pressure, or as a metering pump providing an infinitely variable flow over the delivery range. The pump is set to a predetermined pressure by a pressure-reducing valve in the air supply. As a metering unit, an accuracy of plus or minus two per cent. has been consistently maintained in test runs. It can also be used in a production plant where service conditions are light.

The pump is available in either single—or double-ended form; the single pump unit gives intermittent delivery, whereas the double unit will give almost continuous delivery. Overall dimensions are 17 in. by 10½ in. by 9 in. for the single-ended form, and 22 in. by 10½ in. by 9 in. for the double unit. Temperature range is between 4° and 80° and pressure range 0 to 30 lb. per sq. in. delivery.

Firm: Crane Packing Ltd., Slough, Buckinghamshire, England.

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DUST SAMPLER

An instrument which enables a close watch to be kept on the state of contamination of the air in coal mines, cement manufacturing plants and other industries where workers are likely to breathe in large amounts of dust is being marketed by a London firm. The equipment, officially certified safe for use underground was originally designed at Britain's Mining Research Establishment and gives a single sample collected over a period of eight hours of the average dustiness in mines and elsewhere.

The instrument collects dust by a combination of gravity settlement and thermal precipitation and consists of a sampling head, power supply components and a pump which draws air through the sampling head and blows it out again.

It is stated that only respirable dust is collected during the sampling process. The selection of the fraction is effected by drawing the dust through a horizontal duct, the action of which simulates that of the human nose and upper respiratory passages.

Firm: W. Ottway and Company Ltd., Orion Works, Northfield Avenue, Ealing, London, W. 13, England.

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FLOCKING MACHINE

To meet the increasing demand for semi—or fully-automatic flock processing of materials—to give a suede or velvety finish—a new range of equipment has been designed which uses high voltage electricity to deposit the flock fibres. It consists of a flock precipitation unit with optional additional units for adhesive application, flock recovery and drying.

The machine enables man-made fibres to be used for obtaining plain or patterned finishes on a variety of products ranging from greeting cards to cabinet linings. It is claimed that the superiority of the high-voltage method over compressed air flock spraying is marked by the production of a better pile and finish and by greater cleanliness and ease of control.

The flock precipitation unit consists basically of a reciprocating hopper and sieve mechanism carried on a framework, with a series of vibrating electrodes below. The hopper may be replenished without stopping the machine and the speed of the hopper and frequency of electrode vibrations may be adjusted to suit the requirements of the material to be coated. A generator provides the static charge which causes the flock to be precipitated in an end-on fashion.

Automatic operation is governed by controls which can be set to regulate the amount of flock deposited, the intensity of the flocking and the speed of the vibrating sieve. A recovery unit, available additionally with the machine, enables surplus flock to be collected into containers and returned to the machine's hopper. Infra-red drying cabinets are provided in the same width as the other units.

The machine available in units giving flock-finished widths of 18, 36, 54 or 62 in. will process lengths up to 1½ yds. over their full width in about one minute.

Firm: Hivolt Ltd., 91—93, Princedale Road, London, W. 11, England.

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LINEAR ACCELERATOR

From the Mullard organisation comes a 4 MeV (million electron-volts) electron linear accelerator for the rapid and economic irradiation of plastics and rubbers. Irradiation of long-chain polymer plastics and other materials results in greatly increased resistance to heat and acids, and an increase in the elastic modulus of the material above its normal melting point. Furthermore, apart from the treatment of finished materials or articles, irradiation techniques can also be used to initiate polymerisation reactions. Advantages of the irradiation method in this respect are that temperatures can be reduced to normal room levels and pressures greatly reduced also.

Irradiated plastics have a much greater potential application than similar, untreated materials. Treated polyethylene, for example, can be use satisfactorily in ambient temperatures up to 250°. This immediately suggests its use for bottles and other containers which require sterilisation in boiling water. Another obvious use is in the electrical and electronic industries, where irradiated polyethylene is used as a wire sleeving or high-temperature insulation. Damage due to excess current flow or careless use of a soldering iron is thus eliminated.

In vulcanising natural rubber the conventional methods used to achieve the required molecular cross linking involves additives such as sulphur, and the application of heat. Precisely the same effects can be achieved, without the use of heat or additives by electron irradiation. Moreover, if a specimen of rubber is irradiated under tension it will retain its original directional orientation. Thus a single specimen may be invested with two distinct properties; one parallel and one perpendicular to the direction of stretch. Certain types of silicone rubber also benefit considerably from this form of treatment. Again no heat or additives are required, and the need to remove harmful by-products, which arise through conventional curing, is obviated.

The Mullard linear accelerator is highly versatile, simple to operate, giving high reliability, and is suitable for most routine applications. Because of its compact nature, installation problems and building requirements are minimised. The steel-cased accelerator unit is a standard item, and for industrial electron, irradiation or laboratory applications, can be carried together with its associated vacuum equipment in vertical or horizontal mountings. For therapeutic and industrial radiography purposes the accelerator and vacuum equipment can be mounted on gantries.

Radio frequency power is supplied by a pulsed magnetron, which is driven by a standard high-power pulse modulator. The accelerator can be designed for any selected beam energy in the range 2–5 MeV.

Firm: Mullard Ltd., Torrington Place, London, W. C. 1, England.

EXPANSION OF STEEL INDUSTRY

According to a report, Australia's steel industry would soon have an output capacity of 3,000,000 ingot tons a year. It may be mentioned that in 1951, Australia was producing only 1,400,000 tons of steel but in 1956 with capacity of 2,400,000 tons production was 2,300,000 tons and in the latest three months production period that year, output had reached a rate of 2,800,000 tons a year. Australia ranks 16th in the world as a producer of steel and third in the British Commonwealth behind Britain and Canada. With an installed capacity approaching 3,000,000 tons a year, Australia had a per capita output of steel that placed it among the first seven countries in the world.

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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