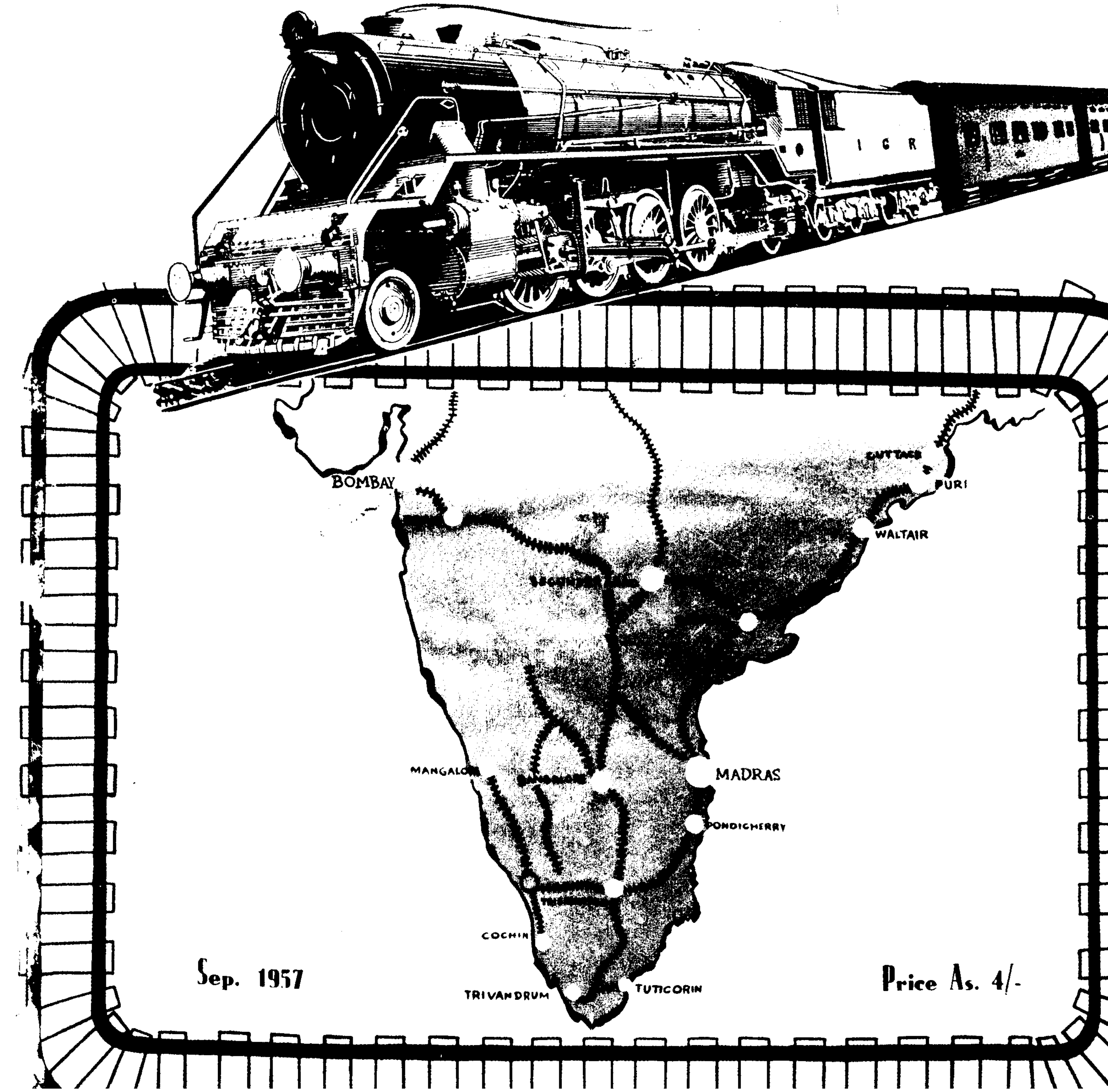
SOUTHERN RAILWAYS *Magazine*



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192230

(Inserted in the interests of Travelling Public)

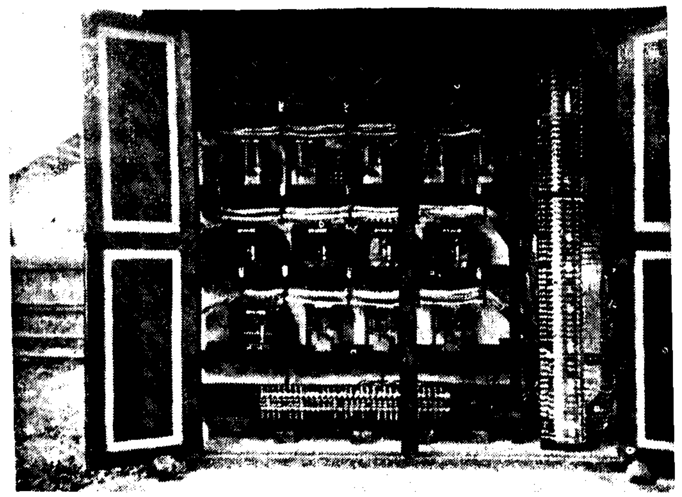
Cables and Connections for Railway Signalling and Interlocking Circuits

By H. C. Towers, M.I.E.E., M.I.R.S.E., M.Inst.T.

FOREWORD

IN the early days of railways the only electrical appliance concerned with train operation was the telegraph the use of which was initiated by the Great Western Railway in 1837 following successful experiments by the inventors, Cooke and Wheatstone. Later, electrical indicators of various types were introduced for performing a number of functions to assist train working. These appliances did not require many wires and an earth return was used as part of the circuit. No particular form of wiring was necessary and the quantity involved was small. The commencement of the present century saw the inauguration of power signalling in this country. Rapid progress was made with this form of signalling with the construction of the Piccadilly, Bakerloo and Kampstead lines of the then London Electric Railway and the electrification of the District line. The new signalling required a large number of wires for connecting the apparatus as compared with earlier telegraph circuits. During fifty years of development the quantity of electrical equipment and the number of wires has increased enormously. The present day demands are for quickly detachable, plug in apparatus and pre-wired relay racks and similar facilities.

The first power signalling installations constructed in the United Kingdom favoured the placing of relays and fuses in polished wooden cases. Those containing relays sometimes had glass doors of the lift out type. Except for very large installations, the fuses were generally mounted at the bottom of the relay cabinet this portion of the door having wooden panels. The incoming cables were brought into the basement of the signal box, where the electrical apparatus was usually housed, in wooden troughing or trunking. The cores were stripped of the outer insulation and protective sheath at the point where the relay cabinet was entered, taped, and run in smaller trunking, or treed, to the fuses. The wires were attached to the fuse bases by O or 1BA termina and fed through a hole in the mounting board into the main run. In nearly all these early installations it was the practice to hide the wiring out of sight but it may be assumed that the policy then was to secure its protection rather than to conceal it from view.



Relay and terminal cubicle constructed in brick and asbestos as used on Western Railway, Bombay section, India.

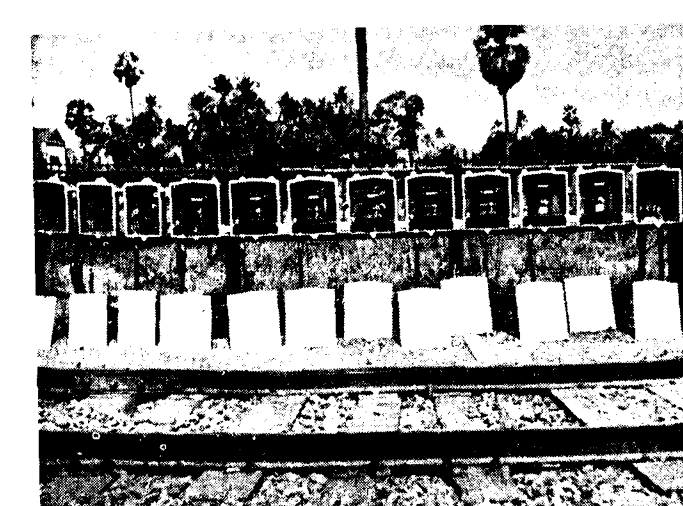
The cables were mostly run underground or through ducts the method depending on the locality and the nature of the ground to be negotiated. Some railways used wooden trunking of substantial section, mounted on short posts. Single wires were run inside the trunking. Other railways ran cored cable direct from the fuse case in the signal box to the function out on the track. For example, a power operated signal might require five wires for the operation and indication circuits. These would be run in a five core cable from the fuses direct to the signal post. If it was necessary to loop the cable through a point detection box it would be taken down to the permanent way and back again. Intermediate disconnection boxes were not considered then and often connections were made outside the signal box by means of plumbed joints. Cable faults were frequent particularly in damp places.

The year 1923 marked the commencement of the various extensions and modernisation of the London Transport Railways and this period initiated a new era in power signalling and the introduction of more modern methods in cabling and wiring. In early power installations, where a signal read over a pair of facing points, it had to detect that those points were correctly set and locked before it could show " Proceed ". This was accomplished by taking the signal control circuit through a contact box fixed to the point sleepers which

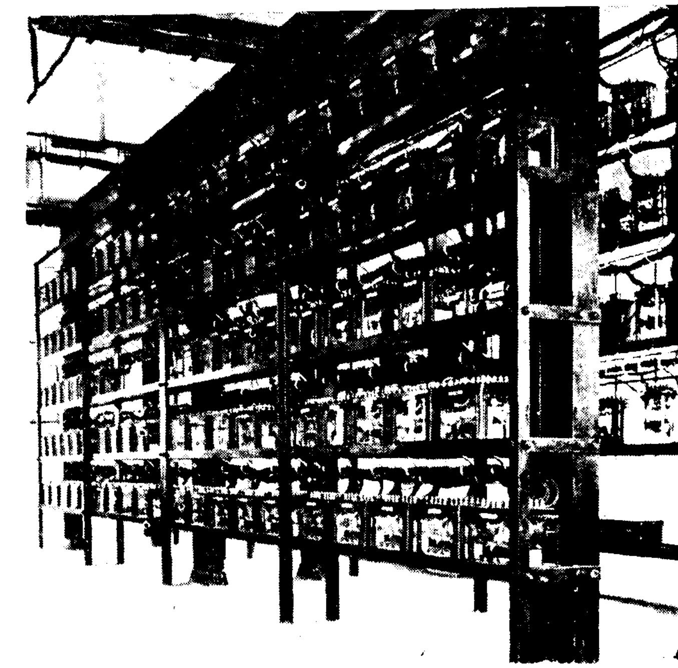
opened and closed contacts according to the position of the points. The practice of breaking the signal control cable for this purpose was not a good one and it introduced the possibility of failures and cable faults. The point detector was therefore made to operate a point detector relay in the signal cabin, the relay working on a polarised circuit being energised one way when the points were normal and the other when the points were reverse. The detection of the points by the signals was then carried out inside the signal cabin, with internal wiring, the signal control cable running direct to the signal. This principle of repeating functions out on the track by relays in the signal box and running cables direct to the apparatus they operate was introduced as general practice.

MULTI CORE CABLES

Although some railways prefer to use a separate cable for each point or signal, the general practice today is for all circuits to enter and leave the signal box in main cables which are looped into location cases at convenient situations along the cable route. The number of cores in a cable are usually kept to a standard number in order to avoid having a large number of cables of different sizes. For example, the smallest cable may be a 5 core and the largest 61 cores with intermediate sizes of 12 core, 10 core, 27 core, 37 core and 48 cores. The gauge of wire used is 0.064 or 0.044. Larger diameters are used in special cases while the size of the signal main supply cable varies proportionately with the load. The insulation and armouring of multi core cables is usually to the British Standards Specification or to the railways specification where some overseas installations are concerned.



Track and signal relay location using cast iron boxes. Western Railway, India.



Part of relay rack in basement of signal box at Bandra, Western Railway, India. A steel platform between the two racks gives access to the interior of the power frame.

These cables are manufactured for burying direct in the ground and this is what most railways require. This leaves the earthwork immediately adjacent to the permanent way free of obstruction and the cables are not liable to damage in case of derailment. Some railways prefer to have their cables above ground running them in cable brackets fixed to short posts, spaced four to six feet apart. Another method is to use railposts fifteen to twenty feet high and twenty feet or more apart. The cables are slung from a steel messenger wire stretched tautly between the posts and regulated at intervals by adjusting screws The signal supply main is generally run at the top of the poles consisting of two weather proofed insulated conductors spaced eight to ten inches apart by suitable insulators fixed to crossarms. The main signal cables are placed about three to four feet above formation level. This type of run is economical in some respect but unsightly in appearance.

When cables run on posts have to cross the tracks they are sometimes run into concrete troughing. This troughing is made in varying cross section and length and has a removable cover to permit inspection and for cleaning out the trough. Other fitments for concrete troughing include cornering, for changing direction, usually about 90 degrees and risers, for bringing the cable up from formation to cable run level. Concrete trunking is reinforced and strong enough to stand the

(Continued on page 13)

WORKSHOP FOR SMALL-SCALE INDUSTRIES TO BE SET UP IN DELHI

The Government of India have decided to set up a Prototype and Training Workshop for Small-Scale Industries, with financial and technical assistance from the Federal Republic of Germany.

The Workshop, which will be a multi-purpose project, will be set up close to the industrial estate at Okhla outside Delhi.

It will impart practical and theoretical training to workmen and technicians required to man small-scale industries as well as specialists to be attached to the Small Industries Service Institutes. These institutes have been set up by Government to provide technical guidance to small industries.

The Workshop will also develop special purpose machinery for the improvement of plant in small-scale enterprises and develop and build prototypes of machines, implements, components, etc. which are suitable for the use of small industries. The workshop may also execute job orders which cannot be carried out by small enterprises for some time to come.

In course of time, the prototype and training workshop will become a model for smaller training centres to be set up in different regions to meet the growing requirements of trained personnel for small industries.

This workshop will meet a long-felt need in the development of small industries in India because it will fulfil dual role of turning out skilled personnel and making prototypes of machines for small industries.

The German Government has offered to spend Rs. 50 lakhs on the project in the form of the plant and equipment required for the workshop and the services of a number of German experts for a period of three years. The rupee expenditure, to be met entirely by the Government of India, will be about Rs. 47 lakhs.

A delegation of Indian officials and experts is leaving for West Germany shortly where it will have discussions with representatives of the Federal Republic on the execution of the project. It will also visit German enterprises and study training methods followed at German Small Industries Training Centres.

The Delhi Prototype and Training Centre is expected to have a capacity to provide Training to 240 people. The different courses to be introduced will help to turn out 964 trainees every year.

EPOXY RESINS

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

THE epoxide resins which are available from CIBA under the name of 'Araldite' have, by reasons 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 its 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 coefficient 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 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

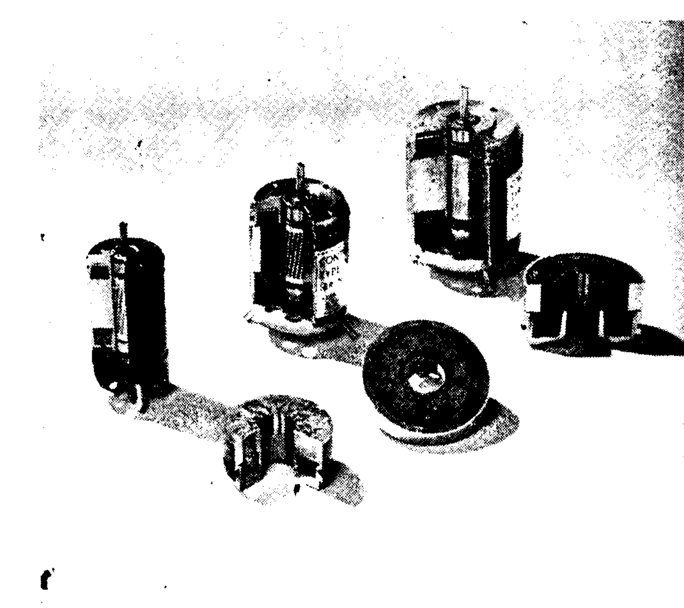


Fig. 1. Servo motors. Laminations bonded with 'Araldite' 15, potted in 'Araldite' casting resin B.
(By courtesy of Kearfott Co., U. S. A.)

eans of increasing the heat-conducting properties (see able 2) and considerably reducing the cost of the resin iix, as these fillers are usually cheap.

IIXING OF FILLERS

When fillers are being used they have the effect of aising the viscosity of the mixture, and with most fillers is the viscosity at pouring temperature which limits the mount of filler which may be added. The increase in iscosity means that there is a much greater possibility f any air which is entrapped in the mould being unable o escape, thus causing blow-holes in the final casting. n order to obviate this possibility, it is advisable to ubject 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.

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 ..	$9 \text{–} 10 \times 10^6$	$1.7 \text{–} 2.0 \times 10^6$

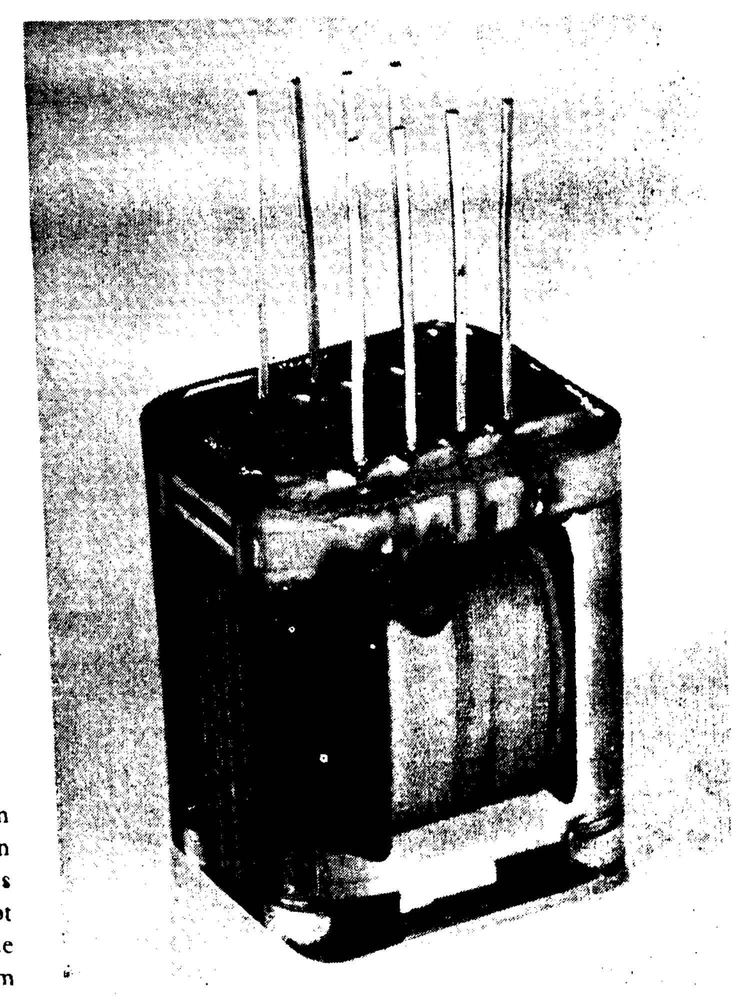


Fig. 2. Transformer potted in "Araldite" D. (By courtesy of Evershed & Vignoles Ltd.)

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.

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.

With a new mould it quite often happens that, when silicons 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.

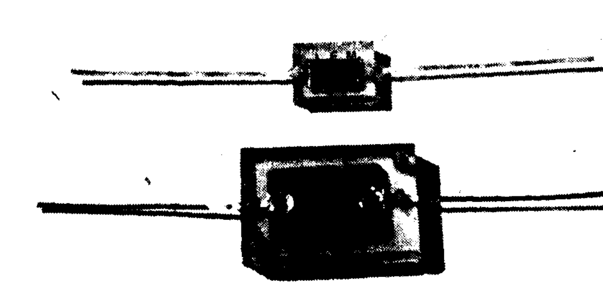


Fig. 3. Silver mica capacitors cast in "Araldite" casting resin "B" (By courtesy of London Electric Mfg. Co., Ltd.)

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.

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	$0.42–0.57 \times 10^6$	$0.64–0.78 \times 10^6$	$1.7–2.0 \times 10^6$	$2.1–2.6 \times 10^6$	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 ,, 0.008	—	approx. 0.54 ,, 0.036	approx. 0.73 ,, 0.036	kcal/m h °C. watts/ich²/°C.in.
Thermal coefficient of linear expansion	ASTM D696–44	$60–65 \times 10^{-6}$	60×10^{-6}	$30–35 \times 10^{-6}$	$25–30 \times 10^{-6}$	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 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 to the ceramic insulator and the electrial 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 the 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.

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 type D
2. Casting resin type 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 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 on 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

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

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 resins, 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.

(By courtesy : JOIE, Bombay.)

FIRST EXPORT OF INDIAN IRON ORE

Shri N. Kanungo, Minister for Commerce, Government of India is reported to have disclosed recently in the Parliament that India, for the first time in 1875–76 exported five tons of Indian iron ore valued at Rs. 100. As against this, total export of this ore last year amounted to 1.793 million tons.

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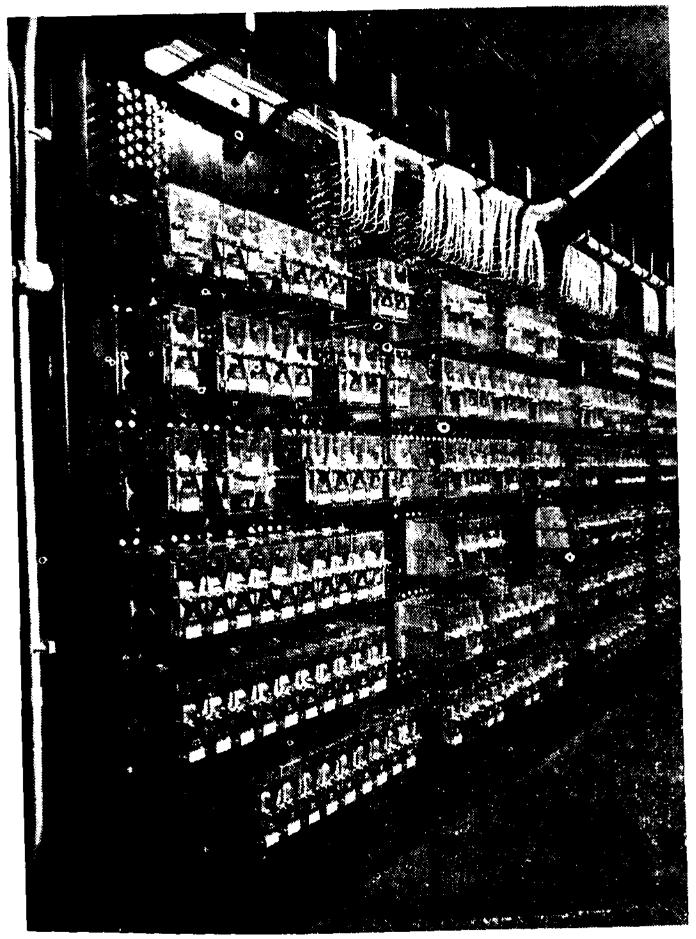
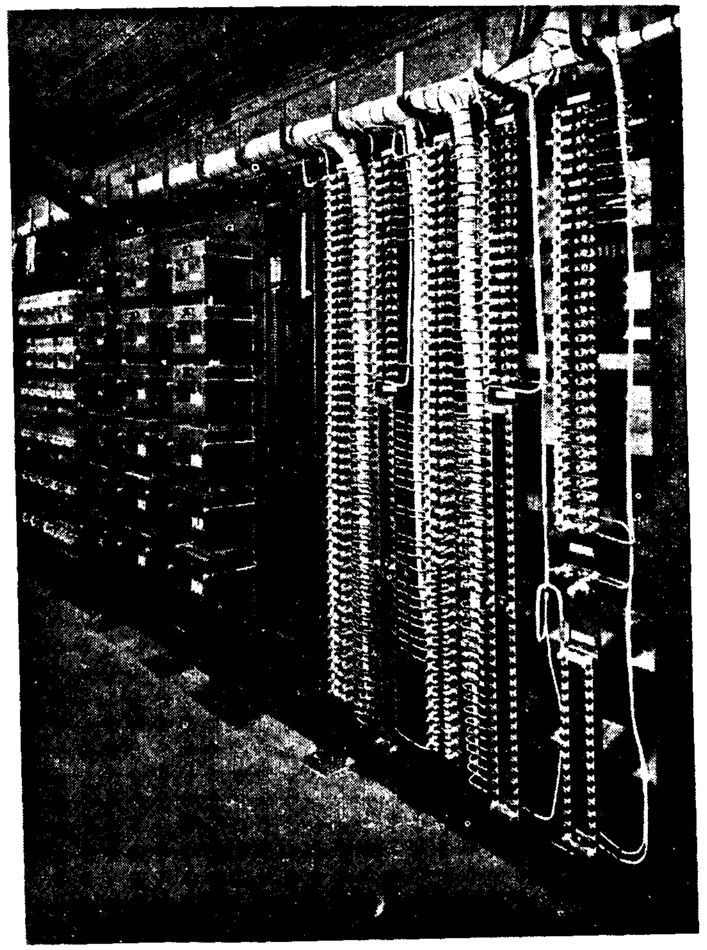
ordinary wear and tear of the permanent way. It is not affected by damp or termites the two chief reasons for not using wood.

LOCATIONS

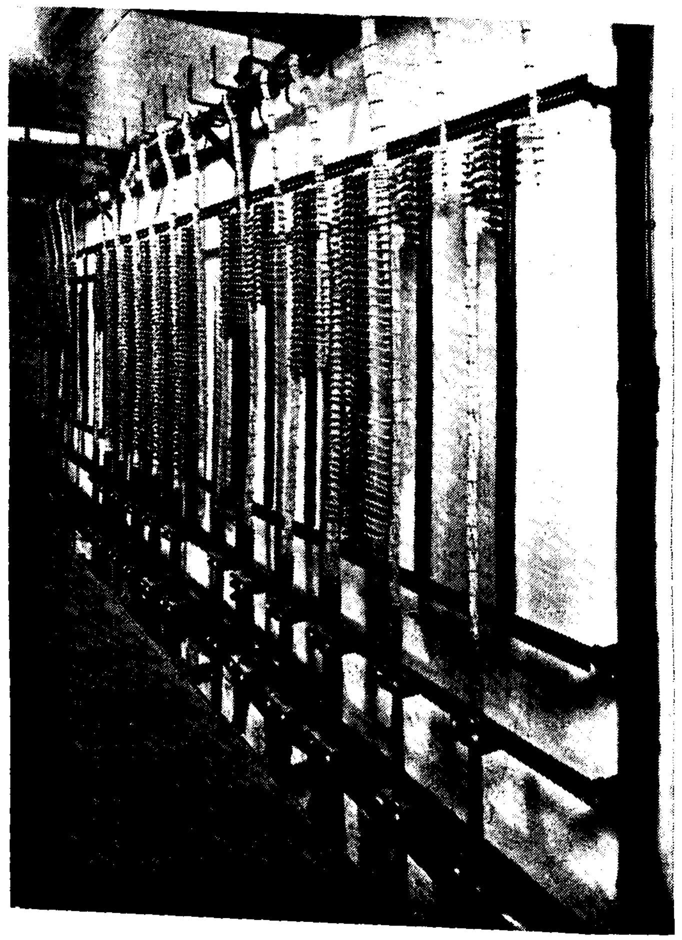
In most signalling schemes there are a number of track circuits situated too far from the signal box to have the track relay placed there. It is necessary to house the track relay at the track circuit and use a track repeater relay, operated by the track relay, in the signal box. In the case of railways with four or more tracks there may be quite a number of track relays to house at one place. In earlier works each relay was accommodated in its own individual cast iron case. The appearance of a number of these cases can be seen in the accompanying photograph. If the lids are not distinctly marked with the designation of their contents, the signal lineman may lose time when tracing a fault. A much more convenient arrangement is to place all the relays, fuses, etc. in a cubicle or location case. The railway on which the writer was Chief Signal Engineer used brick cubicles manufactured by the Signal Department staff. These brick cubicles had a corrugated asbestos roof and teakwood doors with asbestos panels. The cubicle was constructed on a substantial concrete base wide enough for staff to stand on when the doors were open. The corrugated roof was also large enough to extend over this space and thereby shelter the staff, and the apparatus, during heavy rain. This is not the case with individual, cast iron relay boxes which give no protection at all from rain once the cover is removed. The inside of the cubicle was fitted with a steel framework provided with shelves for supporting track relays and other equipment with a framework at one side for the fuse bases, terminal blocks etc. the cable terminations being made at this point. The wiring diagram of the location, position of fuses etc. was fixed inside one of the doors and suitably protected from damage. This form of construction was found very suitable for tropical climate for the combination of asbestos roofing and brick sides kept the apparatus cool. The over-



Rack of plug in relays in signal box relay room. (British Railways)



Fuse board and plug in relays in signal box relay room. (British Railways)



Cable termination board and terminal blocks in signal box relay room. (British Railways)

hanging roof also sheltered maintenance personnel from sun and rain in the monsoon season. The cost of these cubicles was much less than a steel location case.

There are instances where the signals at manually worked signal boxes were converted to multi-aspect colour light signals with track circuiting. The points continued to be worked manually by means of rodding. The basement of a mechanical signal box is not very suitable for accommodating electrical signalling equipment and in such case a small cubicle or relay room, of the same brick and asbestos construction, was built on the outside of one of the signal box walls.

Electrical developments in this country and overseas have made such progress in recent years that it is hardly possible to find a place where an electrical supply is not available. On overseas railways there are, however many stations where electrical signalling plants have to be powered from primary batteries. Some types of batteries require periodical cleaning and changing of the electrolyte. This work is best done outside the signal box basement and for this reason the same type of brick cubicle were used for battery accommodation and were very successful.

An alternative to the locally constructed brick cubicle is the sheet steel location case which is supplied in several sizes. These cases are fitted to an individual railway's requirements and can be used as cable junction points, distribution points and also accommodate relays, local transformers and rectifiers, batteries etc.

A location case is positioned close to a group of signals, points, track circuits or other functions. Separate cables are run from the location to the function but they all join the main cable terminating or looping into the case. For example, two 61 core cables run from the signal box to the first location case. Here wires have to be distributed to two multi-aspect signals, a pair of points and two track circuits requiring probably 17 wires in all. These were contained in one of the 61 core cables which continues to the next location case as a 48 core cable, the next standard size. The 17 wires are connected to the functions concerned by short lengths of 3, 5 or 7 core cable, as required. The connections to track circuits is by means of single wire and is of necessity of heavier section than the cable cores. Four wires are attached to the running rails, two at each end of the track circuit. These wires are subjected to heavy vibration and have to be flexible and heavily insulated. A 7/,029 wire is a fairly standard section and this is protected by insulation in accordance with the requirements of the British Standard Specification for signal cables. The single wires are run direct from the running rails to the terminals in the location case. The number and size of cables between location cases diminishes as the distance from the case to the signal box, increases. The first location case attached to the signal box, and farthest from it, may have only a 7 core cable running from it to the next case. Here the size of the cable running from the second to the third case changes from 7 core to 19 core and so on. The cables connecting the last location case, or cases, to the signal box, may be as many as five or six 61 core cables.

The number of cables cores terminating in a signal box relay room depends on the size of the installation and may be from several hundred to several thousand. The great increase in the number of wires has made original methods obsolete and at the present time the normal way is to terminate cables on to fuses or terminal blocks fixed to open racks. The racks are made of steel, fixed to the wall of the relay room, with the terminal blocks screwed to verticle steel strips.

The cables enter the relay room by means of an open trough at floor level. The cores are separated, taped and suitably finished and attached to the terminals on the blocks.

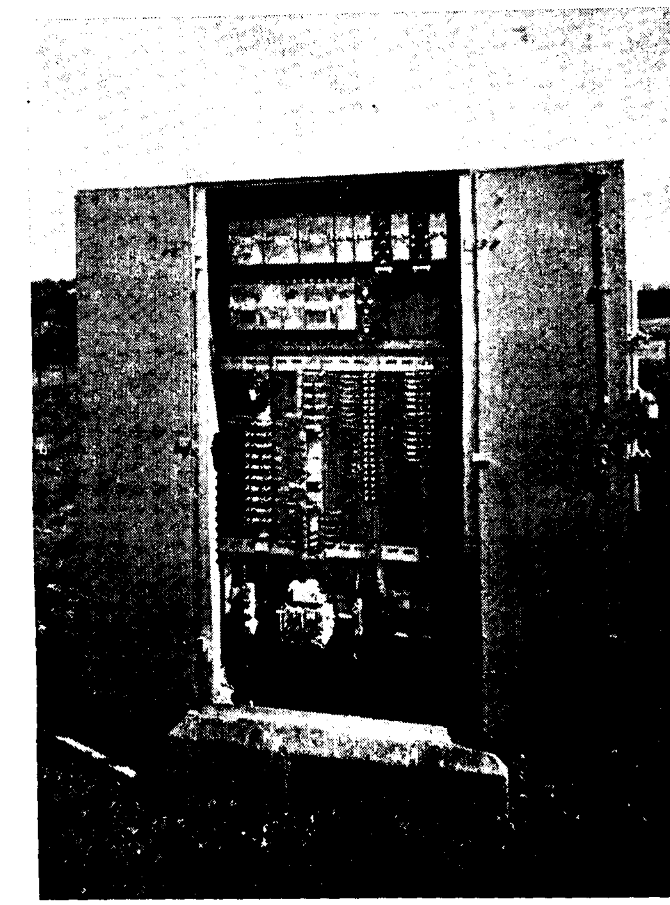
Several ways have been used for labelling wire terminations. One method is to fix an engraved label against the terminal block or fuse at the junction point between inside and outside wiring or to paint the designation on a wooden strip. If the wire has to be disconnected during alterations or other work, it has to be specially labelled. For this reason some railways use a sleeve, with the wire designation stamped on it, slipped over the wire and this seems to be the safest method.

CONNECTIONS BETWEEN SIGNALLING AND INTERLOCKING RELAYS

The Underground's extension and modernisation programme, which began in 1923, brought with it a large number of new signal boxes and although power level frames were in vogue at that time, the interior arrangements of the signal boxes, particularly with regard to the relays and wiring, were entirely different to their predecessors. Access to the bottom portion of the older power frames was obtained by removing the side, back or front panels. The connections to the lever contacts and lever locks were not easily accessable and illumination was supplied by means of an inspection lamp. The wiring between the lever frame and the cabinet containing the relays was run in wooden trunking.

The floor of the upper portion of the new signal cabins had a rectangular opening constructed in them which exactly fitted the area covered by the power frame. The relays were placed on open shelves, fixed to angle iron racks, and these were arranged around the opening in the relay room ceiling and signal box floor in the form of a square U. A steel platform ran the whole length of the opening, a few feet below the ceiling and access to this was obtained by a steel ladder. By this means the whole interior of the power frame could by inspected with great ease by the signal maintenance man mounting the ladder and standing on the platform. Fixed lights illuminated the interior of the power frame. The various relays being arranged around the floor opening considerably shortened the amount of wiring necessary. This was run on the open system being neatly treed and supported by aluminium hooks.

In modern signalling, relays have to accommodate many wires. If a relay becomes defective it has to be changed necessitating the removal of the wires and their correct replacement. The task is simplified if the wires are already labelled but the process is a



Steel location case showing terminals, fuses and plug in relays. (at top)

length one and great care and attention is essential. When the work is completed all the circuits affected have to be tested to ensure that wires have not become accidentally changed. A relay failure on a busy suburban section can cause severe dislocation of traffic and it has to be changed as quickly as possible. The maintenance personnel who have to change the relay are naturally all too conscious of the necessity for speed and it is this factor that could cause wires to be inadvertantly exchanged. The facility for testing all the circuits involved after the work is completely is not immediately available with trains running at close intervals. This very real problem led to the development of the detachable top relay. This relay has two tops, one permanently fixed to the relay case with its terminals connected to the contacts, coils, etc. The removable top has the terminals to which the outside wiring is secured. The two tops are clipped together by a special locking device which brings the underside of the terminals and the contact pieces leading to the interior of the relay together. Once the relay is connected up it is unnecessary to disconnect it again when it has to be changed. When a relay has to be

ANNOUNCEMENT

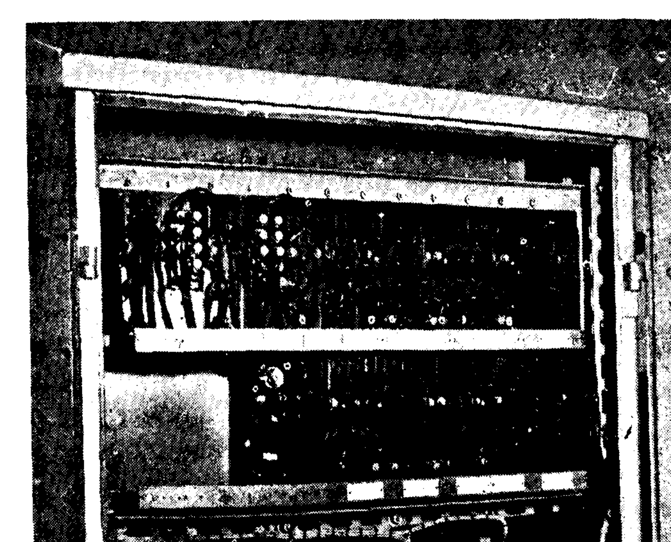
We have pleasure in announcing to all our Readers and Advertisers that we propose to bring out a special Number to our Magazine entitled "EIGHTH ANNIVERSARY TRANSPORT & ENGINEERING" sometime in January 1958.

EDITOR.

changed, the locking device is opened and the terminal top is lifted off with the wires for the various circuits attached to it. Hooks are provided on the underside of the relay shelf immediately above and they support the terminal top while the relay is being changed. Not only does this mean that the changeover can be done very quickly but there is no likelihood of wires becoming crossed. To prevent the wrong type of relay being used in place of the one being removed, each relay has one or two sets of code pins. If a relay of another type, with different contact arrangements and characteristics is substituted, the terminal board cannot be fitted to it. A difficulty with the detachable top arises with the wiring. If this is run flat across the terminal top and treed where they leave the relay, some resistance is experienced when lifting up the top. Some railways attach the wires singly and vertically each one going through a hole in a guide board into the wire run over the relay.

PLUG IN APPARATUS

Another type of signal relay which has become very popular is the plug in type. These relays are plugged into a plugboard which has terminals at the back. The plugboards are mounted on verticle racks. Connections from the relay are run out through the base as springs which engage on contact strips on the side of wedges composed of insulating material on the plug base. Each relay is supported by two brass rods projecting from the plugboard and these act as guides. The relay is pushed right home and secured in position by two knurled nuts. A relay can be changed in a very short time and a dexterous man can do it in about 30 seconds. The wiring between the plugboard terminals is arranged in the same manner as the earlier type relays and the wiring from the relay rack is taken across to the cable terminal rack or control unit at suitable positions through overhead steel channels. Inadvertent use of the wrong type of relay is checked by coding pins as with the detachable top type.



Rear view of upper portion of location case showing rear view of relay plugboards.

In another type of plug in relay, the plugboard is not provided with terminals but with detachable terminal spades or contact pieces to which the connecting wires between relays are soldered. When it is necessary to remove a wire from a relay, the detachable terminal spade, which is locked in position at the back of the plugboard, is withdrawn by means of a special tool. If wiring alterations are necessary at any time, new wires can be run with the terminal spades already attached ready for exchanging or for insertion in new positions. The main feature of the detachable terminal spade in the relay plugboards is that disconnection points are available without the necessity for providing independent terminal boards for each relay. Special arrangements are also made to permit a Voltmeter or an ammeter to be connected in circuit without interfering with the operation of the relay in any way.

Plug in equipment is also used for outdoor apparatus. The plugboards are mounted on a framework fitted inside the location cases and the method of changing relays is exactly the same as in the signal box relay room. Quickly detachable plug coupler arrangements are also provided for the electrical movement and connections in searchlight signals.

PREWIRED APPARATUS

In order to reduce the amount of wiring required to be done at site, signal cabin relay racks and location cases for the main cable run can be prewired by the manufacturers or in the railway's signal shops. Not only does this save work out on the track but it permits the work to be done more neatly and accurately. The only wiring to be done outside is that of connecting the main cables to the location cases, the incoming cable to the fuse and terminal racks in the signal box relay room and the wiring between one relay rack and another or to the control unit.

In new construction work now being carried out, both at home and abroad, and in work still in the planning stage, quickly detachable, plug in facilities will be required for almost all types of apparatus to be used. Whole units will be manufactured assembled and prewired in the workshops with the object of cutting down the amount of wiring on installation work to a very minimum.

HOW TO RESERVE ACCOMMODATION

Unless you reserve your berth (I Class) or Seats (II and 3rd Class long distance) in advance, you may not be sure of getting accommodation on the train you wish to travel by.

Application should be made to the Station Master of your starting station at least 3 days in advance specifying the date and train by which you intend travelling and the tickets must be bought in advance. The reservation fee leviable is 8 Annas per seat or berth.

Reservation by I and II Class from intermediate stations by Express trains can also be made similarly, but reservation ticket can be issued only after getting an advice from the Reservation Centre that the reservation has been made.

Tickets will be issued only if accommodation is available.

If the reserved seats or berths are not occupied at least 5 minutes before the booked departure of the train the reservation will be cancelled and the seat or berth given away to another.

Reservation fee is not refundable.

III Class seats are also reservable on Express and certain other important trains for long distance passengers from the train-starting stations on payment of a reservation fee of 4 Annas per seat.

Do not occupy a berth or seat reserved for another, as you are liable to be displaced at the last moment.

If you find another person occupying the berth or seat reserved for you and if he will not vacate it on demand, report it to the Guard or Station Master. They will help you.

(Inserted in the interests of Travelling Public)

CLEANLINESS LEADS TO HEALTH AND HAPPINESS

Clean orderly habits contribute to general health and welfare and as such to happiness and prosperity; they are more important than medicines.

Cleanliness prevents disease; medicine only attempts to cure.

Cleanliness of the person, of the houses and colonies, reflects discipline in the individual and the community. Discipline is the foundation stone for progress of oneself and the country. Cleanliness is a good habit. It is also cheap.

All Railwaymen should set an example of cleanliness. This will help others and themselves.

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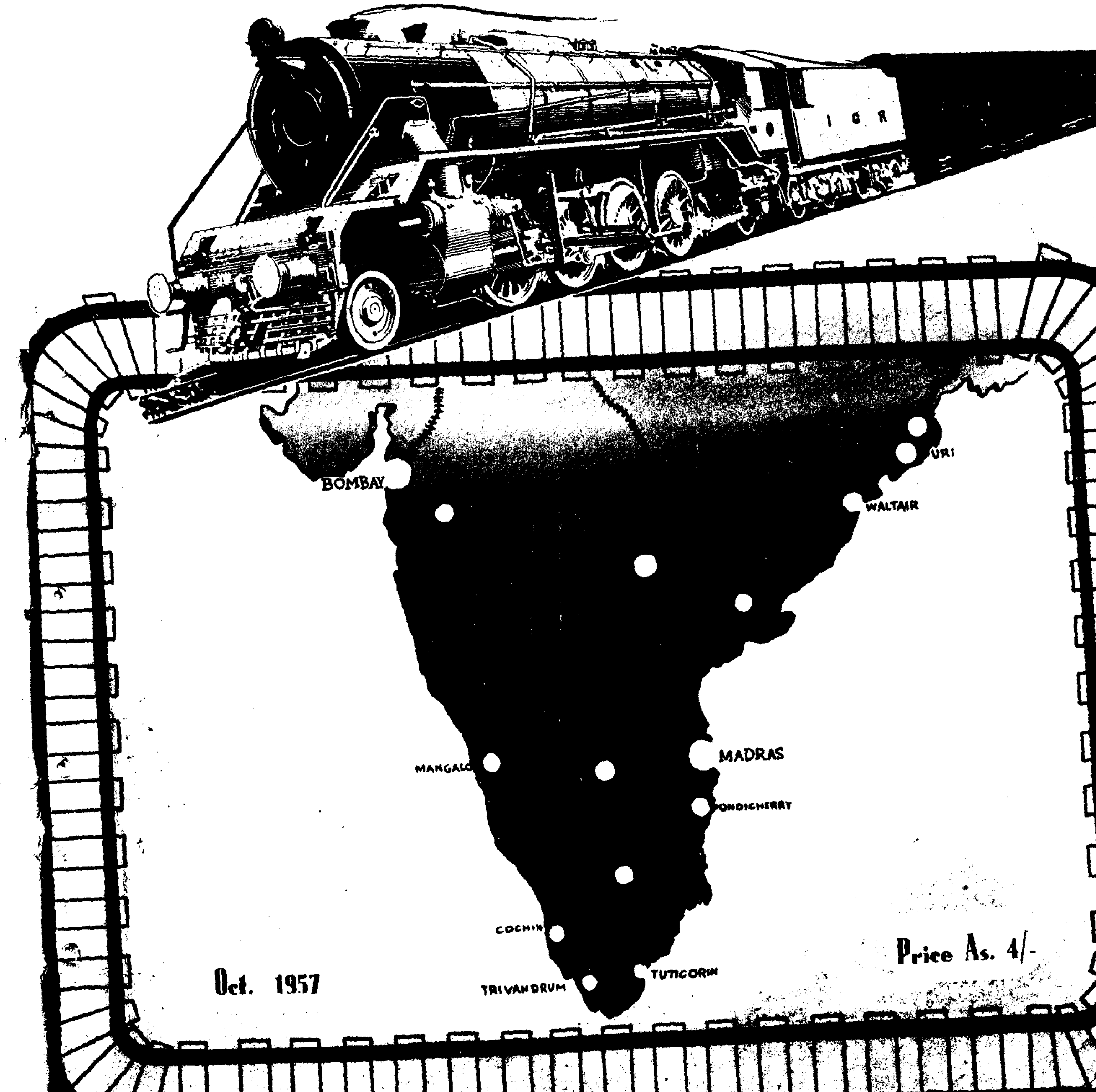

Oct. 1957

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SOUTHERN RAILWAYS MAGAZINE

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ALLOYS, FERROUS & NON-FERROUS METALS SUPPLEMENT

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Now Routinely-Travelled Tunnel under New York's Hudson River has Romance, Drama in History

ONE of the oddities of New York, the world's most heavily-populated city, is that its largest suburb is separated from it by a two mile-wide river and a state boundary line.

Daily, a million or more people must travel by boat, bridge and tunnel across the Hudson River from the northern section of the state of New Jersey to man the factories, stores and office buildings of New York, Globe Press Service reports.

A good portion of this group travels on the Hudson and Manhattan Railroad which fords the river through dug beneath it.

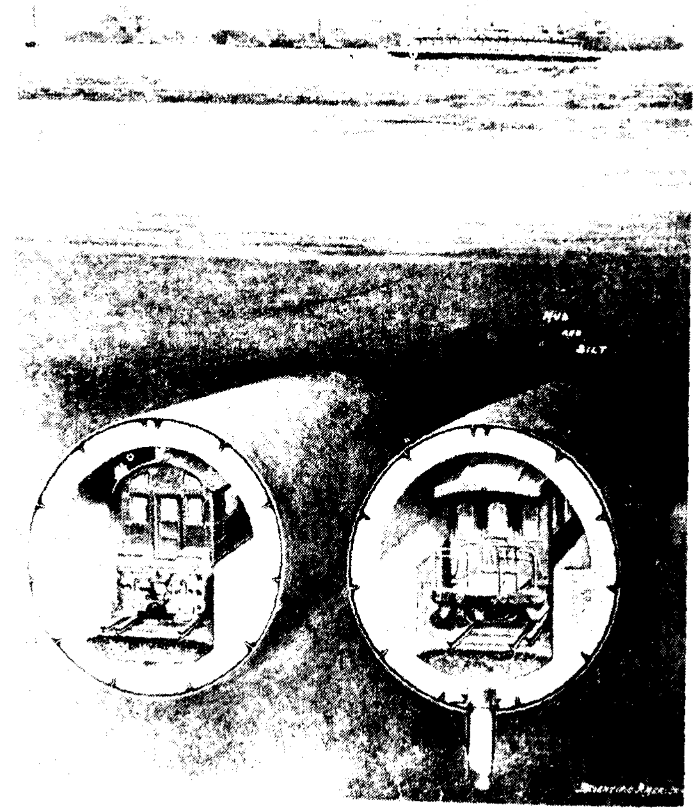
Modern rapid transit cars can make the trip in a few minutes. And, the Railroad has just announced that it is buying 50 of the most modern with high-speed, light-weight propulsion equipment built by General Electric (U. S. A.). The cars will be capable of rapid acceleration and braking, and have such conveniences as air conditioning, picture windows, light-weight steel bodies and insulated floors covered with asbestos tile to reduce vibration and noise.

In short, travel beneath New York's Hudson River is up-to-date, modern, common place. Passengers ride the trains without a thought to the fact that, at some points, they are over 100 feet below the surface of the river.

Such was not the case, however, in 1908, when the first under-river tunnel was completed. It was, according to the New York Times of that year, "conceded to be one of the greatest engineering feats ever accomplished; greater even than perhaps the Panama Canal."

Thirty-four years of work had gone into the construction of the first river tunnel—an era of engineering heartbreak, financial discouragement, disaster and delay.

It was begun in November, 1874, by a man named DeWitt C. Haskin. Haskin started excavating a 6.o-foot deep shaft for the tunnel on the New Jersey side at a time when the project was universally regarded as impossible.



On July 19, 1909, after 34-years of oft-interrupted work, two tunnels were completed beneath the Hudson River, situated as shown in this artist's sketch circa 1910. Today, modern high-speed electrified railway cars, powered by General Electric (U.S.A.) drive, make the three-mile under-river trip in a matter of minutes. General Electric recently announced that it is building more traction equipment for 50 additional high-speed cars, which will be among the most modern in existence, featuring air conditioning, picture windows, light-weight steel bodies and insulated floors covered with asbestos tile to reduce vibration and noise.

—GLOBE PRESS SERVICE

Initially, it seemed as if the skeptics were right. Work was halted during Haskin's first year of operation because of financial difficulties.

The bottom of the river, engineers discovered, is composed of fine mud and silt, soft enough when permeated by water to flow through the smallest opening and so unstable as to offer precarious support, at best, to a tunnel.

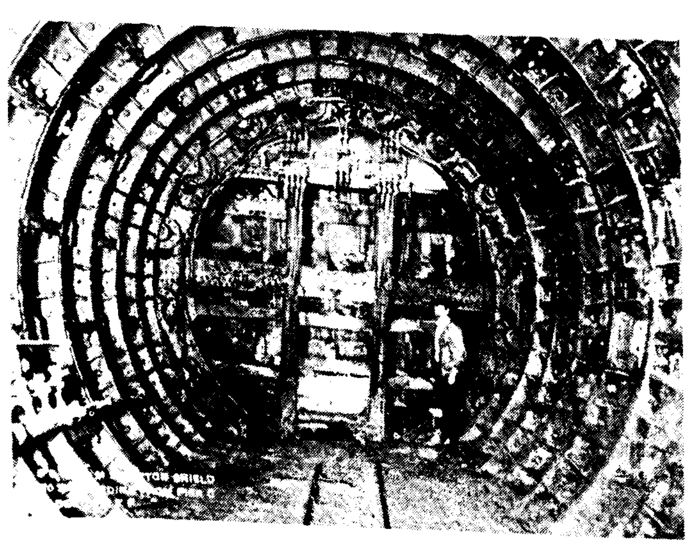
In addition, on the New York side of the site selected, a rock ledge projects up to near the river bottom and any tunnel had to pass partly through this rock with its upper edge in the treacherous silt—a condition never before encountered in under-water tunnel work.

Under these conditions, Haskin's original plan to line the tunnel with brick would surely have proved unworkable, even had he been able to continue.

Five years went by before construction of the shaft was resumed. It was finished in November, 1879, and the lateral penetration for the tunnel began.

Within a year, work has halted again—this time by disaster.

While trying to enlarge the juncture between the shaft and the tunnel, there occurred what is most feared



Pictured is the shielded main tunnel built for the Hudson & Manhattan Railway. As work progressed, the forward wall of the tunnel was pushed ahead and sealed to prevent the encroachments of water which, in one disaster, claimed twenty lives. Under the final arrangements of the tunnel, the original plan to line the tunnel with brick was scrapped in favor of curved steel plating shown here.

—GLOBE PRESS SERVICE

by "sandhogs," as the men who worked on underwater construction were called—a "blowout."

A large section of the tunnel ceiling was crushed under the pressure of the water above and the river poured in. Twenty workmen were trapped and killed and for each of these workmen, a year passed, as if in memoriam, with no further progress on the dream of a tunnel beneath the Hudson River.

In 1899, the project was sold under foreclosure.

There finally appeared on the scene in 1902 a man who felt the tunnel could be completed. His name was William Gibbs McAdoo and he convinced financiers that the tunnel could not only be finished, but opened and operated at a profit. So powerful were his arguments, he gained backing from them.

McAdoo, then president of the Hudson and Manhattan Railroad Company, put the company's chief engineer, Charles M. Jacobs, in charge of the project. Jacobs approached the job with greater skill and more modern methods.

He proposed to line the tunnel with cast iron and push shielding ahead of the construction workers to prevent flooding. Before starting, however, he first had to pump the water-filled tunnel dry.

With the renewed interest, work moved ahead quickly and a second tunnel was started even before the first was finished in 1908.

The celebration that attended the opening of the first tunnel on February 25 of that year was nothing short of sensational.

The tunnel was three miles long and reduced travelling time between New York and New Jersey from 45 minutes by motor car and ferry to 15 minutes by train.

Thousands waited in line from 9 a. m. the previous morning in order to get the first ride under the river. First in line was a young girl, Barbara Schlatter, from Hoboken, New Jersey. She and the others had waited all day in the snow.

(Continued on page 44)

METALS SUPPLEMENT

"Alloys for High Temperature Service"

*By *Dr. D. Swarup, B. Sc. (Met), Ph. D. (Sheffield), F. I. M.*

THE phenomenal development witnessed in recent years, in the production of jet engines, gas turbines and the various types of rockets has exerted a tremendous influence in the evolution of many alloys suitable for service at high temperatures. The efficiency of a gas turbine is, among other factors, a function of operating temperature and so is the case with the internal combustion engine components which are subjected severe service conditions—particularly alternating stresses at elevated temperatures. It has been said that the possibility of jet propulsion arises mainly out of the development of alloys capable of functioning at high temperatures. It is proposed to deal with some of these developments briefly in this paper.

HIGH TEMPERATURE ALLOYS

It may be admitted at once that the theoretical principles of alloy making have not advanced to that stage at which, given the requirements, one can prescribe a suitable composition and a thermal treatment. Constitutional diagrams of binary alloys are available for almost all the useful metallic elements, as well as a few ternary diagrams. These and the properties of the pure metals offer some guidance, but the majority of industrial alloys are complex systems and the behaviour of these under a set of conditions cannot be reliably forecast. The development of alloys, therefore, is largely empirical and suitability has often to be decided by service tests. Inspite of these difficulties, quite a number of alloys have been developed. It has been said that "alloys and steels used in modern jet engines (which are of course only one application of the gas turbine engine) have to withstand stresses equivalent to hanging two saloon cars from a red hot piece of metal about the thickness of a fountain pen, without stretching or distorting it. They have in fact, to withstand 10 tons per sq. in. at 850 deg. C. Moreover, conditions in the engine are such that the fountain pen might have to be red hot at each end and comparatively cool at the centre. The necessity for meeting demands of this sort has led the steel industry's scientists into some unusual paths."

The high temperature alloys for use above 600–650°C have an austenitic matrix and several types are found. A few of these are :—

(i) Stainless steel type, which are essentially of Fe–Cr–Ni base. Timken 16 — 25 -6 and 19 — 9 DL belong to this class.

(ii) Stellite type alloys, which are essentially Co–Cr–Mo or Co–Cr–W base. Vitallium and Jessop G–32 are representatives of this class.

(iii) Inconel or chromel or nichrome type. These are essentially Ni–Cr alloys made hardenable by alloy additions such as Ti. Inconel -X, Nimonic 80 etc. typify this class.

There are other types which are modifications of the above. The evolution of a creep resisting alloy 'Cromadur' in place of 'Tinidur' is a notable development of the last war. Tinidur is an austenitic alloy containing 30% nickel. Shortage of nickel in Germany necessitated its replacement by manganese and the alloy 'Cromadur' was developed. The composition of some these alloys is given in Table I.

The use of non-metallic materials (Ceramics) along with creep-resistant metallic powders which are pressed and sintered under appropriate conditions, is yet another field of research. These ceramic—bonded metal parts are more resistant to thermal and mechanical shock than ceramic materials, but they present many new problems as they are relatively brittle and the method of bonding is far from satisfactory.

In high-temperature operation, the behaviour of metallic parts depends more upon their plastic properties

* Principal and Professor, College of Mining & Metallurgy, Banaras Hindu University.

TABLE I HEAT RESISTING ALLOYS.

Sl. No.	Type.	Chemical composition. Ni	Cr	Mo	W	Cb	Ti	Other Elements	Remarks.
1	Cr-Ni-Fe	8	18	0.4 to 3.0	1 to 3	0.3	0.2 to 1.5	Balance Fe	
2	Ni-Cr-Fe	20 to 50	14 to 25	4 to 14	Upto 4	Upto 4.2		Balance Fe	e. g., Timken Cr/Ni/Mo : 16/25/6
	Refractaloy A	50	20	14	—	—	—	Balance Fe	
3	Ni-Cr-Co-Fe	15 to 33	14 to 27	3 to 10	Upto 4	Upto 4		Co 13 to 45 N_2,B,Ta Balance Fe	
4	Ni-base : Hastelloy B	65	—	29	—	—	—	Fe 5	Forged buckets for use under 1400°F.
5	Ni-Cr & Ni-Cr-Co	37 to 75	14 to 22	—	—	—	—	Co Upto 22	Hardened by Al or Ti
	"Nimonic 80"	74	22	—	—	—	2.5	Al 0.6	
6	Co-Cr :-Vitallium	—	28	5.6	—	—	—	Balance Co	Precision cast buckets.
7	Co-Cr-Ni	10 to 32	23 to 25	Upto 6	Upto 12	—	—	Balance Co	
8	Cromadur	—	12	—	—	—	—	Mn-18 V-0.7	

than upon the elastic properties which dominate their behaviour at low temperatures. The plastic properties are more difficult to characterize, since the plastic deformations are not proportional to the applied loads. In the high temperature range, a part may creep under constant load so that in time the plastic deformation much exceeds the elastic strain. The tendency of the part to flow, the deformation continuously increasing in time, is a high temperature property of immediate concern to design engineers. Metallurgists recognize additional properties necessary to successful operation at high temperature. These properties are listed in Table II.

Table II. High Temperature Properties.

1. Chemical composition.
2. Processing data.
3. Room temperature properties compared to high temperature properties.
4. Short time tensile strength.
5. Stress rupture strength.
6. Creep strength.
7. Design data.
8. Hot impact strength.
9. Hot fatigue strength.
10. Change in the elastic constants with temperature.
11. Change in the coefficients of thermal expansion.
12. Change in the thermal conductivity.
13. Hot hardness.
14. Relaxation tests.
15. Influence of combined stresses.

HIGH TEMPERATURE TESTS

The testing of these alloys includes high temperature creep and rupture tests. Some figures of the former are given in Table III which is self-explanatory.

Table III.—Stress-Rupture Tests at 1500°F.

S. No. Material	Stress for rupture in thousands of lbs. per sq. inch in 10 hours.	100 hours.	500 hours.
1. Cr-Ni-Fe	12.5 to 22	11 to 16	10 to 11
2. Ni-Cr-Fe	17 to 22.5	10.5 to 18	8.5 to 12.5
3. Ni-Cr-Co-Fe	20.5 to 34	16 to 25	12.5 to 20
4. Ni-base	25	15 to 17	11.7
5. Ni-Cr & N Ni-Cr-Co-Fe (Ti & Al hardened)	21 to 40	13 to 29	17 to 21
6. Co-Cr	21	11 to 28	14 to 25
7. Co-Cr-Ni	25 to 33	27 to 30	24 to 27

Since most of the components out of these alloys are to be manufactured to very close tolerances for interchangeability, as well as for considerations of high operating efficiency, dimensional changes under working conditions and during the working life have to be known before hand. Creep tests are used for this assessment which measure the deformation in terms of the stress in lbs. per sq. in. required at a particular temperature to cause a creep rate of one-ten millionth of an inch per hour for every inch of the length of the specimen. It may be mentioned that the average working life of an aero-engine is about 300 hrs. and that of an industrial unit is about 100,000 hrs. (11 years). The figures given in Table IV are indicative only of the magnitude of the creep.

Table IV—Some Creep Data of High Temperature Alloys.
Temp. 1350°F.: Stress 15,000 lbs./Sq. in.

Sl. No.	Material and Treatment	Creep rate per hr. @ 1000 hrs.
1.	Cr-Ni-Fe: C. O. 26, Cr. 18, Ni. 8. (Oil-quenched & aged)	0.00004
2	Ni-Cr-Fe: C. O. 4, Cr. 13, Ni. 19, Mo. 4.28, W. 3.87, Cb. 4.2. (Water-quenched and aged)	0.000101
3.	Ni.-Cr-Co-Fe: Refractaloy M 284 C. O. 11, Cr. 20, Ni. 20, Co. 30, Mo. 8, W. 4 (Oil-quenched and aged)	0.000052
4.	Ni-Cr-Co-Fe: (Ti and Al hardened) Refractaloy 26. C.O.03, Cr.18, Ni.37, Co.20, Mo. 3, Ti. 3, Al. O. 25 (Oil-quenched & aged)	0.00001
5.	Co-Cr:—Vitallium C.O. 2, Cr. 28, Mo. 5.6, Co. Bal. (Cast and aged)	0.000440

Similar data for other values of stress and duration have been investigated and reported in the literature, on the basis of which design data have been arrived at which are helpful in deciding the suitability of an alloy for a particular application.

POSSIBILITIES IN INDIA

A large majority of the high temperature alloys are face—centred cubic at the service temperatures and the main elements present form solid solutions. The solid solutions being non-creep—resistant, alloy constituents such as carbon, molybdenum, tungsten, columbium, tantalum, titanium, nitrogen are added to strengthen the matrix by forming carbides, nitrides or intermetallic compounds. Their dispersion in the metallic matrix help in retarding creep.

A characteristic draw back of these alloys is that they lose their creep resistance rapidly above 800°C. The future largely depends upon developing alloys which will be creep resistant at higher temperatures. Among the alloys known, metals such as nickel, cobalt and iron have been, more or less, completely investigated as alloy—bases. Low melting metals such as aluminium, magnesium, silver, copper, tin and zinc are obviously unsuitable as alloy—bases for service at high temperatures, since melting points of the metals which make the alloy base is a criterion. Prohibitive cost stands in the way of metals such as platinum, rhodium, osmium, palladium etc. from being used. Therefore, comparatively only a small number of metals are primarily suited for high temperature range. As far as this country is concerned, the available metals

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Aluminum contributes to the Progress of Railways

*By *J. Balachandra*

DEVELOPMENTS in the Light Metal industry in the last fifty years have been remarkable. Aluminum has a rightful claim to be a "modern metal". Aluminum a laboratory curiosity in the latter half of the last century, now ranks second only to steel in the tonnage produced. Historically the availability of high strength alloys in large quantities is an accomplishment of the present century. Early interest in the metal has been mainly due to two important properties of the metal viz. light-weight and corrosion resistance. There has long been an awareness that the traditionally heavy rolling stock of the railways could be lightened to great advantage. However the deterrent factor has been the comparatively high cost of aluminum. It has now been realised that economic returns due to the use of aluminum are of a long term nature.

Recent developments in the aluminum industry have further focussed the attention of railways on the numerous possible uses of these alloys. Small additions of alloying elements like magnesium, Silicon, Copper and Zinc markedly alter the properties of the metal. Aluminum alloys with their low weight, good strength, resulting in high strength to weight ratio, and ductility in addition to other useful mechanical properties, suggest themselves as potential substitutes for steel in many situations. These alloys are available in all wrought shapes and as castings. They can be classified as non-heat treatable alloys and heat-treatable alloys. The non-heat treatable wrought alloys of moderate strength contain manganese or magnesium as a major alloying element. These have exceptionally good resistance to corrosion and are strengthened by cold work. Maximum strength is obtained by heat treatment of alloys containing Magnesium, Silicon, Manganese and Copper. By comparison with steel these heat treated alloys are considerably more resistant to corrosion but to a lesser extent than the non-heat treatable alloys. Casting alloys combine strength with resistance to shock. Sand, gravity, or pressure die castings can be chosen to meet the requirements of any particular application. Ease of machining and production of castings to close tolerances lower production costs. Properties of some selected alloys are given in the tables, I, II & III.

Physical properties: The important physical property is the low specific gravity which is about 1/3 that of iron and steel and less than 1/3 that of copper and its alloys

TABLE I

Minimum properties of selected Non-heat-treatable wrought alloys

Alloy B.S. 1470 (sheet)	Specific composition Major elements % Mg.	Mn.	Temper	Pr of Stress .1% (tons/in²)	Tensile strength tons/in²	elongation 2 in. %
			o	(2)	5-6.5	30
SIC	99% pure aluminum		½H	(6.5)	7-8.5	7
			H	(9)	9.0	3
			o	(3)	6-7.5	30
N3.	—	1.0-1.5	½H	(8.5)*	9-11	7
			H	(11)	11.5	3
			o	(5)	11-14	18
N4.	1.75-2.75	—	½H	12	15	5
			o	6	14	18
N5.	3.0-4.0	—	½H	11	17	8
			o	8	17	18
N6.	4.5-5.5	—	½H	14	19	8

(Continued from page 8)

are titanium, zirconium, beryllium, and hafnium. These are distributed in various parts of the country. Occurrences of cobalt and nickel are negligible. Chromium as a base has been found to be ineffective owing to the brittle nature of the alloys made and molybdenum and tungsten (which exist in the country to a minor extent) have their two fold disadvantages of high density and susceptibility to oxidation. Amongst the four metals titanium, zirconium, beryllium and hafnium beryllium because of its low melting point and hafnium because of its scarcity and high density are precluded. It is evident, therefore, that in a programme for development of high temperature alloys in this country, titanium and zirconium are bound to play a major role.

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TABLE II

Minimum properties of selected Heat-treatable wrought alloys

Alloy H10 B.S.1470 (sheet)	Specific composition Major elements % Cu.	Mg.	Si.	Mn.	Condition	Proof stress .1% (tons/in²)	Tensile strength (tons/in²)	elongation 2 in. %
H10	—	0.4 to 1.5	0.75 to 1.3	—	W	7	13	15
					WP	15	19	8
H14	3.0 to 5.0	0.5 to 1.2	0.7	0.4 to 1.2	T	14	24	15
H15	3.5 to 4.8	0.6	1.5	1.2	W	14	24	15
					WP	20	26	8

TABLE III

Minimum properties of selected casting alloys
(chill cast)

Alloy B.S. 1490 (castings)	Specific composition Major elements % Cu.	Mg.	Si.	Mn.	Condition	Proof Stress .1% (tons/in²)	Tensile Strength (tons/in²)	Elongation 2 in. %
LM4	2.0 to 4.0	—	4.0 to 6.0	0.3 to 0.7	M	(4.5)	10	2
LM5	0.1	3 to 6	0.3	0.3 to 0.7	M	(4.5)	11	5
LM6	—	—	10.0 to 13.0	—	M	(4.5)	12	7
LM8	—	0.3 to 0.8	3.5 to 5.5	0.3 to 0.8	W	(7)	15	5
					WP	(13)	17	2.5
LM10	—	9.5 to 11.0	—	—	W	(11)	20	12

* Bracketed figures are typical values.

and 1/4 that of lead and silver, the density range being 162 to 180 lbs./cft for the alloys. The electrical and thermal conductivities of the pure metal rank next to copper with about 50% of its value. The natural colour and tarnish resistance are an asset.

Mechanical Properties : Apart from the wide variation in tensile strength obtainable by a suitable choice of alloy there is one important mechanical property which while apparently a disadvantage can be a practical asset. This is the modulus of elasticity. The modulus of elasticity is about 1/3 that of mild steel and indicates that for a specific stress the elastic deformation is about three times that of steel. So when stiffness is the main factor suitable change in geometric form must be made for increasing the moment of inertia of the section. On the other hand ability to withstand shock is an advantage in construction.

APPLICATION TO RAILWAYS

The earliest application of aluminum in the railways in the United Kingdom was for panelling and interior fittings of rolling stock. Even after a long and severe service the material has been found to be in good shape. Later a cast alloy LM 6 was used for connecting rods. Two of the rods supplied were found to be in excellent condition in service. Considerable advantage has been claimed for the use of light alloys in Diesel engines. In these engines there is a limitation on the weight imposed to meet axle load requirements. Aluminum is used to great advantage in panelling, superstructure and engine cooling components. Bus bars and conductors can also be of aluminum.

Within the last few years great strides have been taken in the design of light-weight trains. Use of aluminum and its alloys in the body shell and for the structural components has been extensive. The underframe and body has been of the HE 10 or HS 10 alloy. A saving of about 6½ tons as compared with steel construction has been claimed by the London Transport Executive. According to them a reduction in weight of 14% corresponds to a saving in energy of 12%. The stock of the Toronto Transit Commission has also an all body structure except for body bolsters. The main framing members are of HE 20 WP alloy. Side sheets and rivets are of N5 alloy and the floor sheets of N4—½H alloy. For carriage fittings LM5 castings and H510—Wp wrought materical have been used. A saving of 5½ tons per unit is claimed.

Interest evinced by the British Railways in aluminum and its alloys as a promising constructional material took concrete shape in the design of a light alloy electric train exhibited in 1951. The matter of saving in weight is of paramount importance on railways with high frequency of service between stations at short distances since the energy or fuel consumption is directly proportional to the weight of the rolling stock.

Again rolling stock designed for greater passenger comfort, greater speed and punctuality can be provided for fairly long journeys. If the traffic density is high, high acceleration and braking rates which are as important as speed can be attained.

In the exhibit alloy "Kynal" M 39/2 a proprietary alloy containing Manganese, magnesium and silicon, manufactured by the I. C. I. Metals div. has been mainly used for load bearing structures. There has been a saving in weight of 37% in the car body and 20% in the overall weight.

Successful competition from air and bus lines resulting in mounting deficits on passenger operations has prompted the North American Railroads to seek greater economy and efficiency of operation. During 1956 four companies designed and tested light-weight trains. The designs varied virtually from an all aluminum train to trains containing varying amounts of aluminum employed in the construction. All designs however were based on the light-weight, strength and durability of the alloys. The first of these was the Pullman Standard train 'X' a typical prototype being named the 'Xplorer'. Essentially of an all aluminum construction, the central section of the underframe was of 6061—T6 alloy, the frame of 6061—T4 alloy and the skin of 2024—T3 alloy aluminum clad. Aluminum cladding of alloy plate improves the corrosion resistance of the clad metal. The weight saving compared to a steel counterpart is claimed to be nearly one-third with about the same value of saving in cost General motors very well known as leading manufacturers of automobiles introduced the "Aerotrain," a design based on the proved performance of aluminum and its alloys in bus body design. Each train was a complete unit consisting of 10 cars and a 1200 h. p. diesel locomotive capable of speeds up to 100 m. p. h. The superstructure and the exterior have been fabricated out of aluminum alloys. The weight saving has been claimed to be 50% with a corresponding saving on maintenance and operating costs. This in fact is expected to provide a solution for low cost travel. The third design of interest is the 'Jet Rocket' by the ACF industries, basically a TalgoType design. Some new features have been introduced. It has a steel underframe with 6061—T6 aluminum alloy structural components in the superstructure and inside trim, the outer skin being of stainless steel. Apart from the light-weight resulting in 50% saving compared to a standard railway car better weight distribution, new type of suspension system and guided wheels are some of the additional features.

In our own country there is an outstanding example of the use of light-weight trains in the introduction of broad gauge multiple unit electric stock on the suburban routes of the Western and Central railways. These designs using a combination of light alloys and high tensile steel is a step in the right direction. It is a positive sign that aluminium has come to stay as one of the important structural metals in this "light alloy" age. In the stock used on these railways a saving of 26% on previous designs has been claimed.

India has vast resources of raw materials for production of aluminum and its alloys. The development of this industry is largely dependent on demands of potential consumers like the aircraft and the automobile industries and the railways. Railways can immensely benefit by the use of aluminum and its alloys in diverse applications and in turn subscribe to the rapid development of an important metallurgical industry. The appeal of the anodised and dyed aluminum in decorative finishes and inside trim will not fail to please the aesthetic sense of the travelling public. With all these developments one can cherish the fond hope that utmost in travelling comfort might be an accomplished fact in the not distant future.

PRESIDENT'S AWARD TO RAILWAY ENGINE DRIVER SAVED LIVES OF HUNDREDS OF PASSENGERS

The President has posthumously awarded the Ashoka Chakra, Class II, to the late Shri Manasser Johannes, engine driver of the South Eastern Railway. The citation accompanying the award says :

"Shri Manasser Johannes was the driver of the 315 Up Howrah-Adra-Chakradharpur passenger train approaching Khargpur from Jakpur on the night of July 26, 1956. Shortly before midnight, there was a sudden blow-back of fire from the fire box door into the cab where he was standing. Trapped in the flames, Johannes and the two firemen who were on duty with him received serious injuries. The firemen jumped out of the moving train. There were about 400 passengers in the train. Realising that a disaster must result if he too jumped out, Driver Johannes remained at his post in the flame-filled cab and though severely burnt he eventually brought the train to a stop near the outer signal of Khargpur station. He then alighted from the engine and painfully crawled back to the rear of the train to tell the Guard what had happened. Shri Johannes was rushed to a hospital but he succumbed to his injuries within a few hours of admission.

"Shri Manasser Johannes acted with great courage and heroism in order to safeguard the lives of hundreds of passengers travelling in the train in his charge. His spirit of sacrifice and devotion to duty will be a noble example to others".

The right alloy for the right job —
A guide to fabrication in aluminium

*By *R. K. Chari*

"THE right material for the right job", a basic principle dating back to the beginning of scientific construction, often times is overlooked in relation to fabrication work in aluminium. This is a direct consequence of generally insufficient knowledge of the salient characteristics of aluminium and its alloys amongst our engineering circles, with their education and training basically in steel fabrication.

Aluminium with its wide range of alloys, is a versatile medium of construction suited for a variety of applications, from cigarette cases to ship superstructures. These alloys, while possessing in common light-weight and resistance to corrosion, feature a wide range of physical and mechanical properties like tensile strength, hardness etc. To derive the best advantage from fabrication in aluminium, it is essential to make the right choice from out of these alloys, having specific properties adequate to the particular application. The many alloys of aluminium commercially available in India and their salient properties are discussed below in some detail.

Aluminium sheets, now being produced in India in a number of alloys, can broadly be divided into two groups; (i) those in which the mechanical strength is achieved by cold rolling or work-hardening, and (ii) those in which the mechanical strength is developed by heat-treatment after rolling. Among others, commercially pure aluminium belongs to the former category and duralumin alloys, used in aircraft construction, fall under the latter.

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The range of mechanical properties, in which sheets in varying tempers in these alloys are available, are shown below:

Alloy Specification	Type	Ultimate tensile strength (in tons/sq. in.)	.1% proof stress (in tons/sq. in.)	Brinell Hardness Number
I.S. SIC	Work-hardening	5½—10	2 —9	21—44
I.S. NS3	Work-hardening	7 -13	3 —11	29—55
I.S. NS4	Work-hardening	12 -16½	5 —14½	48—76
I.S. HS 20	Heat-treatable	8 -20	3½—17	60—90
I.S. HC 15	Heat-treatable	12½-31	5½—26	115—135

The fabricator, therefore, has a considerable range to choose from to suit the mechanical strength demanded by each application. The different tempers in each alloy make available varying degrees of workability in operations like pressing, folding etc. Some other important properties are comparative resistance to corrosion and surface finish. Pure aluminium, I. S. SIC, ranks the highest in corrosion resistance, with the other alloys, I. S. NS3, NS4, HS 20 HC 15, coming after it in order. While this is true in a general sense, the magnesium bearing alloy, I. S. NS4, is superior in resistance to corrosion by marine atmospheric conditions. Where surface finish, which is very often improved by resort to anodising, is important, alloy I. S. SIC is again the best choice. In applications like floor plates for platforms etc., calling for high wear-resistance, alloy I. S. HS 20 is an excellent choice.

Aluminium sections, like angles, channels, tubes etc. and specially designed profiles for particular uses, are being produced in India, by the extrusion process. The range of mechanical properties of these alloys, in the various tempers, are shown below:

Alloy Specification	Type	Ultimate tensile strength (in tons/sq. in.)	.1% proof stress (in tons/sq. in.)	Brinell Hardness Number
I.S. HE 9	Heat-treatable	7—16	5—12	45—75
I.S. HE 10	Heat-treatable	15—20	9—18	60—90

Here again, the different tempers enable different degrees of workability. For stressed structural applications, sections in I. S. HE10 alloy, which has high mechanical strength, are best suited. For architectural applications like windows, doors etc. and for trims and mouldings, where asthetics are of prime importance, I.S. HE 9 alloy is the ideal choice, since it combines adequate strength with fine surface characteristics suited to finishing processes like anodising, polishing etc.

Satisfactory and durable fabrication of any component demands careful consideration of a number of factors in selecting the material for construction; to mention only the more important, adequate mechanical strength, suitability for fabrication operations involved, and resistance to corrosive factors. Depending on the demands of each application, these and other pertinent factors assume importance in relative proportions. Failure to conform to the principle of "The right material for the right job" often leads to unsatisfactory, and occasionally disastrous, results. The need for choosing the right alloy and temper of aluminium for each job, in the light of its duty conditions, cannot therefore be exaggerated.

Admittedly, an article of this nature hardly permits an exhaustive discussion of the many aspects, knowledge of which enables the right choice. It is hoped, however, that the foregoing will help in achieving a widened appreciation of the variegated range of section that aluminium offers. The aluminium industry in the country also places at the service of fabricators technical advice and assistance, in order to facilitate the most adequate and advantageous utilisation of aluminium.

MYSORE IRON AND STEEL WORKS

The Mysore Iron and steel Works, Bhadravati, has completed the erection of a new cast iron spun pipe plant at a cost of Rs. 55 lakhs. The plant will be inaugurated this month by the Union Minister for Steel, Mines and Fuel, Sardar Swaran Singh. The new plant will enable the Mysore Iron and Steel Works to increase the production of iron pipes needed for water-supply schemes. The erection of the plant completes the first stage of the development of the Mysore Iron and Steel Works under the second Plan.

The Mica Mining Industry in India

*By *D. B. Sahana*, *B.A., F.G.S.(Lond.), A.M.I.E.T.(Lond.), A.I.M.M.(Lond.), A.I.M.E.(U.S.A.), M.M.G.I., F.G.M.S., M.I.S.E.*

IN the modern age of industrialisation, electricity and electrical appliances, as you all know, are of very great importance and use. Mica is considered to be a very important material in the construction of electrical machineries of all kinds. A country with sufficient amount of mica deposits is thus considered to have unique and strategic position in the world. For your information I may tell you that India is at present supplying about 80% of the world's requirements of mica. In the present days of India's intimate connection with the U. S. A., it is found that mica is one of the principal dollar earning materials of India. The importance of mica industry is, therefore, cannot be over emphasized. So I would like to address you on the subject of Mica Mining Industry in India—its history and development.

At the outset, I would refer to you about the discovery and use of this important material in India in the past. From available source I may tell you that mica was largely employed in the ancient Hindu System of medicine. I may also inform you that though there is not any definite documentary evidence, India had trade relations with the Roman Empire in the past. The amphitheatre in Rome used to be decorated with the spreading of powdered mica, thus imparting a glistening effect. In those days, mica used to be exported to Europe under the name of 'ABHRA' which was regarded as 'Talc' in the foreign market. From the information I could gather, I may say that mica was first produced in Bihar in India and this used to pass as 'Bengal Mica' in England and other foreign markets, and had the reputation for its fine quality and its beautiful ruby colour.

Mica (Muscovite) in Bihar, occurring in the pegmatites and for its peculiar colour and lustre, could attract the notice of some of the local aborginal tribes known as the Labanas and Mahajins inhabiting the different places in the Bihar Mica Belt. These peoples started producing mica from narrow cylindrical shafts, not exceeding a depth of 30 feet on an average, in and around Kodarma. As they did not known the use of explosives, they invariably avoided to bore holes in the harder pegmatite rocks for the recovery of mica, but they had enough intelligence to attack the pegmatites by burrowing through the softer mica-schist country rock on either side of the pegmatite containing valuable books of mica, which were taken out a random. Mica thus extracted used to be placed in the market for various local uses for decorating and medicinal purposes. Those places where the aboriginals began their operations turned out afterwards to be some of the best mica mines in the locality.

After this period of the activities of Labanas and the Mahajins, there was big gap or dark period when no mica was produced due to several factors both political and economic, or foreign invasion, of which we have very little documentary evidence. But we have some amount of definite information about the beginning of systematic mica mining in the year 1880 or thereabout by some enterprising men like F. F. Chrestien, Raj Krishna Sahana, W. R. Macdonald and Manoranjan Guha Thakurta, who were pioneers in this industrial development. The old system of mining that was prevalent amongst the Labanas was not strictly followed by these industrialists, but they started an improved method of mining and as gunpowder, a mild explosive which was available at that period, was freely used, the hard pegmatite rock was directly attacked and blasted. Thus they could reach greater depths to extract mica books. The only method that was adopted for both pumping out of water and haulage, was by the employment of manual labour which was freely used. The water that accumulated in the shallow mines used to be baled out by human agency and the debris which accumulated in the mines after blasting used to be removed by labourers with the help of iron pans.

This state of mica mining continued for a good length of time until the World War I, when steam engines, steam boilers, steam haulage engines and steam pumps and high class explosives like dynamites, gelignites etc. together with detonators were introduced. These improved devices gave an impetus to the Bihar Mica Mining and greater and greater depths could be attained without much difficulty, the depths reached varying between 100 and 200 feet.

After 1924 or 1925 pneumatic drills operated by air compressors and better facilities of haulage system had been introduced thereby increasing the efficiency in the matter of increased production of the mica and safety of the mines. Much greater depths could be reached by these better mining methods and 500 to 600 feet depth is quite easy under the present day mining conditions.

This state of affairs has been going on but more efficient mining and increased production will only be possible when improved mechanised mining is introduced with the application of machineries operated by electricity. With such improved types of machineries, it will be possible for us to reach even greater depths and to quicken the production of mica, so that the increased production may compensate the overhead cost of improved types of machineries. The Damodar Valley Corporation should supply electricity to the mica mines at chief rates as early as possible, so that the mica industry may take advantage of it for the sake of stepping up mica production which will ultimately lead to the welfare of the nation.

Regarding the transport in the area where mines are scattered in different inaccessible parts of the mica belt covering an area of more or less 1500 sq. miles, I may point out that the position is very unsatisfactory because there is practically no good all weather roads in this region. For want of this communication facilities between the factories and the mines, the work in the production is seriously affected. The improvement in the transport facilities should be immediately undertaken by the Government, so that the work of mica mining can be carried out smoothly.

Those who have practical experience of mica mines in Bihar will bear me out when I say that for want of good roads, we cannot take suitable machineries to the site of mines for improved production. I think the attention of the Government should be focussed to this transport problem facing the mica industry. The road cess that is being collected at the rate of —/8/— annas per maund of mica every year should be utilised for the improvement of communication in the mica mining area. If this fund appears to be rather inadequate, certain amount of money can be diverted from the labour welfare cess which is also accumulating at the rate of about ten lacs of rupees per annum.

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As this transport problem is seriously standing in the way of development of the mica industry, we are really very anxious to see that immediate improvement is done in the direction. I think I am voicing the opinion of all who are vitally interested in the mica industry of Bihar.

PROCESSING OF MICA

After Mica has been produced from the mines it is transported to the factories, which are mostly located far away from the mines, where the crude mica is processed.

Regarding the different stages of processing, I may mention that crude mica books are first rifted and cut by sickles to remove the flaws in order to recover the valuable portions. This method has been going on since the inception of the mica industry in this part. The rejections of mica by this method come to about 80% of the run of mine. These rejections are put in dumps and later on tapped to recover small percentage of mica for splittings. The only deviation made from the long standing method of cutting of large size mica by sickles in Bihar is by knives. This has proved to minimise waste in production of cut mica. The mica occurs in various places in South India in pegmatites and the most important mica mining centre nowadays being concentrated in the Nellore Dt. Mica mining was started in South India from very old days. The Nellore mica belongs chiefly to green variety (muscovite) and the quality varies between clear and heavily stained and spotted. The cutting of Nellore mica is chiefly done by scissors into different sizes of round, square and rectangular shape. Recently the Bihar method of cutting by sickle has also been introduced in Nellore area. The grading however, is the same as in Bihar.

The pegmatites of Travancore contain phlogopite mica of good quality which has got special uses.

The mica miners in Rajputana follow the usual method of mining mica from the pegmatites. Rajputana mica belongs to ruby variety (muscovite), quality being mainly stained and heavily stained. They have also adopted the Bihar method of cutting and grading with great success. Moreover, sufficient amount of Rajputana mica comes to Bihar for splitting and subsequent export to foreign markets.

With the introduction of electrical appliance in the latter part of the last century use of mica gradually went up, and the importance of graded mica was realised by the manufacturers. In this way, grading of mica into different sizes came into practice in our mica industry and the same thing has been going on except miner modification from time to time e. g. introduction of sizes of Nos. $4\frac{1}{2}$ and $5\frac{1}{2}$. The Indian Standards Institution is trying to introduce standards and various specifications of finished products coming out from different industries. Regarding mica, they are suggesting metric system of measurement in the grading of mica sizes. But as far as the information goes neither the foreign buyers nor the Indian producers seem to be in favour of such method.

Now regarding quality, it will be said that it varies between wide limits due to the presence of impurities in the shape of various forms—both inorganic and organic. Quality is classified into clear, SS, FS, GS, stained, heavily stained and densely stained due to the various and varying types of impurities. Besides, there is another variety of mica which contains lot of black spots and marketed as black-spotted mica. Some researches have been carried out regarding the nature of these spots and the results have already been published. The di-electric strength which in an important property of mica with reference to electrical uses varies according to the amount and nature of the spots. Price of such mica also varies accordingly. The grading of mica into various qualities as is done in India by visual tests, can not be described as a very perfect method. Testing of mica done by electrical devices is being carried out in U. S. A. for grading into quality, and I think this method of mica testing is worth trying in India because this may prove successful in the method of proper grading of mica into different qualities for specific uses.

SPLITTINGS

Mica is split into very thin flakes right down to $\frac{1}{1000}$ of an inch. This art of splittings is carried out very efficiently by Indian labourers and India holds monopoly in this respect. In Bihar alone, about one lac of women are engaged in this splitting work and this may be looked upon as a cottage industry in some district of Bihar.

LABOUR

Regarding labour in the mica industry, the majority of the miners are more or less migratory and imported labourers but some of them have settled down in these localities and may be regarded as local. With regard to the factories the labourers are mostly local. Formerly, the labour bills accounted for about 50% of the mica

mining expenses but after the award of the Industrial Tribunal in 1948, there has been a substantial increase in labour wages which have amounted to more or less 66% of the mica mining expenses. Inspite of this increase in labour wages, efficiency of the labourers has not correspondingly improved. It has rather gone down.

A cess known as 'Labour Welfare Cess' is already being levied at the rate of $2\frac{1}{2}$% on the export of mica and a large sum of money has accumulated in this fund. The economic position of this industry is such that any further increase in the cost of production without corresponding increase in the market value of the shipments will have a serious repercussions on the mica industry by losing her position in the world market. A good proportion of amount accumulated in the Labour Welfare Cess Fund should be utilised for betterment of the living condition of the labourers including housing, supplying of pure drinking water, sanitation and hygiene, medical aid, education including technical training as far as possible. As already pointed out earlier, road communications should be improved by having better roads throughout the mica belt. This is not only necessary for improving production of mica but also essential for labour welfare.

In order to do that and if necessary, certain amount of money from the Labour Welfare Fund may be diverted towards construction and improvement of roads.

MARKETING

From the beginning of the Mica Industry in India in the Eighties of the last Century, the marketing of mica has been confined to a small number of firms and individuals who unfortunately compete amongst themselves and sometimes cut down the prices of mica in an attempt to secure orders for Mica. Mica is also sent on consignment basis to the foreign countries. There is practically no consumption of mica in India. Consequently there is a "buyer's market" in mica and sometimes it is found that the prices obtained are uneconomic. During the Second World

War a buying organisation was set up known as the 'Anglo-American Joint Mica Mission'. The Mission bought everything which was produced by the Mine Owners and the factory owners and if I am not wrong, made large profits inspite of its heavy overhead charges.

State Trading of this important mineral may bring more foreign exchange. The State may offer the mica to the buyers abroad leaving a decent margin of profit. In the First Five Year Plan it was suggested to explore the possibility of setting up a Central Marketing Board for Mica which would reduce the complaints by the foreign purchasers about the quality of mica shipment but nothing appears to have been done so far.

STANDARDISATION

In order to have better results in marketing the different grades and qualities of Indian mica, it is absolutely necessary that we should have a standardised product with regard to grade and quality. Now, it is a matter of great satisfaction that the Indian Standards Institution has already taken upon itself the task of evolving some suitable standards acceptable to both the producers and the consumers. Results of such investigations, I am sure, would be of great help and use to the industry for marketing the mica in a more scientific way.

UTILISATION

It is no use repeating the various applications in different ways, but I would like to mention a few words about the waste or scrap mica which is lying in huge dumps scattered all over the mica fields. This is being exported to foreign countries giving us a very little return. But if finely ground mica can be prepared here and exported, we would certainly get very good return as very finely ground mica has got important industrial uses. I would, therefore, make a suggestion to the mica industry in this country to take up this project of making finely ground mica from the scrap and export it as ground mica. We should also like to have connection with the Government National Laboratories in order to find out suitable means of grinding of the scrap mica into fine powders. I hope the National Laboratories will take up this line of research and help us in the matter.

Another interesting line of utilisation of mica is in the preparation of micanite sheets out of mica splittings. This is an important line of development of mica industry in which India should specialise. A step in this direction would help us in exporting micanites with a better return of foreign currencies. Two Micanite Factories, one in Kodarma and the other in Bhopal, I am glad to say, are under construction.

TAXATION

The incidence of direct taxation (Income-tax) on the Mineral Industries in India, is the heaviest in the World as no depletion allowances are granted for taking out the wasting assets. Substantial allowance and reliefs in the form of depletion in Canada, U. S. A., Australia and other countries of the world are allowed. I am quoting below a resolution recently passed by the Mining and Metallurgical Society America:

> "The council holds that the continuance of a healthy and prosperous mining industry and the contributions it can and should make to the public revenue, to employment, to national security and to the general welfare, depends upon continuing production from now operating mines and the continuing discovering and development of new deposits. Essential to this is the hope for profits commensurate with the difficulties, the effort and the risks of losses involved. The inherent risks in mining cannot be avoided, and taxes should not be imposed in nature or amounts as will kill incentives for incurring these risks and will result in loss of government revenues and harm to the domestic economy."

The total value of minerals produced in India during 1956 was about Rs. 110 crores as compared with Rs. 70 crores in 1954. So there has been an increase of more than 50 percent. The mineral Industries deserves to be given further encouragement and incentives in order to produce more by giving relief from taxation so that the national wealth may be augmented for the successful implementation of the Second Five Year Plan. It will indeed be a short-sighted policy to kill the goose that lays the golden eggs by imposing such deterrant taxes as wealth tax. The Mineral Industries are already groaning under the heavy burden of taxation. The Mineral Industries play an important role in the economy of India and as such deserve to be encouraged in every possible way.

I am quoting below:

Half Yearly Comparative Statement of Indian Mica during 1955—57

	1955			1956			1957		
	Quantity Tons.	Cwt.	Value Rs.	Quantity Tons.	Cwt.	Value Rs.	Quantity Tons.	Cwt.	Value Rs.
Mica Block	862	11	1,30,92,244	1053	14	1,56,90,738	950	8	1,62,65,623
Mica Splittings	4019	1	1,77,87,534	3636	13	1,73,52,425	3986	15	2,38,20,672
Mica Scrap	9298	17	66,00,887	6366	17	80,22,368	9009	17	79,52,587
Mica of Mixed Description	236	3	19,32,027	175	6	19,48,599	112	10	7,12,675

Metals in the Canadian Economy

*By *T. F. Harris*

THE Canadian economy, during the past decade and a half, has exhibited a rate of growth which is probably without parallel in the history of the world. The country's population between 1939 and 1957 has increased by nearly 50 per cent to over 16 million. During the same period per capita national income has risen from $388 or Rs. 1940 to $1340 or Rs. 6700, at the present exchange rate of approximately Rs. 5 to 1 Canadian dollar. The market value of goods and services produced by Canadian residents during 1956 (Gross National Product) reached a record of $29½ billion, or approximately Rs. 14,750 crores, an increase of some 11 per cent over 1955's Gross National Product. If moderately increasing prices are taken into account, the increase was approximately 7 per cent in physical output terms.

One of the most dynamic elements in this history of growth has been the development taking place in the metal's field—both ferrous and non-ferrous. These developments in turn have been sparked by a high and growing level of world demand for Canadian mineral products, as well as by far-reaching technological advances in the fields of mineral exploration and processing.

METAL PRODUCTION IN 1956

Metal production continued its upward trend in 1956 reaching a value of $1,134,400,000, 13 per cent above the 1955 total and constituting 55 per cent of the total value of mineral production. *Quantities and values of all metals produced in Canada in 1955 and 1956 are shown in the table at the end of this article.*

IRON ORE

Iron ore headed the list of actual production gains made. Output in 1956 rose to 22,500,000 short tons, a 38 per cent increase over 1955 and three times the output in 1954. Developments under way indicate a total iron-ore output of between 50,400,000 and 67,200,000 tons within the next decade. More than 13,440,000 tons of the 1956 output came from mines in Labrador and Quebec of the Iron Ore Company of Canada. Additional iron ore output is coming from the treatment of pyrite and pyrrhotite by Noranda Mines Ltd., in two sulphur-iron plants in Ontario, and by International Nickel Company in a new $19 million ammonia-leaching plant at Copper Cliff near Sudbury, Ontario. Eventual actual production from this plant will be at the rate of one million tons of iron ore grading more than 65 per cent.

Increased attention is being paid to properties containing low-to-medium-grade iron ore which are amenable to beneficiation. One such property near Hull, Quebec is being prepared for an annual production of 600,000 tons of pellets containing 66 per cent iron The higher content furnace feed thus obtained enables industry to increase blast furnace production by as much as 20 per cent without expanding capacity.

About 90 per cent of Canada's output of iron ore is now exported. Canadian consumption has increased fivefold since 1938 and in 1956 totalled 6,720,000 tons. Despite increasing output, about 72 per cent of the consumption in 1956 was imported, mainly because of geographic factors and company affiliations.

URANIUM

Uranium has become, in the short space of three years, one of Canada's major metals, and production in 1956 was greater than in any previous year. The feature of the year, however, was not the actual production but the great preparations for additional production during the next few years. The total value of agreements for delivery of uranium upto 1963 has risen to more than $1,500,000,000 and estimates of the gross annual value of uranium production in Canada by 1959 range from $300 million to $400 million. In 1956 uranium was in 8th place among metals produced in Canada, but by 1959 it is expected to be the leading metal produced in this country, unless there is a large increase in the output of one of the other metals, such as nickel.

Canada has been one of the world's leading uranium producers since the beginning of interest in atomic energy and has maintained this position despite greatly increased production in some other countries during the last few years. The recent developments indicate that this country will soon assume a much more prominent place among the world producers, and the ore in the Blind River area of Ontario is now considered to be the largest proved reserve of uranium ore in the world.

* Canadian Government Trade Commissioner, Bombay.

COPPER

Copper production rose to an all-time high of over 706,000,000 lbs. in 1956 and this metal led all others in value of production. The increase was largely due to the expansion in nickel-producing facilities in the Sudbury area of Ontario and of a new output from Quebec's Gaspe and Chibougamau areas. When in full production the new mine of Gaspe Copper Mines Ltd., is expected to produce 125 tons of copper anodes daily. The up-and-coming Chibougamau area, from which production started late in 1953, already has three mines in operation with a combined annual output of over 50 million lbs. of copper, and several other properties nearing production. New copper production will also come this year from properties in several other areas.

About 50 per cent of the world's consumption of copper is ultimately used by the electrical industry for conductors such as wire, cable, bus-bars, etc. Increasing quantities of copper tubing are being used for plumbing. The remainder is used in brass, bronze, cupronickel, nickel-silver, and other copper alloys and as copper salts.

NICKEL

The production in 1956 of 355,986,460 lbs. of nickel valued at $223,343,992 was the largest on record and constituted about 81 per cent of the free world output. Despite this increase in production, supply remained tight as a result of high demand in the fields where nickel is traditionally consumed, as well as a continued expansion the area of this metal's application. While the manufacture of stainless and other alloy steels, and nickel cast-iron accounts for approximately 45 per cent of the nickel used in industry, its characteristics are leading to its being alloyed with various other metals. Electroplating uses about 14 per cent. Other uses are in high-temperature and electrical resistance alloys, catalysts, ceramics and miscellaneous applications. Nimonia and Inconel alloys play an important part in the field for gas turbines and jet engines.

LEAD AND ZINC

Lead and zinc production in Canada is largely from areas in which the two metals occur jointly, often with a small percentage of copper or silver. Production of both these metals in 1956 declined. Zinc output was approximately 847.2 million lbs., 2 per cent lower than in 1955 but still high enough to maintain Canada's position as the world's second largest producer. Lead production has shown a gradual decline during the past few years because of slackening in demand in outside markets. Output in 1956 amounted to 373.3 million lbs. compared with 405.5 million lbs. in 1955. Notwithstanding the decline in production, other promising lead and zinc properties are under development.

To the traditional uses of lead—storage batteries, cable covering, petrol additives—atomic energy has brought a new and expanding use based on lead's quality as a shield against radiation.

Large quantities of zinc continue to be used in galvanising, dyecasting and brass products.

GOLD

Gold, a traditional mainstay of the Canadian mining industry, was produced to a value of $150.8 million in 1956. This was somewhat less than the $157 million worth produced in 1955 which was the highest value since the record year of 1941 and which placed Canada second amongst the world producers of this precious metal. The gold industry continues to be faced with difficult economic problems arising from a fixed price for gold and high production costs and, more recently, the high premium on the Canadian dollar.

ALUMINIUM

The non-ferrous metal smelting and refining industry, Canada's second largest, is based on mineral deposits but is also a heavy user of electric power. Because of the availability of that power, most of the non-ferrous ores mined in Canada are processed within the country and for that reason huge aluminium smelters operate in Quebec and British Columbia using imported ores and concentrates.

Each year since 1952 the Canadian aluminium industry has established a new production record. During 1955, output of The Aluminium Company of Canada Ltd., which is an associate of Indian Aluminium Company Ltd., and is at present Canada's only producer, amounted to 588,000 short tons, placing Canada second in world production. This firm's present smelting capacity is 732,000 tons in its various plants and the expansion programmes now under way or planned will raise that total to 912,000 tons by 1960. Augmenting this output will be that of the newly formed Canadian-British Aluminium Company Ltd., which has a planned output of 120,000 tons by 1960.

Aluminium is finding an expanding range of applications based on its characteristics of low density, high electrical and thermal conductivity, malleability, reflectivity and high strength. In applications where these qualities are essential or desirable it has given, and continues to give, strong competition to traditional metals and other materials.

STEEL

Canada, which ranks seventh in the world in the production of steel, has had in the period since just prior to World War II the greatest proportionate increase in steel productive capacity of any of the world's major steel producers. At January 1957, Canada's steel furnaces had a rated ingot capacity of 5,504,000 net tons per annum, an increase of 6 per cent over one year earlier and of 51.6 per cent over 5 years earlier. Prior to World War II Canada's annual production never exceeded 1,500,000 tons; 1953 production reached 4,200,000 tons. In 1954, due to decreased demand, production was 3,195,000 tons. In 1955 the mills produced 4,442,000 tons and in 1956 a record 5,200,000 tons. Some measure of the industry's future is indicated by the estimate of The Steel Company of Canada that on its Hamilton, Ontario mills alone they will have to spend up to $1 billion for expansion (not including plant maintenance) over the next 20 years.

Despite the remarkable growth of domestic production, Canada imports steel from the United States, the United Kingdom, Europe and Japan. Because of the comparatively small population of Canada, this country will continue to be an importer of certain kinds, sizes and shapes of steel.

From September 8 to October 9 this year, Canada was host to the Sixth Commonwealth Mining and Metallurgical Congress. During that time Canada's mineral industry was on display to delegates from some seventy countries, who visited almost every type of mineral operation in Canada: precious and base-metal mines, coal mines, smelters and metallurgical plants, industrial mineral operations, and petroleum, natural gas and

chemical installations as well as universities and various branches of government administration, research and scientific investigation. Tremendous changes have taken place in almost every field of mineral endeavour since 1927, the year in which the Congress was last h[illegible] in Canada. This article will give the reader at least idea of some of the developments that have taken pl[illegible] in the metal sector of the thriving mineral industry.

Quantities and Values of Metals Produced in Canada, 1955 and 1956

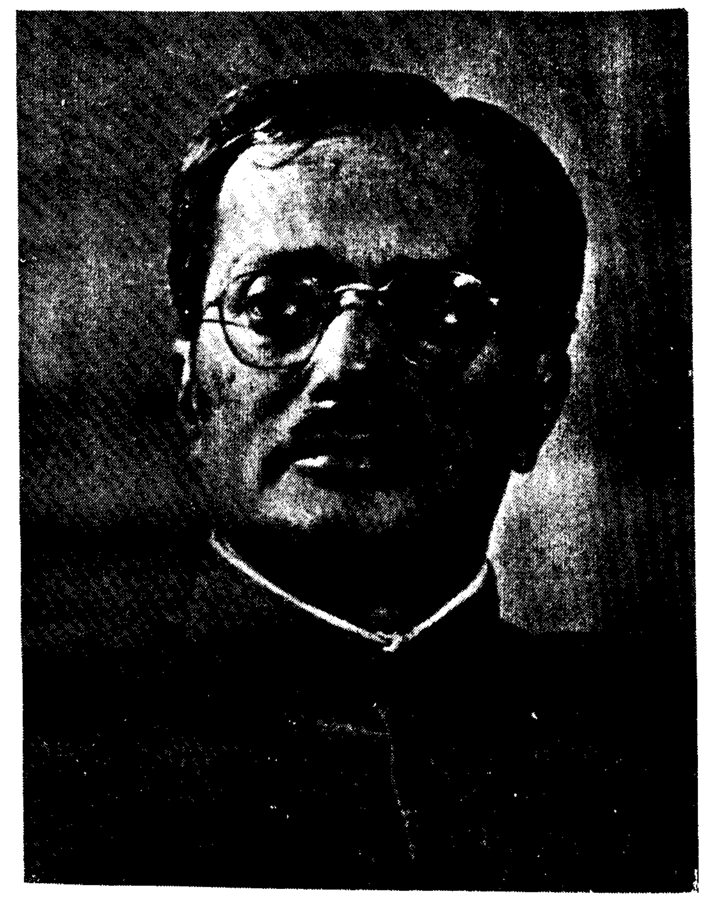
Metals		1955		1956	
		Quantity	Value	Quantity	Value
			$		$
Antimony	lb.	2,021,726	563,345	1,820,000	576,300
Bismuth	,,	265,896	572,362	273,007	494,157
Cadmium	,,	1,919,081	3,262,439	2,258,184	3,838,913
Cerium, rare earths	,,	—	988	—	—
Cobalt	,,	3,318,637	8,563,700	3,685,956	9,372,760
Columbium	,,	42	1,032	—	—
Copper	,,	651,987,423	239,756,455	706,585,547	291,469,615
Gold	oz.t.	4,541,962	156,788,528	4,378,862	150,808,010
Indium	,,	104,774	232,598	358,000	805,500
Iron Ore	ton	16,283,177	110,435,850	22,526,311	156,327,885
Iron Ingots	,,	115,955	4,831,845	157,000	6,339,000
Lead	lb.	405,525,038	58,314,500	373,349,541	57,906,514
Magnesium and Calcium		—	6,585,409	—	5,617,826
Manganese ore	ton	—	—	—	1,90[illegible]
Mercury	lb.	75	250	—	—
Molybdenite	,,	1,389,177	823,954	1,452,028	967,461
Nickel	,,	349,856,997	215,866,007	355,986,460	223,343,99[illegible]
Palladium, iridium, etc.	oz.t.	214,252	8,321,633	161,600	6,495,06[illegible]
Platinum	,,	170,494	14,747,732	150,000	15,585,00[illegible]
Selenium	lb.	427,109	3,203,319	508,000	6,858,00[illegible]
Silver	oz.t.	27,984,204	24,676,472	28,794,573	25,831,61[illegible]
Tantalum	lb.	390	9,760	—	—
Tellurium	,,	9,014	15,774	24,000	42,00[illegible]
Thallium	,,	275	378	—	—
Tin	,,	492,781	408,030	611,000	521,55[illegible]
Titanium ore	ton	1,464	10,634	4,443	37,10[illegible]
Tungsten	lb.	1,942,770	5,508,437	2,206,662	6,060,99[illegible]
Uranium		—	26,031,604	—	39,577,00[illegible]
Zinc	lb.	866,714,038	118,306,466	847,239,825	125,476,21[illegible]
	Total	—	1,007,839,501	—	1,134,354,37[illegible]

BLOWING ONE'S OWN TRUMPET

By *Dr. T. Banerjee, D.Sc.(Dacca), F.I.C., Ph.D.(Lond.), F.R.I.C., F.I.M.

[In this review article the author has described some of the contributions of metallurgists towards the development of railways. He has also described the various researches that are now being carried out in that direction and the results, obtained so far, that can be advantageously utilised by the Railway authorities.]

ARRIVING punctually at the Tatanagar Railway Station I could anyhow enter a First Class compartment of the down Bombay Mail, with my shirt and trousers completely soiled with dust from the handle and the door. Inside also the atmosphere was not cool. Two passengers were arguing about the good and bad of blowing one's own trumpet. One of them was a Railway Officer. He was the object of attack (I do not know why) and his opponent, an educated middle-aged youngman, was in the highest pitch of his excitement and extended his attack on all Indians saying that they speak more and do less. Expecting an approval from me, he looked at me. When I said that there was no harm in blowing one's trumpet, he was taken aback and remarked 'Thou too Brutus.' Yes, conservative people do not look upon this blowing as a good act though almost all are eager for it. After all, can we not take it as a sort of social service? If a doctor praises himself (Concise Oxford Dictionary Third Edition puts 'blowing one's own trumpet' as a 'praising oneself') and does advertisement of himself, we come to know thereby about him and can take his help if and when we require the same. Who does not blow his own trumpet? Innumerable advertisements in various newspapers, journals, magazines, etc. are all but manifestation of the same act. You will say that bees will be automatically attracted by the fragrance of a flower. Spreading good smell, according to botanists, is nothing but an act of advertisement by the flower.



Dr. T. Banerjee

Next let us analyse the word 'one's'. This oneness changes with oneself, his family and so on. Extending the oneness still further, it will mean a country when the advertiser is called a patriot.

Any metallurgist or engineer who will look into the condition of my shirt and cloth, will immediately suggest the use of stainless steel for these handles when no dust can collect on them. It does not mean his advertisement. It will not mean blowing his trumpet. It is just dissipating informations. (The atmosphere has cooled down). You can ask the Railway Officer about the contribution of the metallurgists towards the development of railways.

Really one does not understand why the handle and other parts of a railway compartment are not made from stainless steel. Then those will not rust and such changes will decrease the depreciation cost in the long run and the cleaning cost immediately. And passengers' clothing will be spared! You will speak about the high cost of the imported nickel chromium stainless steel. Yes, stainless steel of 18 : 8 variety is costly as you are to import it by paying a high price. In 1956 alone India had to pay about 4 crores of rupees for importing about 6000 tons of stainless steel. But most probably you are not aware of that National Metallurgical Laboratory has developed various types of stainless steels which contain chromium and manganese and do not contain any nickel. As is well known, India is deficient in nickel, she having no workable nickel deposit. India has to pay at the rate of Rs. 15,000/- per ton of nickel imported.

* Asst. Director, National Metallurgical Laboratory, Jamshedpur.

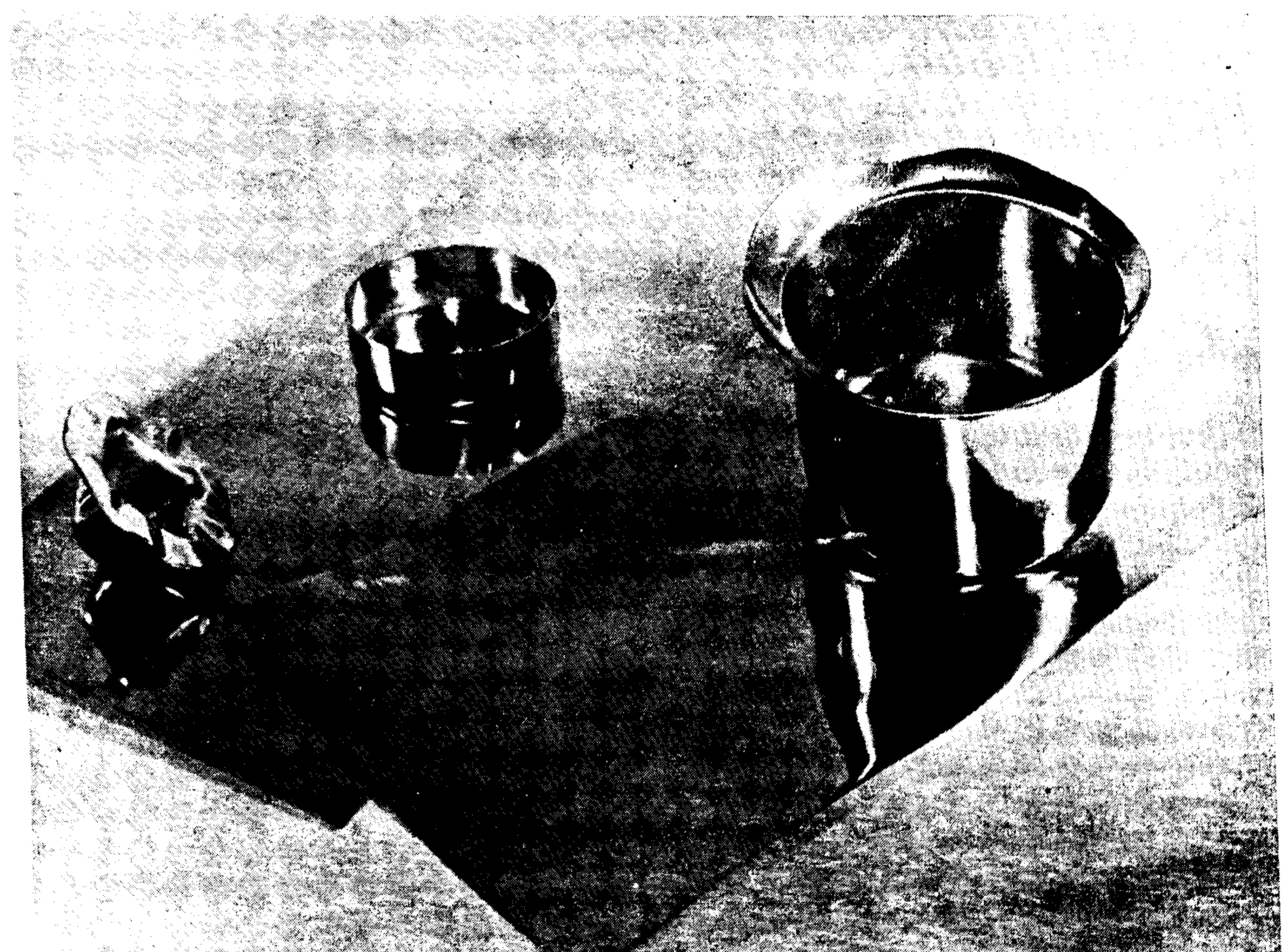
As a result of systematic and painstaking investigations and after making numerous melts, compositions based on the use of totally indigenous alloying elements such as chromium and manganese and not containing nickel have been developed at the National Metallurgical Laboratory. These new substitute stainless steels utilise electrolytic manganese which also has been prepared at the same laboratory from extremely low grade manganese ore containing 10—15% manganese based on methods patented by them.

These stainless steels may be used for automotive wagons and liquid fertiliser tanks. They are very suitable for various railway fittings on the Indian Railway coaches and can be used for cistern and wash basin. If you cared to look into latrines of the third class bogies, you had certainly seen some of the lavatory pans dangerously corroded. Nowadays these are being slowly replaced by imported stainless steel pans. Corrosion of the latrine pans, made of mild steel, is very high due to the corroding action of the fæces, urine and their putrefaction products and also due to alternate wetting and drying. Cr-Mn substitute stainless steel can be profitably used for making those pans.

Let us go to the restaurant car for our breakfast. The stainless steel utensils, you use there, can be replaced by the substitute stainless steel ones. Extensive study on the corrosion resistance of this indigenous stainless steel in citric acid, tartaric acid and lime juice with or without salt have proved beyond doubt its suitability for tumblers, flatwares like thalis and katories, spoon, pots, pressure cookers and various other requirements of an Indian house or restaurant.

We shall find during our discussion that nickel bearing stainless steel is being used or recommended for use in various part of the locomotive or the bogies. The Cr-Mn stainless steel can effectively replace the nickel bearing (containing about 8—10% nickel) stainless steel with considerable savings in foreign exchange. Railways are maintaining a number of hospitals involving great expenditure. Here again the substitute stainless steel can help you in saving some money, as hospital wares made out of it can resist corrosion in presence of various disinfectants, including lysol. Engineers can easily use this steel to meet their requirements about high strength structural steel. The substitute stainless steel possesses ideal resistance to industrial atmosphere and marine corrosion.

You might be thinking that we are not going ahead with the production of electrolytic manganese. We have done ample work in this direction. By working on a pilot plant scale, we have been able to collect optimum conditions for the production of electrolytic manganese from very low grade manganese ores which, at present, have no use and market and are being dumped at the mine-site. For every ton of high grade manganese ore mined either for consumption in India or for export, on the average one and a half tons of this low grade ores are dumped without any possibility of its immediate use. Total reserve of Indian manganese ores has been put at 150 million tons, of which 60 million tons are expected to be high grade, leaving 90 millions as low grade. We can very easily produce electrolytic manganese by electrolysing solution of manganese sulphate, produced from low grade ores, and ammonium sulphate. The cathode is of stainless steel and the anode is made from lead silver alloy sheet. You are enquiring about the cost of production of electrolytic manganese. I am sorry, I should have given you that figure before. If you produce 10 tons per day using ores containing 25% Mn, the cost of production of electrolytic manganese will be below Rs. 1200/- per ton. We

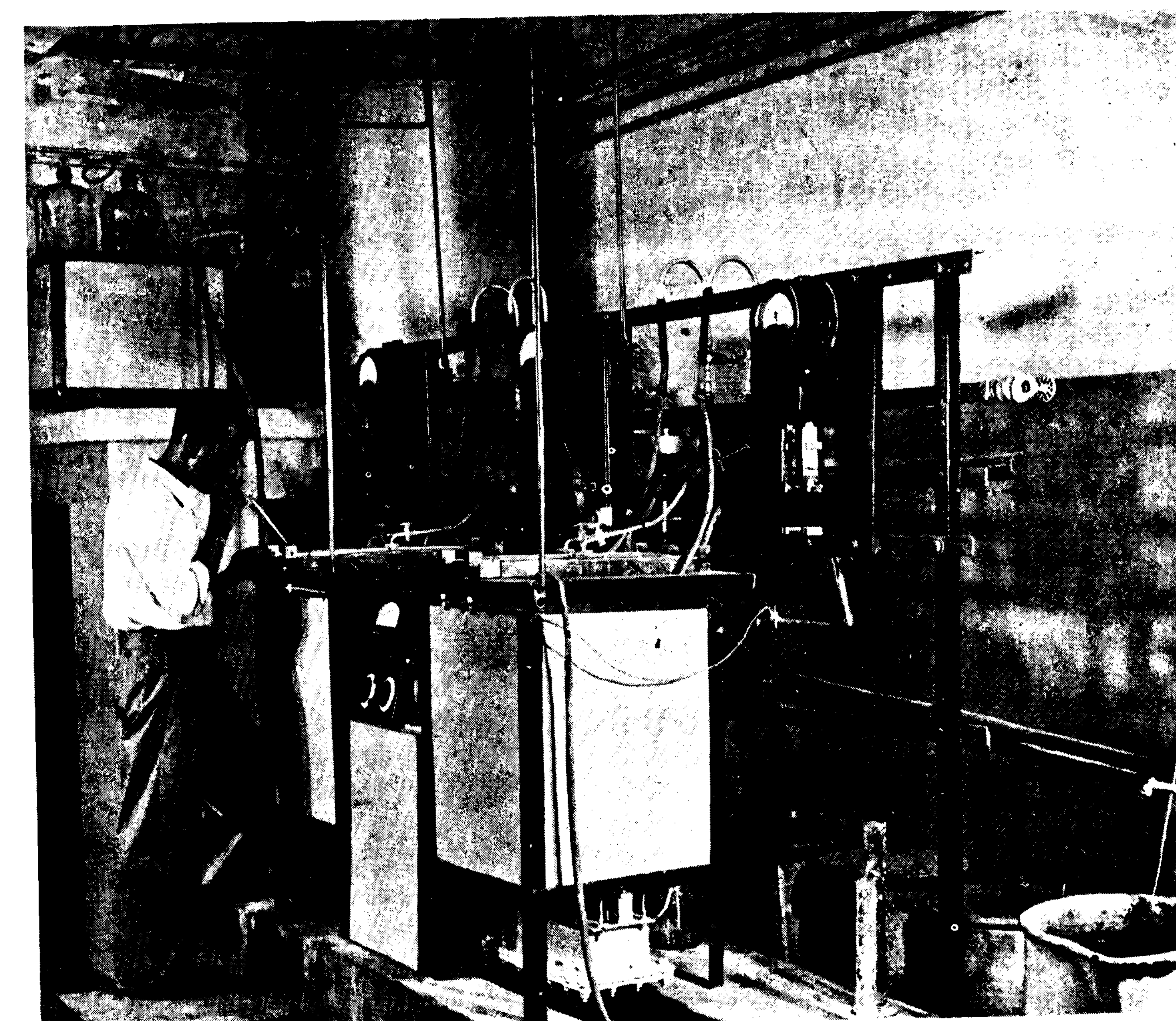


Substitute stainless steel sheets and utensils made out of them.

are importing the same at Rs. 3000/- per ton. It is now learnt that price has gone fabulously high.

What station is this? Kharagpur. I remember a few days before an employee of the Railways died in an accident due to some trouble in the engine. Of course I do not remember the details now. Intensive research work should be carried on the high temperature corrosion of boiler and allied problems. The informations which workers of various countries have accumulated are immense but more requires to be collected. The grate bars for firing coal is generally of cast iron which quickly deteriorate due to the combined effect of oxidation, slagging and growth. In your house you have certainly noted that grate bars of the 'chulli' corrode highly and quickly due to high temperature oxidation and attack by the alkaline ash from the coal. Use of nickel chromium cast iron of Ni-resistant type, chromium white iron or silicon iron of the 'silal' or 'Nicro-silal' type will largely increase the life of these gratings. Ni-Cr steels can also be used for fire boxes, fire doors, automatic stokers, etc.

The addition of alkali to boiler water for increasing the pH of water to 11 to 11.5 is necessary as the corrosion is then the least. Addition of sulphites, ferrous hydroxide, nitrides or any other organic reducer should be made to remove dissolved oxygen which gives rise to pitting type of attack. The alkali may induce caustic cracking of boiler which can be



Manganese Pilot Plant at the National Metallurgical Laboratory, Jamshedpur.

avoided by adding sodium nitrate with concentration maintained at about 20—30% of the sodium hydroxide alkalinity. With increasing use of higher boiler pressure it is necessary to use alloy steel for the manufacture of boilers. Use of 3.0% nickel steel, having a maximum tensile strength of 70,000 lbs. per sq. inch gives very satisfactory life. This steel also resist embrittlement much better than other steels. In America steels with carbon content of 0.1%—0.2% and about 20% nickel has been used for boiler tubes; cylinders and piston rings can also be made of nickel steel (containing 0.5—1% nickel).

Coming to railway bogies and wagons, their mild steel bodies are to be protected from corrosion. Paints should have both good corrosion resistance and mechanical properties as in addition to atmospheric attack, they are exposed to a blast of cinder, sand and stones. Specially this is more acute in desert areas. Iron oxide in ordinary linseed oil is too soft but use of tung oil, stand oil, synthetic resin etc., gives better result. Further increase in life of paint can be obtained by an additional layer of water repellent like calcium soap, aluminium soap, etc. For good adhesion of a paint the steel base or frames are given a preliminary treatment, known as phosphatising, bonderising or parkerising (these latter two being the patent names) whereby an inorganic phosphate coating is formed on the base. This coating, which is responsible for good adhesion of the paint coat, is produced by dipping the panel in a metal phosphate solution. Anybody who has gone to Perambur coach factory has seen the large phosphatising tank.

Metallising by aluminium of wagons and tanks will also increase their life. Aluminium metal is now being used, as is being done by Hindusthan Aircraft Ltd., for making passenger bogies. Stainless steel is also used for the same. Nickel steel has been used to build wagons for carrying coal because of its high strength and resistance to corrosion.

The heavy cast steel frames of locomotive wheel centres, steel cylinders, axles, crank pins, etc., when made with low nickel steel, give longer life and greater weight carrying capacity. They also possess good resistance to atmospheric corrosion. Use of substitute Cr-Mn steel deserves investigational verification. 1—2.5% Mn containing Al-Mn steel can also be used when high corrosion resistance with excellent mechanical properties is wanted.

I think you agree to the importance of using good

(Continued on page 29)

Brasses for Engineering Purposes

*By *S. S. Khanna*, B. Sc. (Met.)

THE word " Brass is commonly used as a general term for the whole range of copper-zinc alloys although in particular it is used for those alloys containing only 50 to 80% of copper rest being zinc. Now brasses are being used at each and every place in the Engineering side as well as domestic side. The various brasses have their own distinct extensive use due to their properties and ease with which they can be cast, extruded forged, rolled, pressed, drawn, machined or otherwise fabricated and polished. These alloys are also corrosion resistant to marine and atmospheric effects so they are extensively used for fine and minute machineries as watches, meters etc.

The different compositions and uses to which they are put to are tabulated in Table A.

The most commonly used brass in foundry is the Muntz metal or 60/40 Brass. It has got a structure of L+B brass i.e. an eutectic of L & B brass. This is the most extensively used composition in Engineering field. It is used for hot rolling of sheets plates, extruded section and castings used in machine parts. Brass articles are very common in use. They can be as small as micro screws used in watch industry to as big casting as the propeller blades of huge ships.

After hot working the properties are as follows:

Tensile strength	30 tons/sq. inch.
Elongation	40 Percent.
Youngs Modulas	14×10^6 lb./sq. inch.
Thermal Expansion	0.000020 per degree centigrade
Conductivity	29%

(Continued from page 28)

wear resistant steel for the rails. Long life due to superior wearing quality and good corrosion resistance or both can be achieved by the addition of manganese, copper, nickel, chromium, etc. Of all steels, austenitic manganese type steel, with or without 3% Ni, has proved to be the best. But because of its high cost its use has been limited, as mentioned before, to locations of intense wear e. g., switches and crossings carrying very heavy traffic. These are the places responsible for miseries and woes of many families. In case of pronounced gradient 0.8% Cr. steel rails has been recommended. The presence of 0.2% to 0.4% copper in steel reduces the corrosion when the track is laid in the open in a comparatively mild atmosphere. For highly polluted atmospheres of tunnels, places near the sea-coast or factories, rails should be given sufficient protective measures with paints containing special resins or black bituminous paint or asphalt. This will reduce the tendency of the rails to pit, which gives rise to fatigue failure of rails.

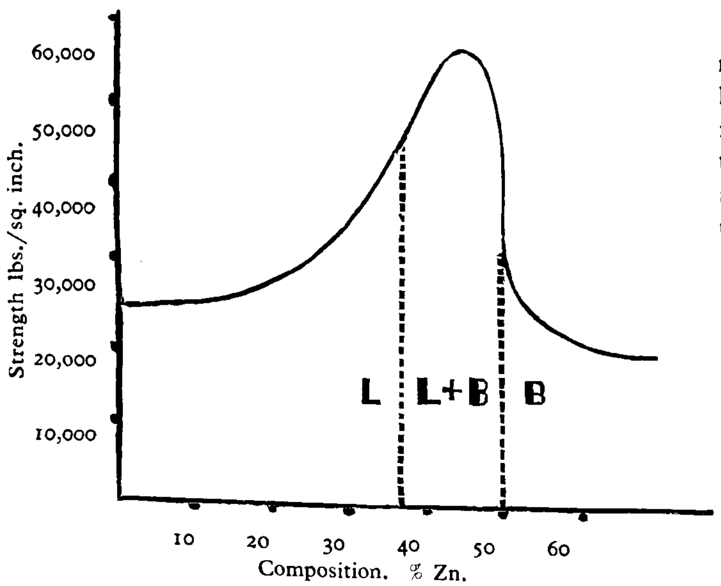
At the National Metallurgical Laboratory we are always eager to be of use to industries and organisations. We have started systematic investigations on alloy steels. Some of the projects in which Railway authorities may be interested are wears of wheels and rails, production of bearing material without tin, such as tinless bronze, etc.

We are nearing Howrah. We shall have more discussion when we meet next. Your friend is a Manganese Ore Magnet! He has already become interested in our projects and wants to know more about substitute stainless steels and electrolytic manganese. If he writes to our Director, Dr. B. R. Nijhawan, we can send him the relevant reports.

So Brother, blowing one's own trumpet has worked. You want to visit our laboratory during your return journey? You are welcome and I shall be glad to take industrialists like you round on any working day. Of course, Saturday is the day when visitors in general are admitted and the staff of our Liaison & Intelligence Section take them round blowing N. M. L. trumpet, of course, in a sweet melody.

Cheerio! Good Day.

* Lecturer in Metallurgy, Banaras Hindu University, Varnasi.



It is clear from the above diagram that the strength of cast brasses increases from about 20,000 lbs./sq. inch to more than 60,000 lbs./sq. inch with 45% Zinc, so that, by chosing the proper composition any desired strength within the limits may be obtained.

Melting Practice :— Brasses have a melting point ranging from 950 to 1100°C. Previously people were having the idea that for melting these non-ferrous metals reducing atmosphere is suitable to minimise the evaporation and oxidation losses of such metals as Zinc. But after extensive investigation now it has become a practice to use an oxidising atmosphere with a flux or reducing covering on the molten metal. The fluxes used are :—

Charcoal Powder	3%
Borax	2%
or Salt upto	5%

Borax has been found to be the best flux for brasses.

Any type of furnace Electric Induction, Oil fired or Coke fired furnace can be used.

Preparation of Alloys :—It is one of the most easiest type of alloy which can be prepared in the foundry, but on the other hand it is a difficult too. Because if the additions are not done at suitable temperature or if the

furnace atmosphere is not controlled properly then economic production of the alloy will not be possible and the whole aim of metallurgist will be gone. The standard practice can be classified as follows.

(1) The crucible is first preheated before charging the material into it. This is done so as to prevent cracking of the crucible due to the sudden change in temperature.

(2) The calculated amount of copper (pure) Electrical or scrap is charged. When this has melted down the surface is covered with charcoal and flux. This is done so to prevent oxidation and gasification.

(3) When the metal has become molten it is taken out of the furnace and Zinc and other alloying elements are added in small pieces before the casting. At the time of addition of Zinc the temperature of the bath should not be very high otherwise evaporation losses will be more.

The following precautions should be observed to reduce evaporation losses.

(1) Melting period should be short.

(2) The crucible should be full all the times and charging should be done in parts so that the cold metal over hot metal acts as a covering.

(3) Zinc is to be added in the last stage.

(4) This should be added in small pieces and should be slightly heated before charging.

(5) Zinc pieces should be pressed in the molten metal with stirring rod and they should be regularly stirred.

To increase the machinability sometimes 1 to 3% of Lead is added in the metal. This does not forms any alloy with either of the two metal but remains in suspension and increases the machinability. Inspite of all these precautions for compensating evaporation losses about 1 gm. for every 15 gms. of Zinc more should be weighed for the charge.

After the alloying elements have gone into solution the metal is poured into ingots or castings, at suitable pouring temperature to minimise the pipe formation.

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ANNOUNCEMENT

We have pleasure in announcing to all our Readers and Advertisers that we propose to bring out a special Number to our Magazine entitled "EIGHTH ANNIVERSARY TRANSPORT & ENGINEERING" sometime in January 1958.

EDITOR.

BRASSES

TABLE—A

Name	Composition % Cu	% Zn	% Pb	% Sn	% Others	Typical Mechanical properties Elastic Temp.	Tensile Strength Tons/Sq. In.	Elongation %	Brinell Hardness	Remarks
Cap copper	95	5	—	—	—	1(A) 12(H)	16(A) 30(H)	40(A) 4(H)	60(A) 140(H)	Caps for ammunition
Gilding Metal	90	10	—	—	—	2(A) 15(H)	18(A) 33(H)	55(A) 4(H)	60(A) 150(H)	Used for architectural metal work, imitation Jewellery.
Cartridge Brass	70	30	—	—	—	3.5(A) 18(H)	21(A) 45(H)	70(A) 5(H)	65(A) 185(H)	Deep drawing brass with maximum ductility, used for locomotive & condenser tubes and cartridge cases.
Ordinary Brass	65	35	—	—	—	4(A) 18(H)	21(A) 45(H)	65(A) 4(H)	65(A) 185(H)	A good cold working alloy, Used for utensils and general castings.
Yellow or Muntz Metal	60	40	—	—	—	4	24	40	75	Used for Hot stampings, sheets etc. Alloys hot worked only.
Leaded Brass	62.5	36	1.5	—	—	4(A) 10(H)	21(A) 35(H)	55(A) 5(H)	65(A) 150(H)	Good machinability.
Admiralty Brass	70	29	—	1	—	4(A) 15(H)	22(A) 38(H)	70(A) 10(H)	65(A) 175(H)	Resistant to corrosion by sea water. Used for tubes, plates etc.
Naval Brass	59	40	—	1	—	5 — 10	24 — 30	20 — 40	80 — 120	Fairly resistant to corrosion by sea water. Used for Marine Castings.
Manganese Bronze or High Tensile Brass	58	39	—	1.4	1% Fe .4% Al .2% Mn	8	33	25	120	Alloys combining high strength with fair corrosion resistance. only hot-worked. Used for Marine Propellers, water turbine runners, bodies of large or reciprocating pumps, autoclave valves, gear wheels etc.

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A — Annealed condition.
H — Most fully work hardened condition.

WHY USE ALLOYS?

By *H. N. Sinha, B. Sc. (Met. Engg.), Banaras, M. Eng. Sc., Ph. D. (Melb.), A. I. M. (Lond.)

METALS in their pure state find a very limited application as engineering materials because they lack the required physical and mechanical properties. Recent developments in the fields of engineering and technology have placed a very heavy premium on materials and specifications which have become very rigid can no longer be met by pure metals. The properties of metals can, however, be improved by the addition of other metals and non-metals. The ever growing importance of alloys is quite evident from the amount of research which is being done in alloy technology and the number of new alloys which are constantly being developed. It is the skill of the metallurgists to develop and manipulate new alloys which is responsible for the present level of engineering and technology. Steel, which is at the root of our material civilization, furnishes a very good example of the importance of alloys as it is essentially an alloy of iron and carbon with the addition of other elements such as manganese, silicon, phosphorus, sulphur, etc., added either deliberately or otherwise.

STRUCTURE OF METALS

The crystalline nature of the metals is very well established and each crystal of a metal is built up by a symmetrical arrangement of atoms in space. The atoms are closely packed in a manner that they accommodate the forces between them. The structure repeats indefinitely in all directions and is bounded by the boundaries of the individual grains. All the grains have the same structure but different orientation in space and the grain boundary is a zone in which the atomic arrangement is not perfectly regular since it exhibits the transition state from one orientation to another.

Metals, generally, have a space lattice out of the following three common types of symmetry i. e. (a) face centred cubic (b) body-centred cubic and (c) closed-packed hexagonal structure. Most engineering materials conform to one of these three types of structure, but the actual dimensions of the unit cell are characteristic of the particular metal; though there are some minor deviations from these types also.

In the case of metallic crystals, the calculated values of the strength are far greater than those obtained in ordinary tensile tests. The discrepancy may be attributed to the fact that most metallic crystals contain either imperfections or a secondary structure of some kind which is responsible for weakness. Also, as the plastic deformation occurs by the gliding of one plane of atoms over another and the slip takes place along the planes of maximum atomic density; pure metals which usually have simple space lattice and symmetry are prove to easy deformation, thus exhibiting low mechanical properties.

MECHANISM OF ALLOY FORMATION

When a metal is added to another metal to form an alloy, in majority of the cases the alloying addition enters into a solid solution with the parent metal. If it be so, the atoms of the solute must find places for themselves within the frame work of the lattice of the solvent metal. This can be achieved in two ways:—that the atoms of the solute element should occupy lattice site of the parent metal, or that the atoms of the alloying element should occupy space in the interestices of the parent lattice. The two types of the above solutions are called, 'Substitutional' and 'Interestitial' solid solutions respectively. Substitutional type of solid solution is by far the most common; interestitial solutions are generally formed only by small atoms such as carbon, nitrogen and hydrogen, which can be easily and readily accommodated in the spaces available.

During the addition of an alloying element, a stage reaches when sufficient foreign atoms have been added and any further addition makes the solid solution unstable. At this stage a new phase appears which is of such a structure as to accommodate the interatomic forces conveniently.

The introduction of a new atom of a different size from the parent lattice causes a greater or lesser distortion in the atomic pattern and this leads to a greater resistance to deformation than does the regular atomic pattern of the pure metal. The alloy is thus harder and stronger than the parent metal.

The presence of separate phases produced by alloying

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is also quite important vis a vis to the mechanical properties of the alloy. The occurrence of the different phases in a variety of forms ranging from needle like to globular shapes and the response of the alloy to heat-treatment influences to a great extent the physical and mechanical properties of the alloy. It also provides a scope to metallurgists to vary the properties of alloys without altering their chemical composition.

MINOR ADDITIONS

Generally, by alloying it is assumed that the additions to a metal have to be made in large quantities to substantially change its structure and mechanical properties. However, the role of minor additions (elements below 1%) in affecting considerable changes in the properties of metals cannot be over emphasized when it is considered that the addition say, of half a per cent of carbon to iron results in an alloy which is enormously stronger and more versatile than the parent metal. Similarly, an increase of sulphur and phosphorus over 0.05% is harmful in steel. It is sometimes observed that the presence of a very small quantity say of the order of 0.005 per cent exerts a marked influence on the properties of a metal. The hot rolling properties of copper containing as much as 0.005 per cent bismuth are seriously impaired and as hot rolling is very often practised to make copper sheets, the presence of bismuth even in small quantities is most undesirable. Likewise, there are numerous other examples where minor additions have been used to modify the specific physical or chemical properties of metals and alloys. Some of the examples include, addition of about 0.5 per cent of titanium to stainless steel to prevent weld decay; addition of 0.75 per cent thoria to tungsten filaments to inhibit undue grain growth; presence of 0.36 per cent of lithium to eliminate the harmful effects of bismuth on copper; addition of 0.01 per cent oxygen to high conductivity copper to improve its working properties, etc.

SOME IMPORTANT ALLOYS

With the rapid developments in the technical fields especially in aviation, atomic energy etc., there has not only been a demand for newer materials but also of materials which are supposed to operate under diverse conditions. Thus, it may not be possible to find any one material which may be found satisfactory under many circumstances and the number of alloys in use in the recent years has reached a few thousand.

In view of the large number of commercial alloys which have been developed and the limited scope of this paper, it is proposed to include and discuss under various groups only a few of the important alloys. The groups have been made with respect to very similar properties and utility of the various alloys.

I. EASILY FABRICATED ALLOYS

The first category of alloys is those which are widely used in a fabricated form and are not expected to bear any appreciable load. These materials are easy to work and machine, can be deep drawn and rolled into sheets. Some of the important alloys are as follows:

Mild Steel: 0.2—0.3% C—widely used for agricultural implements, automobile accessories, building and construction hardware, electrical equipment, metal containers, wires, pressed and formed articles, galvanized sheets, etc.

Alpha Brasses: 70% Cu, 30% Zn—deep drawn structures, cartridges, condenser tubes.

Nickel Silver: 60—65% Cu, 7—30% Ni and remainder Zn—as a base for flat ware or hollow-ware, food handling equipment, marine fittings, optical & jewellery industries, spring elements in electrical relays.

Screw stock or free machining alloys: Generally steels containing 0.25% S or 0.25% Pb which make machining operations very easy.

II. HIGH STRENGTH ALLOYS

This group includes alloys which combine high strength with toughness and also corrosion resistance. They are alloys of construction and are used as wrought structural alloys. Some of them find their application for automobile parts such as shafts, connecting rod, gear, pinions and springs.

Nickel structural steels: 0.4—0.5% C and 3—4% Ni; U. T. S. 90,000—115,000 Psi.

Mild alloy structural steels: Contain 0.2—9.25% C and combination of either 3—4% Ni and 1—2% Cr or 0.75—1% Cr and 0.15—0.2% V.

High carbon, high tensile steels: 0.8—1.0% C—used for cable wires in suspension bridges etc.

Spring steels: They require a combination of strength, toughness and high yield strength. These properties are met by:

(i) Chromium—vanadium steels—0.4—0.5% C, 0.8—1.0% Cr and 0.15—02% V.

(ii) Silico-manganese steels: 1.8—2.25% Si and 0.7—1.0% Mn.

Besides the steels, light metal alloys (alloys of aluminium and magnesium) have also been extensively developed as high strength alloys. These alloys are as strong as steels when considered on the weight basis. Because of their light-weight, high strength and machinability, the alloys described below have been widely used in air-craft motors and structural parts, parts of rapidly moving machinery in the textile industry, portable equipment, etc.

Duralumin: 4% Cu, 0.5% Mn, 0.5% Mg and remainder Al., age hardening type.

Hinduminium: 1.5—3.0% Cu, 4—6% Zn, 2—4% Mn and remainder Al., besides strength these alloys are resistant to corrosion also.

Y-Alloy: 4% Cu, 1% Mg, 2% Ni and remainder Al—corrosion resistant as well.

Magnesium alloys: 2.7—3.5% Al, 0.2% Mn, 0.6—14% Zn and remainder Mg.

III. CORROSION RESISTANT MATERIALS

The third group of alloys includes materials which are resistant to water and atmospheric corrosion.

Wrought Iron: resistant to water and atmospheric corrosion used for stay bolts, hooks and chains.

Brasses:

(i) Muntz Metal: 60% Cu and 40% Zn.

(ii) Admiralty Brass: 70% Cu, 1—1.5% Sn and remainder Zn.

(iii) Naval Brass: 60% Cu, 1% Sn and remainder Zn.

Bronzes:

(i) Gun metal: 88% Cu, 10% Sn and 2% Zn.

(ii) Aluminium Bronze: 90% Cu and 10% Al.

(iii) Manganese Bronze: 61% Cu, 0.25% Mn, 0.75% Al, 0.75% Sn and remainder Zn.

Cupro-nickel: 70% Cu and 30% Ni.

The above described copper base alloys are used for making condenser tubes, valve stems, propellers, pump bodies, marine castings, etc.

IV. CHEMICAL ATTACK AND HEAT RESISTANT ALLOYS

Besides atmospheric and water corrosion, certain alloys are required to withstand the chemical attack and also retain their strength at elevated temperatures. High temperature alloys are the necessity for gas turbines, jet engines, etc. and concentrated efforts are constantly being made to develop such alloys. The alloys in this group are:

Stainless Steels:

(i) Hardenable type: 12—16% Cr.

(ii) Ferritic type: 16% Cr and above and low carbon

(iii) Austenitic type: combined Ni and Cr over 24% with not less than 7% of either; a typical composition is 18% Cr and 8% Ni.

Silchrome: 8—9% Cr, 3.5% Si and 0.4—0.45% C—exhaust value of aircraft engines.

Monel: 65—67% Ni and 30% Cu.

Inconel: 75—78% Ni, 0.2% Cu, 12.5—14% Cr and 6.5% Fe.

Nimonic alloys: Nickel base with additions of chromium, molybdenum, titanium, vanadium, etc.

Titanium base alloys: with additions of Al, Cr, etc.

Though not essentially the alloys of metals, a new and interesting field of research to develop high temperature materials has been on 'Cermets' which are ceramic base materials with the addition of metals to provide the bond and plasticity and formability. Cermets are used as turbine parts.

V. WEAR RESISTANT ALLOYS

In certain applications especially for rail roads, railway crossings, grinding balls, crusher parts, shovels, etc. alloys having wear resistant properties are required. The typical of these are:

Rail Steel: 0.6—0.8% C and 0.7—1.0% Mn.

Hadfield steel: 0.9—1% C, 10—14% Mn and 0.3—1% Si—austenitic in character and has a very good wear and abrasion resistance.

VI. TOOL MATERIALS

Tool materials are very important to ensure production and proper finishing of the engineering products. Besides hardness and strength, these alloys in many cases are expected to be non-deforming and also retain strength at elevated temperatures. Mostly alloy steels are used as tool materials and alloying elements which are generally added include chromium, vanadium, tungsten and manganese.

High speed steel: 18% W, 4% Cr and 1% V.

Silico manganese punch and chisel tool: 1.75—2.25% Si, 0.6—0.9% Mn and 0.5—0.7%C.

Die Steels:

(i) High carbon and high chromium: 12—15% Cr and 1—1.5%C

(ii) Tungsten die steels: 8—19% W, 2—4% Cr, 0.25—0.6% C and 0.3—0.6% V.

(iii) Non-deforming dies: 0.8—1.0% C, 0.2—0.4% Si, 0.1—025% V and 1.5—1.75% Mn.

Beryllium Copper: 2—2.25% Be and remainder Cu—Age hardening type used as non-sparking tools in mines etc.

Sintered carbides such as tungsten carbide with mixtures of titanium and tantalum carbides are also used as tool bits.

VII. BEARING ALLOYS

This is an interesting and 'important group of alloys and perhaps no other material is required to meet so many conditions as a bearing alloy. Hence a large number of alloys have been developed for different uses.

Tin base alloys:

(i) 80% Sn, 10% Sb and 4% Cu.

(ii) 90% Sn, 5% Sb and 5% Cu.

Lead base alloys: 82.5% Pb, 15% Sb and 1% Sn—heavy duty.

Cadmium base alloys:

(i) 98.5% Cd and 1% Ni.

(ii) 0.5—2.25% Ag. and remainder Cd.

(iii) 96—25% Cd, 3% Ag and 0.75% Cu.

Lead Bronzes: 80% Cu, 10% Sn and 10% Pb.

Alkaline earth metals bearing alloys: 96.5% Pb 0.4—0.5% Ca. and 2.5—3% Ba.

VIII. ALLOYS WITH ELECTRICAL AND MAGNETIC PROPERTIES

Finally the alloys which are used for properties such as electrical resistance, magnetic permeability and hysteresis losses, retention of magnetic properties etc. have been described below.

Electrical resistors:

(i) Nichrome: 80% Ni and 20% Cr.

(ii) Manganin: 4% Ni, 12% Mn and 84% Cr.

Transformer Sheets: 4% Si and—0.1% C.

Permanent Magnets: 10% Al, 16% Ni, 12% Co, 6% Cu, 0.7% Ti

(i) Alnico

(ii) Tungsten alloy steels: 0.7% C, 0.20% Cr, 5.5% W.

The description of various alloys given above is by no means exhaustive. New advances and developments are constantly being made in alloy technology and thus new alloys are developed every now and then. However, this paper has included some of the important alloys used in industry and elsewhere and has perhaps provided an answer to the question which was posed at the outset.

Possibility of Ferro-Manganese Manufacture in India by the Blast Furnace Technique

*By *A. K. Moitra*

INDIA, barring Russia, is the world's biggest supplier of high grade manganese ore which is largely used for the manufacture of ferro-manganese required in the making of steel. The outside demand for manganese ore is generally met by raw, unprocessed, high grade ore obtained by picking from blasted ore burden at the quarries. The reserves of high grade manganese ore are assessed at half the total Indian reserves of 120 million tons. In fact the position of the actual reserves may considerably improve on further exploration. Our high grade ores have been substantially depleted over the past decades by export to world markets for the urgent and irreplaceable use of ferro-manganese in the steel industry. The sale of high quality manganese ore has, no doubt, helped us greatly in earning foreign exchange but not to the extent it could do if the raw ores were processed within the country and sold as ferro-manganese.

Indigenous manufacture of high grade ferro-manganese is also needed to meet the home requirements consequent on the installation of new steel plants. Any surplus may be exported to earn foreign exchange, which will be more than twice our earnings by export of raw manganese ore. The foreign exchange earned by export of nearly a million tons of manganese ore amounts to about Rs. 15 crores a year, but the conversion of these high grade ores should yield about 350,000 tons of exportable grade ferro-manganese a year (containing phosphorus less than 0.3 per cent), which will fetch at least Rs. 30 crores a year, if not more. The economic benefits accruing are evident.

During the Second Plan period, licences have been granted for the production of approximately 160,000 tons of ferro-manganese, mostly by the electro-thermal process. However, it is known that the blast furnace technique of ferro-manganese manufacture is considerably cheaper than the electro-thermal process. It is estimated that the cost of manufacture of standard ferro-manganese by the blast furnace technique will be about Rs. 550—600/- per ton as against Rs. 750/800 by the electro-thermal process.

The electro-thermal process will also require low phosphorus and low ash coke (not manufactured in the country at present), although the requirements of such cokes per ton of ferro-manganese manufactured is only about 0.5—0.7 ton/ton of ferro-manganese as against 2.0—2.5 ton/ton of ferro-manganese by the blast furnace technique. The blast furnace method for the manufacture of high grade ferro-manganese has not been adopted so far because of lack of coke of suitable quality. *In view of the experiments carried out at the Central Fuel Research Institute on blending of coals for production of metallurgical coke, it now appears feasible to produce high grade exportable ferro-manganese by the blast furnace technique from indigenous coals by careful selection of blends. In fact, coke of this quality will be produced at the Durgapur Coke Oven Plant whose capacity can be increased for the production of coke required for ferro-manganese manufacture.*

SPECIFICATIONS OF FERRO-MANGANESE

Some typical analyses of the ferro-alloys used in the steel industry based on Indian high grade manganese ore are given below:

		Mn%	Fe%	C%	Si%	P%	S%
Standard ferro-manganese		78-82	12-16	6-8	1-0 (max.)	.30-.35 max.	.05 max.
Low carbon ferro-manganese	1	90	—	.07 max.	1.0 max.	.06 max.	.05 max.
	2	80-85	—	.10 max.	,,	.2 max.	,,
	3	80-85	—	.20 max.	,,	,,	,,
	4	,,	—	.30 max.	1.0 max.	.2 max.	
	5	,,	—	.50 max.	,,	,,	
	6	,,	—	.75 max.	7.0 max.	.25 max.	

* Central Fuel Research Institute.

	Mn%	Fe%	C%	Si%	P%	S%
Medium carbon Ferro-manganese.	80–85	—	1.50 max.	1.50 max.		
Spiegeleisen 1 or	16–19	—	6.5 max.	3.0 max.		
Spiegeleisen 2 alloy of iron and manga-	19–21	—	"	"		
nese 3	26–28	—	"	1.0 max.		
Electrolytic manganese	99–98	.001 max.	.004	nil		
Manganese metal Thermit	95–98	2–2.5	.06–.20	1–1.5		

It will be interesting to compare the composition of high carbon ferro-manganese made in India by the blast furnace technique and the quality used in America.

	Indian Fe-Mn per cent	'Standard' Grade Fe-Mn per cent.
Manganese	70/75	78/82
Carbon	6/8	7/5 max.
Phosphorus	.5/.6	.35 max.
Sulphur	.027	.05 max.
Silicon	.55	1.24 max.

The high phosphorus in our home product is mainly due to high phosphorus from the ash in our coke. The table below shows the difference in the quality of coke used in India and America in the blast furnace method of producing ferro-manganese.

COKE ANALYSIS

	India	America
Phosphorus	.18/.25%	.01/.012 %
Iron	1.25/2.3%	.75/.85 %

The average Indian ore "(oriental mixture)" has the following approximate composition :.

Mn.	Fe	SiO_2	Phosphorus
48/52%	6/8%	8%	0.10%

The manganese-iron ratio is about 7 : 1 against the Caucasian ore ratio of 60 : 1, Gold Coast 10 : 1 and Brazil 12 : 1.

The quality of manganese ore together with the Indian coke used does not give a blast furnace smelted ferro-manganese of desired quality for the export market. By careful selection of ore resources, it is possible to get manganese ore of lower phosphorus content i. e. having a maximum of about 0.09 phosphorus from Madhya Pradesh. The more serious drawback however, is the quality of Indian coke, which has an average phosphorus content of 0.2% and an iron content of 1 to 2.5%. Since 2—2.5 tons of coke are required to produce a ton of ferro-manganese in an iron blast-furnace, the phosphorus introduced into the ferro-alloy by the coke alone would be about 0.4%. The iron content of the Indian coke, and the low manganese iron ratio in the Indian manganese ores dilute the ferro-manganese, lowering the final manganese content in the ferro-alloy. Approximately 0.4% (66%) out of the 0.5—0.6% phosphorus in the Indian ferro-alloy is derived from the coke. *The crux of the problem is, therefore, to find a metallurgical coke with a much lower phosphorus content* for blast furnace production of ferro-manganese. Although, India does not have coals with very low ash, the most suitable grade available are the Giridih and Laikdih coals which have a phosphorus content of about 0.01%—.05% and could be utilized for making the right type of metallurgical coke for blast furnace ferro-alloy manufacture.

Briefly, the factors governing the making of standard grades of ferro-manganese acceptable for export are :—

(a) *Manganese-ore :*

1. The manganese/iron ratio should be as high as possible.
2. The phosphorus content should not exceed 0.1% to 0.13%.
3. The silica and alumina contents should not exceed 8 and 10% respectively.

(b) *Coke :*

1. The fixed carbon content should be 77% minimum.
2. The iron and silica contents should be 1% and 10% maximum respectively.
3. The phosphorus content should be 0.065 % maximum.

There are several ways in which the problem of making a ferro-manganese of the 'standard' grade could be tackled in India.

1. The quality of the coal could be improved by washing and/or by blending with other low phosphorus coals.
2. The use of selected Indian coals which contain low phosphorus.

INDIAN COKE SUITABLE FOR FERRO-MANGANESE MANUFACTURE

Thus it is seen that with the type of coke normally used for the production of pig iron, it is not possible to manufacture high grade ferro-manganese by the blast furnace technique. For this, coke not only of desired physical properties but with above 75% fixed carbon, 1% Fe_2O_3 / 10% silica and low phosphorus (less than 0.065%) is required. Judicious choice of coking coals low in phosphorus and other impurities, such as those from lower Karharbaree seam (Giridih), Laikdih seam (Raniganj) and possibly XI seam (Jharia) will produce coke of the quality necessary for the manufacture of ferro-manganese by the blast furnace technique.

The Central Fuel Research Institute has for the past few years, carried out extensive investigations on the blending of coals for the manufacture of metallurgical coke. As a result of these investigations it has been shown that metallurgical coke, high in fixed carbon, and comparatively low in phosphorus, ferric oxide, and silica can be manufactured from suitable blends of coals from the seams of Laikdih, Karharbaree, Dishergarh and Jharia in admixture with or without coke dust.

Typical analyses of the coals used for this investigation are given in Table I.

The physical properties of the coke from some of the typical blends amongst many studied are given in Table II.

The tests were carried out not only on the laboratory and pilot plant scales but in some cases, were confirmed by large scale tests in commercial ovens.

The test results indicate that a coke from a blend containing 50 per cent Laikdih Coal 25 per cent Giridih Coal, 20 per cent Dishergarh Coal, and 5 per cent high temperature coke dust will produce metallurgical coke which can be considered suitable for use in the blast furnace for ferro-manganese manufacture.

In fact the coke ovens of the Durgapur Project (West Bengal Government) have selected a similar blend of coals for the production of metallurgical coke for foundries. The present target of production of a little over 0.3 million tons of coke per annum will largely cater for foundries for which there is a great shortage of good quality coke. But with the expansion of the batteries, the Durgapur Project could produce coke of a quality suitable for the manufacture of high grade ferro-manganese by the blast furnace method. Besides using coke of requisite quality for high grade ferro-manganese manufacture, steps could be taken to obtain manganese ores from mines like Ukwa and Bhawali of Madhya Pradesh, which contain low phosphorus and are of a high grade. This will ensure a better quality of the ferro-manganese with the quality of coke that will be available.

During the Second Plan period the target of steel production has been set at 6 million tons. The requirements of ferro-manganese for the above quantity of steel will be roughly 100,000 tons excluding demands from

TABLE—I

Analyses of Coals used in blend for coke manufacture

	Seams				
	Laikdih (Raniganj)	Dishergarh (Raniganj)	Lower Karharbaree (Giridih)	Jharia XI	H. T. C. Coke breeze.
Analyses on Air dried bases					
1. *Proximate analysis.*					
Moisture %	0.8	3.0	1.0	0.9	—
Ash %	14.2	14.7	12.8	21.5	25.5
V.M. %	29.2	35.7	25.2	19.3	2.7
F. C. %	55.8	46.6	60.0	58.3	71.8
2. Sulphur % (Total)	0.60	0.35	0.40	0.65	—
3. Phosphorus %	0.035	0.107	0.006	0.036	—
4. Caking Index B.S.	22	17	19	15	—
5. SiO_2 in Coal	6.6	8.1	8.9	12.3	—
6. Fe_2O_3 in Coal	0.90	1.10	0.72	2.6	—

TABLE—II

Results of tests on coke from different blends

Sl. No.	Coals or blends %				Properties of coke: Screen Analysis		Shatter Index		Micum Index		Haven Stability factor on 1"	Porosity	Analysis of Coke (dry basis)	
	Laikdih	*Giridih*	*Disher-garh*	*Coke dust*	On 4"	On 1½"	On 1½"	On ½"	On 40mm	Thr-10mm.			Ash %	P %
1.	70	10	15	5	44.1	93.8	94.0	98.0	81.7	10. 7	56.8	49	17.2	.045
2.	50	25	20	5	44.8	91.9	94.3	98.3	80.3	10. 5	56.4	53.7	16.9	.045
3.	40	30	25	5	48.5	92.1	94.5	98.5	81.3	10. 6	58.3	53.7	17.0	.052
4.	60	10	30	0	24.3	91.3	88.9	97.3	71.3	12. 4	55.8	51.8	16.7	.054
5.	50	20	30	0	55.6	94.7	92.5	98.8	78.8	10. 0	53.3	—	18.5	.057
	(Tested in pilot ovens)													
6.	50	20	30	5	75.6	94.7	93.0	96.4	78.2	11. 0	50.1	—	18.6	.062
		95												
7.		do	do	do	74.1	93.6	94.3	97.7	79.7	9. 1	49.4	—	18.9	.065
	(Tested in commercial ovens)													
8.	I. S. I. Specification for metallurgical coke (IS : 439—1953).				—	—	85.0	97.0	75.0	10.12	40.0	—	—	—
	Laikdih	*Jharia XI seam*												
9.	60	40			—	—	91.2	97.4	77.4	10. 5	55.5	—	22.3	.058
10.	50	50			66.2	95.7	92.2	98.2	78.5	10. 1	56.5	—	22.8	.047

other sources. Even if the prospective licensees for electrothermal ferro-manganese manufacture achieve the target of production, only a small amount of it will be available for export. It is, therefore, necessary that the manufacture of ferro-manganese should be stepped upto at least 200,000 tons to 300,000 tons a year, so that this can not only meet the internal demands for production of 15 million tons of steel visualised during the Third Five Year Plan, but also leave a surplus for export to earn foreign exchange.

COST ESTIMATES FOR THE MANUFACTURE OF FERRO-MANGANESE

The cost estimates is based on the production of about 400 tons a day (or 146,000 tons a year) of ferro-manganese (grade 80–82 manganese). The raw materials required (for a ton of ferro-manganese of 80–82 Mn. content) are Manganese Ore (40%–46% Mn.):— 2.7 to 3 tons, coke of requisite quality: 2.0 tons, Limestone: 0.6 tons, total: 5.6 tons.

It has been mentioned earlier that for ferro-manganese manufacture, the raw materials should have a minimum of phosphorus. The phosphorus percentage in the manganese ore should be within 0.09% to 0.13% as is usual in the high quality Madhya Pradesh ores. For the manufacture of 400 tons of ferro-manganese a day, it will be necessary to install two blast furnaces of 200–250 tons/day capacity. The ferro-alloy produced from the furnace will be poured on sand beds in pouring bays near the furnaces and will be loaded from there to wagons. The slag will be carried in laddle cars to a dump Thus it will be necessary for the two blast furnaces to have equipments for binhandling, preparations of burden, charging, hot blast supply, blast furnace gas cleaning with the preliminary and flue cleaning and gas holder. Provision has also to be made in the estimates for distribution of water, cooling towers, a high level tank, compressed air, oxygen supply, slag laddle cars, buildings, foundations, track system and erection. For these, the investment cost will approximately be Rs. 5 crores excluding the provision for coke ovens. It is presumed that the project for the manufacture of ferro-manganese will be integrated with a coke oven plant. The surplus blast furnace gas (having a calorific value of about 115 B. t. u./cu. ft.) can be utilized then partly for heating the ovens and partly for steam raising in the existing power plant.

For the production of 400 tons of ferro-manganese per day, the raw materials that will be needed are as follows :—

	Per ton (of Fe-Mn)	*Per day*	*Per year*
Manganese ore	3.0 tons	1200 tons	438,000 tons
Coke	2.0 tons	800 ,,	292,000 ,,
Limestone	0.6 tons	240 ,,	87,600 ,,
Electricity	140 kwh	56,000 kwh	—
Blast	7200 Nm^3	3×10^6 Nm^3	
Water (circulating, cooling, gas cooling etc.)	—	9.02 mil. gals.	—
Water (makeup)	—	0.439 ,,	—

Production:-

	Per ton (of Fe-Mn)	*Per day*	*Per year*
Ferro-manganese (80–82% Mn.)		400 tons	146,000 tons
Slag	1 ton	400 tons	146,000 ,,
Blast furnace gas (total)	8600 Nm^3	3.5×10^6 Nm^3	1277×10^6 Nm^3
Surplus Blast furnace gas	4300 Nm^3	1.7×10^6 Nm^3	635×10^6 Nm^3

PRODUCTION COST

The calculation is based on the following assumed values — of the raw materials delivered at plant viz. manganese ore Rs 150/- per ton, Coke Rs. 56/- per ton, Limestone Rs. 18/- per ton, Blast furnace gas at Rs. 6/- per 1000 Nm^3, Electric power at 3.5 n. p. per kwh. The total personnel required will be of the order of 350–400 men for three shift operations and their wages will be similar to that in the steel plants.

(i)	Cost of ore @ Rs. 150/- per ton	Rs. 6,57,00,000
(ii)	Cost of coke @ Rs. 46/-	Rs. 1,34,32,000
(iii)	Cost of Limestone @ Rs. 18/-	Rs. 15,76,800
		Rs. 8,07,08,800
(iv)	Running expenses including 4% interest on capital, depreciation, maintenance, services, water & power etc.	Rs. 1,00,00,000
		Rs. 9,07,08,800

B/F.	Rs. 9,07,08,800
Credit for surplus blast furnace gas for other utilities	Rs. 38,10,000
	Rs. 8,68,98,800
Say	Rs. 8,68,98,000

Since the annual production of ferromanganese will be 146,000 tons, the cost of production of ferro-manganese will be Rs 590/- per ton or say Rs. 600/-. Since the selling price of 80/82 grade ferro-manganese is approximately Rs. 1000/- per ton, the net profit will be considerably more than that of ferro-manganese produced by the electric smelting process, where the cost of production varies from Rs. 750–800 per ton depending on the cost of electricity.

Ferro-manganese is one of the basic materials required for the iron & steel industry all over the world. The demand for this ferro alloy is to be increased with the increase in steel production both at home and abroad. The production of good quality ferro-manganese apart from earning increased foreign exchange, has to be developed in the larger interest of the country.

THIN-SKINNED WIRE

Westinghouse Electric Corporation engineers in the United States are reported to have developed a "thin-skinned" copper wire which will increase the efficiency of electrical equipment. Using a new metallurgical technique, company scientists have succeeded in coating copper wire with a thin, protective aluminium "skin" that is only one-fortieth as thick as the average skin on the human body. The coating is said to make it possible for the wire to operate over long periods of time at higher temperatures.

(Continued from page 4)

The first public train was five cars long and, needless to say, jammed to capacity. The cost of the ride was five cents, as compared to eight cents via the old route across the river.

President Theodore Roosevelt started service from his desk in Washington when he pressed a button to set the signals for the train. Within 24 hours nearly 100,000 curiosity-seekers had experienced the sensation of riding beneath the river.

The fanfare surrounding the opening of the first tunnel by no means dampened the spirit of the crowd for the second inaugural at 3 p. m. on July 19, 1909.

In all 30,000 to 40,000 people took part in the festivities. Two miles of streets were lit up with decorations.

There was a parade from the tunnel station to New York's City hall, speeches by gathered notables. Two thousand waited in line for the first trip. President William H. Taft sent a congratulatory telegram.

At 3 p. m. promptly, McAdoo's daughter, Harriet, pressed a gold button that turned on the electric current for the railroad cars. Immediately, the four trains waiting to make the first dash across the second under-river tunnel sounded their whistles. Every craft in the river and New York Bay joined in the chorus of whistles, horns, and shouts. Forty bombs were tossed into the air by celebrants in New Jersey. Bunting was displayed on all public buildings and those who didn't press forward to get a ride on the first trains stormed New York's City Hall, where the mayor threw a party that boasted "enough punch and lemonade to flood one of the new tubes......lunch and cigars."

The melee continued for 18 hours.

Today, all is gleaming and bright in New York, the city of the fast pace. People rush to and from their jobs without an outward thought.

They say, though, that if you listen very closely as you ride through the Hudson and Manhattan tunnels, you can still hear faint cheering, a distant horn being blown, a vague shout that accompanied the opening of "one of the greatest engineering feats ever accomplished; greater even than perhaps the Panama Canal."—Globe Press Service.

METRIC SYSTEM IN IRON & STEEL INDUSTRY

The adoption of metric system in the iron and steel industry in India is reported to have been discussed at a meeting of the representatives of steel interests at Calcutta recently. The meeting recommended that from April 1, 1958, the metric system should be adopted by the industry in the purchase of the main raw materials and fuels like iron ore, coal and lime stone and in the sale of their products. The quantities and prices are likely to be expressed in metric units from that date. The meeting urged that metric system for steel should be finalised and the relevant standards should be published by the Indian Standards Institution and approved by the Government by December 1957.

PROGRESS AT BHILAI STEEL PROJECT

According to a statement of the General Manager of the Bhilai steel project, timely supply of machinery from the Soviet Union has helped the authorities in India in maintaining the progress of work according to schedule. The statement added that Bhilai is being linked with the iron ore mining areas by constructing a fifty-six mile long railway line which is expected to be completed by the end of December next. The ores reportedly have been found to be of very good quality. Besides, good quality of lime stone to be used in the blast furnace of the steel project has been found in Nandini mines which is also being linked by rail and road with Bhilai.

ELEVENTH ANNUAL TECHNICAL MEETING OF THE INDIAN INSTITUTE OF METALS AND SYMPOSIUM ON RARE METALS

(1st thru 5th December 1957)

A Symposium on RARE METALS organised by the Atomic Energy Establishment, Government of India, The United Nations Educational Scientific and Cultural Organisation and The Indian Institute of Metals will be held along with the 11th Annual Technical Meeting of the Indian Institute of Metals from Sunday, 1st December to Thursday, 5th December 1957, at the Walchand Hirachand Hall of the Indian Merchant's Chamber, 76 Veer Nariman Road, Churchgate, Bombay 1. About 25 technical papers dealing with the extraction metallurgy of Uranium & Thorium, treatment of irradiated fuel elements and breeder blankets, present status of zirconium and beryllium metallurgy and resources of rare earths etcetra will be presented and discussed by experts from foreign countries viz. U. K., U. S. A., France, Australia, Brazil etcetra and eminent Indian experts. Among others, the following foreign experts will attend the Symposium.

Professor Felix Trombe
Directeur du Laboratorire des Terres Rares
C. N. R. S., Bellevue, France.

Mr. L. M. Wyatt
Head of the Metallurgy Section
Research & Development Branch
U. K. Atomic Energy Authority.

Dr. T. R. Scott
Division of Industrial Chemistry
Commonwealth Scientific and Industrial
Research Organisation
Australia.

Prominent Indian Scientists including Dr. K. S. Krishnan, F. R. S., Director of National Physical Laboratory and President of The Indian Institute of Metals, Dr. H. J. Bhabha, F. R. S., Chairman of Atomic Energy Commission, Dr. D. N. Wadia, F. R. S. Geological Adviser to the Department of Atomic Energy, Govt. of India, Dr. B. R. Nijhawan, Director, National Metallurgical Laboratory, Dr. Brahm Prakash and Dr. J. Shankar of Atomic Energy Establishment, Bombay, Dr. D. P. Antia, Honorary Secretary of The Indian Institute of Metals are expected to take part in the Symposium and the Annual Meeting.

Titles of papers to be presented at the Symposium are attached.

Besides the above, 28 research papers will be presented and discussed in the Eleventh Annual Technical Meeting of The Indian Institute of Metals. Titles of these papers are also attached.

The five day programme will be inaugurated by Dr. H. J. Bhabha, F. R. S., Chairman of The Atomic Energy Commission at 10—30 a. m. on 1st December 1957. The annual Pandya Memorial Lecture will also be delivered on the morning of the 1st December.

The 4th Educational Lecture Series on 'Phase Transformations in Steel' and the 4th Metallographic Contest and Exhibition will also be inaugurated on the same day.

The Annual Dinner of the Institute will take place at Taj Mahal Hotel in the evening of 2nd December 1957.

Visits have been arranged to the Swimming Pool Type Atomic Reactor 'APSARA', the new Canadian Reactor under construction and to Premier Automobile Works.

Papers to be presented at the Eleventh Annual Technical Meeting of I. I. M.

TITLE OF PAPERS	NAME OF AUTHORS
1. Simultaneous determination of copper, aluminium and Magnesium in Zinc Alloys for die-casting by the porous cup-spark technique.	Dr. B. C. Kar, Mr. M. K. Gupta & Mr. V. Muthukrishnan of National Metallurgical Laboratory, Jamshedpur.
2. Hydrogen in Steel-melting processes.	Mr. V. Yavoisky & Mr. S. Roy of Indian Inst. of Technology, Kharagpur.

3. Continuous casting of steel.	Mr. V. Yavoisky & Mr. P. K. Sen of Indian Inst. of Technology, Kharagpur.
4. Martensitic transformations in Steels.	Dr. Rajendra Kumar, Indian Inst. of Technology, Kharagpur.
5. Principles of Heat Transfer in the Fuel efficiency of Blast Furnaces.	Mr. B. I. Kitayev, Dr. Rajendra Kumar & Mr. S. G. Mukherjee of Indian Institue of Technology, Kharagpur.
6. Aluminising of steel by the Aquous Flux Process.	Mr. S. M. Arora, Mr. P. K. Gupte & Dr. B. R. Nijhawan of National Met. Lab., Jamshedpur.
7. A study of early stages of tempering in a 0.2% C, 9% Cr. & 0.38% V Stee.	Dr. A. K. Seal of Bengal Engineering College, Shibpore, Howrah.
8. Deformation texture in Cold-drawn Nickel rods.	Dr. K. Tangri of Atomic Energy Establishment, Bombay.
9. Some observations in Recrystallization and grain growth in Aluminium.	Mr. A. L. Malhotra & Dr. P. Dayal of College of Min. & Met., Hindu University.
10. Fibre texture of recrystallized aluminium wire.	Dr. P. Dayal & Mr. S. Dey of College of Min. & Met., Hindu University, Banaras.
11. Plating on Aluminium using an Iron inter-layer Part I. Application of an iron inter-layer with subsequent flash-plating of copper or brass.	Mr. D. S. Tandon & Dr. T. Banerjee of National Met. Lab., Jamshedpur.
12. Plating of Aluminium using an iron inter-layer Part II. Application of an iron inter-layer without subsequent flash-plating of copper or brass.	Mr. D. S. Tandon & Dr. T. Banerjee of National Met. Lab., Jamshedpur.
13. Plating on Aluminium using an iron inter-layer Part III. Use of iron inter-layer, deposited from ferric chloride solution at temp. lower than 95°C and without flash-plating of copper or brass.	Mr. D. S. Tandon & Dr. T. Banerjee of National Met. Lab., Jamshedpur.
14 Preparation of Titanium alloys by Alumino-thermic reduction, Part II. By use of Energisers.	Mr. R. A. Sharma, Mr. A. N. Kapoor & Dr. A.B. Chatterjea of National Met. Lab. Jamshedpur.
15. Hot Cathode technique for preparing Titanium.	Dr. H. N. Sinha of College of Min. & Met. Hindu University, Banaras.
16. A note on the design of Regenerators.	Prof. P. R. Dhar, Prof. B. I. Kitayev & Mr. S. G. Mukherjee of Indian Inst. of Technology, Kharagpur.
17. Role of carbide in Heat-Treatment of Steel.	Dr. Ing. G. Mukherji of Bhillai Steel Project, Durg.
18. The Heat Capacity of solid solutions of Cadmium in Silver.	Prof. Ralph Hultgren & Mr. K. N. Rao.

19. Friction & Frictional Wear.	Mr. B. N. Das & Mr. R. Chowbey of National Met. Lab. Jamshedpur.
20. Determination of Equicohesive temperature.	Mr. R. Tamhankar of R. &. C. Lab., TISCO., Jamshedpur.
21. Some observations on the Portevin-Le Chatelier Phenomenon.	Mr. R. Tamhankar of R. & C. Lab., TISCO., Jamshedpur.
22. Studies on Silico-manganese Steels, Part I. Influence of Carbon Content on Hardenability.	Mr. S.N. Asthana, Mr. D.K. Sood & Mr. T. V. Cherian of R. & C. Lab., TISCO., Jamshedpur.
23 Studies on Silico-Manganese spring steels, Part II. Influence of Quenching temperature on Hardenability.	Mr. D.K. Sood & Mr. T. V. Cherian of R. & C. Lab., TISCO., Jamshedpur.
24. Studies on Silico-manganese spring steels, Part III. Influence of alloy additions - Chromium and Silicon - on Hardenability.	Mr. D. K. Sood & Mr. T. V. Cherian of R. & C. Lab., TISCO., Jamshedpur.
25. Studies on Silico-manganese spring steels, Part IV. Effect of Carbon Content on Flexure Properties.	Mr. S. Jayram, Mr. H.R.S. Rao, Dr. V. G. Paranjpe & Mr. S. Visvanathan of R. & C. Lab., Jamshedpur.
26. Studies on Silico-manganese spring steel, Part V. Temperability.	Mr. S. Jayram, Mr. H. R. S. Rao & Dr. V. G. Paranjpe of R. C. Lab., Jamshedpur.
27. A new approach to the Synthesis of metallic Hydrides.	Dr. S. Ramamurthy of Indian Inst. of Science, Bangalore.
28. Production of some less common metals by Fused Salt Electrolysis.	Mr. R. K. Mangal & Dr. H. N. Sinha of College of Min. & Met., Banaras.

Papers for presentation at the Symposium on RARE METALS

1. Indian Resources of Rare Metals	Dr. D. N. Wadia, F. R. S. Geological Adviser, Dept. of Atomic Energy.
2. Review of Beneficiation techniques pertaining to Uranium bearing ores.	Mr. P.I.A. Narayanan, Asst. Director, National Metallurgical Laboratory, Jamshedpur.
3. Beneficiation of Indian uraniferous ores and beach sands.	Dr. R. Krishnaswamy, Atomic Energy Establishment, Bombay.
4. The extraction & recovery of uranium ores from Australian ores.	Dr. T. R. Scott, Division of Industrial Chemistry, Commonwealth Scientific & Industrial Organisation, Australia.
5. Problems in the leaching and extraction of Indian low grade uraniferous ores.	Dr. J. Shankar & Mr. B. H. Krishna, Atomic Energy Establishment, Bombay.
6. Ion-exchange method of winning uranium from acid leach liquors.	Dr. T. V. Arden, Chief Development Chemist, The Permutit Co., Ltd., U. K.
7. Extraction of thorium and uranium from monazite sand and their refining.	Mr. H. N. Sethna & Mr. S. Fareeduddin, Atomic Energy Establishment, Bombay.

8.	Brazilian practice for Monazite Treatment.	Dr. P. Krumholz, Orquima S. A., Brazil.
9.	Extraction of rare earth metals.	Professor Felix Trombe, Directeur du Laboratorire des Terres Rares, C. N. R. S., Bellevue France.
10.	Application of rare earth metals in metallurgy.	Dr. B. R. Nijhawan, Director, National Metallurgical Laboratory, Jamshedpur.
11.	Present status of zirconium metallurgy.	Dr. Brahm Prakash & Mr. C. V. Sundaram, Atomic Energy Establishment, Bombay.
12.	Present status of beryllium metallurgy.	Dr. T. Banerjee, Asst. Director & Mr. P. B. Chakravarti of National Metallurgical Laboratory, Jamshedpur.
13.	Developments in beryllium metallurgy with special reference to practice at the Brush Beryllium Co., U. S. A.	Mr. Carl W. Schwenzfeier, Vice-President, The Brush Beryllium Co., U. S. A.
14.	Present status of production of Metallic Uranium and thorium.	Dr. G. S. Tendolkar & Mr. S. K. Kantan, Atomic Energy Establishment, Bombay.
15.	Treatment of irradiated fuel elements and breeder blankets.	Mr. R. Manocha, Atomic Energy Establishment, Bombay.
16.	Recent developments in the pyro-metallurgical treatment of irradiated fuel elements and breeder blankets in U. S. A.	Dr. S. Lawroski, Director, Chem. Eng Div., Argonne National Lab., U. S. A.
17.	Physical metallurgy of uranium.	Dr. K. Tangri, Atomic Energy Establishment, Bombay.
18.	Fabrication and canning of uranium — British Practice.	Mr. L. M. Wyatt, Head, Metallurgy Sec. U. K. Atomic Energy Authority, U. K.
19.	Development in plutonium metallurgy.	Mr. M. B. Waldron & Dr. D. M. Poole, Metallurgy Division, Atomic Energy Research Establishment, U. K.
20.	Physical Metallurgy of Thorium.	Dr. M. K. Madhekar & Mr. M. K. Asundi, Atomic Energy Establishment, Bombay.
21.	Technology of rare metal oxides and carbides.	Dr. V. K. Murthy, Atomic Energy Establishment, Bombay.
22.	Special problems involved in sintering of beryllia.	Dr. R. Caillat, Dept. of Metallurgy & Industrial Chem., Atomic Energy Com., France.
23.	Powder metallurgy in nuclear engineering.	Dr. Henry H. Hausner, Nuclear Engg. Div. Penn-Texas Corpn. U. S. A.
24.	Present status of dispersion type fuel elements in U. S. A.	Dr. H. Weber, G. E. C. Knolls Atomic Power Lab., U. S. A.

PROGRAMME

SUNDAY—*1st December 1957*

9—00 A. M. to 10—30 A. M. — Registration of Delegates.

10—30 A. M. — Inaugural Address by Dr. H. J. Bhabha, F. R. S.

onwards — Presidential Address by Dr. K. S. Krishnan, F. R. S.

SYMPOSIUM ON RARE METALS

2—30 P. M. to 5—30 P. M.

Resources of Rare Metals.

— 1— India's Resources of Rare Metals —by Dr. D. N. Wadia.

Beneficiation of uranium bearing ores and of beach sands.

— 2— Review of beneficiation techniques pertaining to uranium bearing ores—by Mr. P. I. A. Narayanan.

— 3— Beneficiation of Indian uraniferous ores and beach sands—by Dr. R. Krishnaswamy.

Treatment of uranium ores and ore concentrates.

— 4— The extraction and recovery of uranium ores from Australian ores—by Dr. T. R. Scott.

— 5— Problems in the leaching and extraction of Indian low grade uraniferous ores—by Dr. J. Shankar & Mr. B. H. Krishna.

— 6— Ion-exchange method of winning uranium from acid leach liquors —by Dr. T. V. Arden.

MONDAY—*2nd December 1957*

10—00 A. M. to

Treatment of Monazite.

— 7— Extraction of thorium and uranium from monazite sands and their refining—by Mr. H. N. Sethna & Mr. S. Fareeduddin.

1—00 P. M. — 8— Brazilian practice for monazite treatment—by Dr. P. Krumholz.

Production and Application of Rare Earth Metals.

— 9— Extraction of rare earth metals—by Prof. Felix Trombe.

—10— Application of rare earth metals in metallurgy—by Dr. B. R. Nijhawan.

Present status of zirconium metallurgy.

—11— Present status of zirconium metallurgy—by Dr. Brahm Prakash & Mr. C. V. Sundaram.

2—30 P. M. to

Present status of beryllium metallurgy.

—12— Present status of beryllium metallurgy—by Dr. T. Banerjee & Mr. P. B. Chakravarti.

5—30 P. M. —13— Developments in beryllium metallurgy with special reference to practice at the Brush Beryllium Company—by Mr. Carl W. Schwenzfeier.

Production of Metallic Uranium and Thorium.

—14— Present status of production of metallic uranium and thorium—by Dr. G. S. Tendolkar & Mr. S. K. Kantan.

Treatment of irradiated fuel elements and breeder blankets.

—15— Treatment of irradiated fuel elements and breeder blankets—by Mr. R. Manocha.

—16— Recent developments in the pyro-metallurgical treatment of irradiated fuel elements and breeder blankets in U. S. A.—by Dr. S. Lawroski.

TUESDAY—*3rd December 1957*

10—00 A. M. to

Physical Metallurgy and Fabrication of Uranium & Plutonium.

—17— Physical metallurgy of uranium—by Dr. K. Tangri.

—18— Fabrication and canning of uranium — British Practice — by Mr. L. M. Wyatt.

1—00 P. M. —19— Development in Plutonium Metallurgy—by Mr. M. B. Waldron & Dr. D. M. Poole.

Physical Metallurgy of Thorium.

—20— Physical metallurgy of Thorium —by Dr. M. K. Madhekar & Mr. M. K. Asundi.

2—30 P. M. *Technology of Rare Metal Oxides and Carbides.*

to —21— Technology of rare metal oxides and carbides—by Dr. V. K. Murthy.

5—30 P. M. —22— Special problems involved in sintering of beryllia—by Dr. R. Caillat.

Powder Metallurgy in Reactor Applications.

—23— Powder metallurgy in nuclear engineering—by Dr. Henry H. Hausner.

—24— Present status of dispersion type fuel elements in U. S. A—by Dr. H. Weber.

ELEVENTH ANNUAL TECHNICAL MEETING

WEDNESDAY—*4th December 1957*

10—00 A. M. — 1— Principles of Heat Transfer in the Fuel efficiency of Blast Furnaces—by B. I. Kitayev, Rajendra Kumar & S. G. Mukherjee.

to — 2— A note on the design of Regenerators—by P. R. Dhar, B. I. Kitayev & S. G. Mukherjee.

1—00 P. M. — 3— Hydrogen in Steel-melting Processes—by V. Yavoisky & S. Roy.

— 4— Continuous casting of steel—by V. Yavoisky & P. K. Sen.

— 5— Aluminising of steel by the Aqueous Flux Process—by S. M. Arora, P. K. Gupte & B. R. Nijhawan.

— 6— Martensitic Transformations in Steels—by Rajendra Kumar.

— 7— A study of the early stages of tempering in a 0.2% C, 9% Cr and 0.38% V Steel—by A. K. Seal.

2—30 P. M. — 8— Role of carbides in Heat-Treatment of Steel—by G. Mukherji.

to — 9— Studies on Silico-manganese steel, Part I—Effect of Carbon content on Hardenability—by S. N. Asthana, D. K. Sood & T. V. Cherian.

6—00 P. M. —10— Studies on Silico-manganese Spring Steel, Part II—Effect of Quenching Temperature on Hardenability—by D. K. Sood & T. V. Cherian.

—11— Studies on Silico-manganese spring steel, Part III—Effect of Alloy Additions—Silicon and Chromium—On Hardenability—by D. K. Sood and T. V. Cherian.

—12— Studies on Silico-manganese spring steel, Part IV—Effect of Carbon Content on Flexure Properties—by S. Jayram, H. R. S. Rao, V. G. Paranjpe & S. Visvanathan.

—13— Studies on Silico-manganese spring steel, Part V—Temperability—by S. Jayram, H. R. S. Rao & V. G. Paranjpe.

—14— Some observations in Recrystallization and grain growth in Aluminium—by A. L. Malhotra & P. Dayal.

THURSDAY—*5th December 1957*

10—00 A. M. —15— Fibre texture of recrystallized aluminium wire—by P. Dayal & S. Dey.

to —16— Preparation of Titanium alloys by Alumino-thermic reduction, Part II—by use of Energisers—by R. A. Sharma, A. N. Kapoor & A. B. Chatterjea.

1—00 P. M. —17— Hot Cathode Technique for preparing Titanium—by H. N. Sinha.

—18— Production of some less common metals by fused Salt Electrolysis—by R. K. Mangal & H. N. Sinha.

—19— Friction and Frictional Wear—by B. N. Das & R. Choubey.

—20— Simultaneous determination of Copper, Aluminium and Magnesium in Zinc alloys for Die-casting by the Porous cupspark technique—by B. C. Kar, M. K. Gupta & V. Muthukrishnan.

—21— The Heat Capacity of Solid Solutions of Cadmium in Silver—by Ralph Hultgren & K. N. Rao.

2—30 P. M. —22— A new approach to the Synthesis of Metallic Hydrides—by S. Ramamurthy.

to —23— Deformation texture in Cold-drawn nickel rods—by K. Tangri.

6—00 P. M. —24— Plating on Aluminium using an Iron inter-layer, Part I—Application of an iron inter-layer with subsequent flash-plating of copper on brass—by D. S. Tandon & T. Banerjee.

—25— Plating on Aluminium using an Iron inter-layer, Part II—Application of an iron inter-layer without subsequent flash-plating of copper or brass—by D. S. Tandon & T. Banerjee.

—26— Plating on Aluminium using an iron inter-layer, Part III—Use of Iron inter-layer deposited from ferric chloride solution at temperatures lower than 95°C and without flash-plating of copper or brass—by D. S. Tandon & T. Banerjee.

—27— Determination of Equicohesive temperature—by R. V. Tamhankar.

—28— Some observations on the Portevin-Le Chatelier Phenomenon—by R. V. Tamhankar.

FRIDAY—*6th December 1957*

10—00 A. M. Onwards. Visits to Swimming Pool Type Atomic Reactor 'APSARA', new Canadian Reactor under construction and to Premier Automobile Works.

TAX ON RAILWAY PASSENGER FARES

The Railway Passenger Fares Act 1957, recently passed by Parliament for the levy of a tax on railway fares, came into force with effect from September 15, 1957.

The total proceeds of this tax would go to the States which needed resources to fulfil their targets under the Second Plan. The new tax is not leviable on passengers travelling for distances upto 15 miles (inclusive) or on those travelling on Season tickets. As regards other passengers, the tax is leviable at a certain percentage of the fare depending on the mileage of the journey. Passengers travelling for distances from 16 to 30 miles will pay a tax of 5% of the fare, those travelling from 31 to 500 miles, a tax of 15% of the fare, and those travelling over 500 miles, a tax of 10% of the fare.

The tax applies to all passengers irrespective of the class of travel. The tax will be collected along with the fare and will apply to travel over all Indian Government Railways as well as over company managed lines.

Production of Non-Ferrous Castings by the Indian Railways

*By *H. S. Sharma*

INDIAN Railways claim to be the largest single consumer of Non-ferrous metals in this country, particularly in the form of Bronze and Antifriction alloy castings. From an estimate of non-ferrous Castings produced by the entire railway system some three years back, it was computed that the railways produced some 17000 tons of castings in a year. It shall be no exaggeration to suggest that the present day production of such castings, shall be nearer to the mark of 25000 tons. If we have to convert this apparently harmless figure of 25000 tons into rupees, then on the basis of a very conservative average rate of i. e., Rs. 4000/- a ton, we arrive at a stupendous mark of Rs. 10.00 Crores.

It is further estimated that about 40% of the total casting produced involve the use of virgin metals. Thus nearly 4 crore of rupees worth of virgin metals must be imported to make the railways move smoothly. To-day when our country is faced with an adverse trade balance, it is imperative that the balance has to be restored. But we have set certain targets before us in the 2nd Five Year Plan, which must be fulfilled. The Indian railways have also their expansion programme, which must be carried out to enable it to shoulder the ever increasing responsibility of transportation. So this great contradiction in the industrial revolution of India, has set our leaders think aloud. They have already started slashing many a item from

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the plan and have clamped the curtain on luxury goods and restricted the import of even strategic items i. e., Non-ferrous metals. In this great endeavour, it becomes the duty of every citizen, to whatever walk of life he belongs, to find ways and means, whereby the required economy can be effected without halting the tempo of Industrial revolution, which is our set goal.

We, therefore, who deal with the requirement of railways for non-ferrous metals in one form or the other, has also a duty to perform. It calls for a little introspection, casting away of prejudices, a brave admission of our lapses and making a mighty effort to reach our goals.

Then let us peep into our workshops, who handle, in their day to day working millions of rupees of these indispensable precious metals.

Raw Materials: (Non-ferrous metals and alloys) Various Castings required for the locomotive, Carriages or Wagons are produced from well defined Indian railway specification covering the non-ferrous metals or their alloys. To obtain these metals and alloys the railways either produce it themselves or purchase it from the trade. Given the chemical constituent of an alloy, it would be a simpler job to make it from virgin metals but as the railway workshops turn out an enormous quantity of scrap, they are mostly made out of scrap material. Well, it is immaterial, as long as the casting confirms both chemically and physically to the desired specification, be it is made from scrap or entirely from virgin metals. After obtaining the alloy ingots it does not end there, the aim is considered to be fulfilled when the cast product corresponds with the specification and is a sound casting free of porosity etc.

How far this end is achieved is a doubtful factor! The author has had the occasion of visiting scores of railways, ordnance and other Govt. owned factories, including Railway workshops at Jodhpur, Ajmer, Dohad, Izatnagar, Lucknow (Charbagh), Gorakhpur, Lilooah, Goldenrock, Jabalpur (Gun Carriage Factory), Kharagpur, and Mysore. The impression that I could gather during my visit to these workshops, is this that while the railway administration exercises greatest care, when purchasing castings or alloy ingots from the trade, the zeal and enthusiasm fizzles out when it comes to obtain castings in their own foundries. I am sorry to lay down this sweeping remark but with my fourteen years of grinding with railways and their requirement of no n-ferrous metal alloys. I cannot but feel sorry for the national losses. The above is borne out from the following facts :—

The self-sufficiency and economy drive has made the railways to adopt the increased utilization of their own scrap for producing castings. This is being done in two ways (1) Utilising a part of the graded scrap by mixing it with the alloy ingots of known specification (2) Converting the scrap material into ingot form and then remelting it with the addition of fresh virgin metal, till it confirms to specification.

Now, on the paper the above proposition looks quite sound but as a matter of fact in practice it is almost unworkable. For instance the addition of segregated scrap (i. e. upto 25%) of Phosphor Bronze N6/49 Class I, to a charge consisting of balance 75% of alloys ingots, is an intelligent and economic suggestion, provided the said segregated scrap is a guinine collection of Phosphor Bronze of IRS. N6/49 Class I. The so called segregated scrap of Phosphor Bronze is invariably a mixture of mixed metals, which may include Brasses, Leaded Bronze and like. Who cares or bothers to find out in the foundry, whether the Phosphor Bronze scrap issued from the stores does have any semblance with the real Phosphor Bronze? Does the person responsible for segregation have sufficient knowledge to declare the composition of castings by visual or fracture test? No person, however, experienced can precisely predict the composition of mixed castings. It clearly shows that without a chemical testing the segregation of scraps can be approximate and not exact. Thus the resultant mixture of such scraps and alloy ingots shall definitely disturb the balance of the alloy, which is so rigidly bound by the I. R. S. Specification. The Phosphor Bronze N6/49 Class I. limits the usual constituent of Bronze alloys to very rigid limits i. e., the zinc and lead should not accede 0.5%, the Phosphorus contents can vary within close limits of 0.4/0.6. It is therefore, evident that very little respect is intended for IRS. Specification. The castings are continued to be produced in the same vein with lead and zinc contents bounding off their limits from anything 100 to 300 per cent.

Are these castings rejected for failure in chemical test? I have my own grave doubts about it, as this practice is prevalent in all the workshops.

In one of the large railway workshop of the South, large scale consumption of old railway castings is being made. In their usual small morgan crucible furnaces, bronze confirming to IRS. N6/49 Class II is being produced. The heats were melted and cast on the basis of predetermined charge compositions. About 50% of the old scrap was being used and the balance

made up from virgin copper, tin and zinc. On enquiry, about the resultant composition of the alloy, it was reported that lead content often goes up to 2/3% and the tin 8/9%, while it is specified only 1.5% max. lead and 7% of max. tin.

Now, it is understood that the railways have taken up the complete refining of swarf borings to IRS. Specifications, in some of their workshops. The borings that come out of the railway workshops are broadly classified as under :—

(a) Purely leaded Bronze borings.

(b) Mix. borings of non-leaded, leaded bronze, white metal, brass and other metals.

Here again the railways are presumably faced with greater and more complex production problems, when compared to producing castings from alloy ingots.

These are—

1. Lack of bigger melting units and other specialised melting and refining plants.
2. Lack of the manufacturing know how, so much essential for the economic operation.
3. Lack of coordination and underestimation of the financial implications involved in the refining business.

On the actual production side, the swarf borings are usually contaminated with unwanted metals and the cleanest of them all contain a proportion of brass and white metal turnings too. The only equipment in the armoury of railway foundry is the usual morgan Crucible Furnace of 400 Lbs. capacity through which an attempt is made to remove the impurities and obtain alloy ingots to I. R. S. Specifications. The refining of borings and mixed swarf is wholly an uneconomic proposition, without proper equipment, planning and specialised knowledge, so much necessary to run the plants efficiently.

The present day set up of the railway foundries is hardly conducive to obtain standard quality castings, which can only ensure a longer life for our locomotive and rolling stock. And in the midst of their existing difficulties, it will be suicidal to burden the foundries with the job of reconditioning scrap material.

The refining job is not completed by planting a number of melting units, equipment and laboratories. This is a job, which involves too much of a personal factor and financial implication, in which very judicial action of experts is required at every stage, in the gradation, dressing, melting and refining operation. If the railways are so keen on doing their own refining and reclamation work, they have got to evolve an entirely independent organisation. This organisation must be based on a joint enterprise of both private and government interest. The private sector has scores of years of experience of refining jobs and they can provide the necessary technical know how, equipment and finance.

Reverting to the subject of producing vital bronze castings for the railways, let me warn that the present day weakness and latitude towards not strictly adhering to standard railway specification is a very unhealthy sign and spells of greater disaster both financial and otherwise.

The Railway foundries should produce castings, which have optimum of physical properties and deviation from chemical composition is a trend in the opposite direction. As suggested above the utilisation of scrap and swarf must be left to the guidance of a separate organisation manned by experts. The production of a perfect casting is not a simple operation of melting and casting alone. It is well known that a perfect alloy ingot, if melted in a reducing atmosphere or charged with moisture content or kept in a molten state for longer time, shall result in its becoming gassy or even loosing some of the constituent metal, and producing gassy casting with hardly 30% to 40% of the desired mechanical property. Again there is a technique in the pouring of the molten metal in the moulds. If the metal is not poured at the correct pouring rate and temperature, it shall produce weak castings and rejection due to shrinkage etc. shall be heavy.

Metal losses in melting and casting is another important matter to be reckoned with. But this too is neglected factor in the railway foundries. There are practical limits to the metal losses resulting from the melting of ingot material and then why these standards are not strictly observed? For instance Phospher Bronze Class I should not loose more than 0.75% Gunmetal IRS/N649 Class II, III and IV not more than 1%. In railway foundries the melting loss account never touch these standards and it may register

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TRAINING OF WELDERS IN INDIA

By *D. S. Honavar, B. Sc. (Hons.), B. Sc. (Tech.), A. M. I. I. M.

FREE India is marching towards industrialisation. The first Five Year Plan placed us firmly on a path of progress in this direction. We have to move fast if we are to attain a standard comparable to that of western nations. This applies to all branches of industry and so does it apply to "Welding Industry".

Metal-Arc Welding is gaining rapidly in popularity. Indian industries do not have to look up to the foreign suppliers for their requirements of arc welding electrodes. They are now manufactured in India. But welding calls for trained and efficient welders in addition to good electrodes and equipment. This particular aspect raises an important problem, viz. training of welders, which, in turn, requires a training school and a carefully laid out course. An attempt has been made in this article to put forth the various subjects which need to be incorporated in a training programme for welders, dealing mostly with the theoretical part of training.

When the conditions in this country are taken into consideration, one fact which needs emphasis is that the trainees will not only include fresh students who want to take up welding as a career, but also persons who have worked as welders for sometime, without, of course, the requisite knowledge. These welders are likely to have wrong notions about several aspects of the subject and the training should serve of help the welders to revise their ideas and grasp the true picture of the subject. Consider, for example, the term "steel". Many welders are not aware of the true meaning; they are apt to take the term as a generality.

BASIC INFORMATION ON ENGINEERING METALS

Inasmuch as the majority of engineering structures and machines in which the joining is accomplished by welding, are made from steel of some type, it seems logical that the trainee be given a sound background on this material. Studies of this nature should precede any attempt at actual arc manipulation. When it is realised that the term 'steel' is not a generality, some of the difficulties encountered by welders will be solved. The welders have to learn that there are a great many different types of steel, each of which has its individual composition and its own physical and mechanical properties. Welding is to be considered in relation to the effects of the thermal treatment involved on each type of steel, or, in other words consideration of their 'weldability'.

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any figure up to 10%, without rousing suspicion. The surplus metal is left over in the crucibles and sticking to tools etc. .. .. the liquid metal is deliberately spilt over the moulds, which cools down into small globules and finds its way into the refuse wagon. Excess metal is skimmed out with metallic slag and meets the same fate. Lacs of rupees of valuable metal is thus lost annually and nobody seems to bother about it. Sometimes it is sheer neglect and carelessness and often it is intentional.

Yet another important point in the production of bronze castings is the design of the patterns, whereby minimum practical machining is aimed at. A glance at the colossal amount of machined borings produced by each workshop is a striking proof of the failure and neglect on the part of design and pattern shop to provide correct patterns. There are workshops which convert twentyfive per cent of their total castings into borings and swarf.

In an era, when nations are engaged in the successful pursuit of reaching the stars and planets, we are still struggling to learn and practise the fundamentals of producing good castings economically. Let us not be so selfish, let us be worthy citizens to reach the goal assigned to the nation in the second five year plan. All of us, be a furnace operator, a moulder or a research worker, have got to be extremely conscious of our responsibilities. We have got to inculcate a feeling of dearness for our jobs and feel proud of our achievements. Then only we can lead our country to progress and prosperity.

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GOLDEN RULES OF CONDUCT FOR RAILWAYMEN

1. Maintain proper relations with officers and others in the Department in which you work.
2. Use good human relations in your contact with subordinates. Do not make them feel their position.
3. Maintain good public relations with callers and passengers.
4. Be resourceful and find ways and means of doing a job well.
5. Discard the idea of 'Give me some more men to do the job'.
6. Learn the art of getting along with people.
7. Remember the most important thing is to get a job done—not just to do it anyway and somehow but to do it efficiently, safely, economically and expeditiously.
8. Develop the attitude of 'Give me plenty of rock and plenty of wood and just get out of my way'. This typifies loyalty and enthusiasm for work and responsibility.

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1. Get down to the man on the JOB.
2. Move on the line as often as you can as MEMBERS OF THE PUBLIC and not only as officials.
3. Remember pre-arranged and announced expeditions cannot have the same informative value as surprise inspections.
4. Every railwayman has to be convinced that the work that he does is to his own advantage. He should not think and measure his effort merely in terms of wages which is only a motive force.
5. Every railwayman does a specialised job which has no meaning or usefulness by ITSELF unless it is cohered with each other. There is no meaning or value to the work of a permanent way gang unless there are trains to run over the track.

Welding as a process is a general term; whether the welding is done by an electric arc or a flame, by electric resistance or thermite method, heat is applied to the metals to be joined. Thus, although the primary objective is that of joining the metal parts, the process inevitably involves heat treatment which may vary in its extent in each case. It follows that an understanding of the principles underlying the heat treatment will enable the welder to make an intelligent appraisal of what is happening.

ELECTRODE CLASSIFICATION

The A. W. S. and BEAMA codes in electrode classification have proved of immense value to industry. It is thus possible now to specify the type of electrode for a given application without regard to the brands in the market. The trainee should learn these electrode classifications and their characteristics, such as type of coating, polarity, suitability for different welding positions etc. It is only then that he can judge correctly the usefulness of any particular electrode or the superiority of one type over another in respect of the job in hand. It is common experience in India to-day to find welders who, after having been used to handling of one brand or type, for a decade or two, refuse to believe that there can be any other superior electrode and are inclined to reject it outright when approached with one. And yet the average welder is not to be blamed. After all he has been told and has come to believe honestly that the electrode he has been using for years is the best possible. Most of the welders are obsessed with the idea of "one electrode for all jobs", because interested persons may have put it into their heads. The average welder is not aware of any principles involved and therefore accepts as true what he is told by persons who think only of their sales irrespective of the interests of the industry as a whole.

It is obvious that this notion among Indian welders stands as an impediment in the progress of industry, both the welding industry and related ones. It should also be realised that the welder is not responsible for this stalling of progress for the simple reason that he has not received adequate training on scientific lines, is ignorant of the principles involved and has been accustomed to only one or two brands of electrodes for years together. When it comes to handling a new type, with slightly different characteristics, but far superior, he is inclined to reject it on the consideration of the failure of the electrode to satisfy his tastes. He is reluctant to adapt himself to the new electrode type.

The welding industry is thus deprived of the advantages gained from the latest developments in electrode design. To cite just one instance, the introduction of low-hydrogen electrodes in the Indian market may be mentioned. The development of low-hydrogen electrodes has revolutionized the science of welding and has widened the scope of arc welding to fields where only a few years ago, metal-arc welding was in the realm of the 'impossible'. But this electrode type met with stiff resistance from protagonists of the conventional types and of 'one electrode type for all jobs' theory, for considerable length of time, before it was accepted as a solution to some of the major problems in arc welding. Proper understanding of the various classes of electrodes will clear up many a misconception. Knowledge of this nature is much more fundamental than trade names and proprietary designations. It appears a disservice to industry to teach welding from the viewpoint of trade names for equipment and apparatus. But it is doubtful if such a thing can be avoided in view of the fact that manufacturers are concerned about competition and the training of welders provides a useful tool of tremendous value to the popularisation of their products.

Source of Electrical current :

This is another salient part of welder training. The subject should be presented on its merits rather than from personal prejudice as frequently happens. Direct current welding was in favour prior to and during the last war, but since then A. C. has progressed. The shortcomings of the A. C. have been overcome. The arc-striking difficulties encountered in A. C. welding have been eliminated. The capabilities of these two major arc welding methods should be presented to the trainee as also their drawbacks.

Arc Manipulation Ability :

Welding is primarily manual work. Although the welding school is expected to impart theoretical knowledge of his work to the trainee, the most important function of the school is to train the student to acquire a certain degree of manipulative skill. This skill involves more or less complete control over the pool of molten metal into which the filler metal flows under his guidance.

Recent advances in electrode design have resulted in reducing the importance of this ability. "Contact Electrodes" represent this new development. These electrodes do not require any manipulation since the electrode need only be touched to the parent metal.

Ability to manipulate the arc that will develop sound weld metal is, of course, the ultimate test of an accomplished welder. Since welding is done in several positions, the trainee needs to develop manual dexterity to a high degree. This calls for constant practice by the trainee in various positions of welding. Most of the trainees will be found eager to produce a weld bead of pleasing appearance, neglecting at the same time the weld quality. Hence the need for making the trainee quality-conscious. Weld bead appearance is, no doubt, important, but should not be attempted at the cost of weld quality. The trainee has to strive for weld metal free from contamination and under-cutting at the weld edge. The emphasis should be more on soundness of weld metal and joint penetration than on weld appearance.

Safety precautions—Safe practices :

No training in welding and, for that matter, in any industrial occupation, can be considered to be complete, if it fails to inculcate in a welder a sense of awareness to the dangers. It would be readily conceded that ignorance on the part of the welder will in itself constitute a danger to himself as well as his co-workers and the equipment around him. Lack of their understanding of the hazards will thus be a constant liability he will carry with him. Hence lessons on Safe Practices and Health Precautions should form not just a part of the course, but an early part of it so that during the period he is under training, he learns to observe these precautions with due attention.

INSTRUCTORS

The key to the success of any training programme is ready availability of a qualified instructor. The importance of this person cannot be over-estimated. Whatever the standard of equipment, course of study and instructional material, it is ultimately the instructor who has to utilize these facilities to transform trainees into competent welders. Two types of instructors seem necessary, viz. for class room lessons dealing with theoretical aspects of welding and related subjects, and for practical lessons in welding. Both must be fully qualified in their respective fields to meet the needs of the trainees. It may be considered good practice to have separate instructors as stated above for the simple reason that it is difficult to find a person who will completely satisfy the requirements of both the categories. And yet it stands to reason to say that the outcome of the efforts of the school will be as good, if not better, when one and the same person can efficiently perform the duties of the two types. The reason is simple. Since the same person guides the trainees in both the sections, he thereby helps to maintain a continuity which cannot be established with two instructors.

Qualifications Tests and Codes of Minimum standard :

Metal-arc welding is to be regarded as a combination of an art and a science and hence the individual equation enters to a greater extent in metal arc welding than it does, say, in automatic spot welding. The trainee should be introduced to the subject of codes and specifications so that he will gain an appreciation of the qualifications that will be expected of him. It is thus that he will be in a position to give due attention to the various aspects in order not to be found lacking in some of them. He can have a clear idea of the standard he has to attain. One point which need be mentioned in this connection is that it is difficult to prescribe codes of minimum standard which will embrace all the welding jobs; in other words, a welder cannot be certified for every demand within his field, although it would be a great service to the welding profession if such a scheme can be worked out. The welder is confronted with the necessity of requalifying for each different job and/or material and he might wonder why he should have to submit himself to these tests every time he takes up a new welding job. Well, until such time as the all-embracing codes are made available, he has to be prepared to stand for requalifying tests. Hence the need for appraising the trainee of the situation he will be called upon to face from time to time in his career.

It will be worthwhile to mention here that when a welder trainee has completed the course of study in the school, he is not to be considered a skilled welder. He needs to put in a lot of hard work under shop conditions. Now these shop conditions will be of diverse nature because of the variety of applications, possibly differing considerably from the lesson in the school, with the result that the freshly trained welder may find himself almost a beginner in the job in question. Yet, the knowledge, especially the practical part of it, gained in the school will certainly have prepared him to approach any welding job with confidence. To put the whole thing in a nutshell:

The training school serves as a stepping stone to success as a welder. Proficiency in field-work and job shops will be the fruit of additional efforts based on the initial training received in the school.

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Surface Alloying in Brazing and Related Technique

(Contributed by Larsen & Toubro Technical Service)

INTRODUCTION

THE study of the union of two metals is a fascinating subject which has received considerable attention. So far no completely satisfactory explanation has been given of the mechanism underlying bonding of the two metals.

The mechanism of metallic bonding is primarily related to attraction forces between atoms of the two metals. These forces are also associated with the electron configuration of the metals involved. Metallic bonding is aided by diffusion, which is the movement of atoms within the molten metal—usually from regions of high concentration toward regions of low concentration. The rate of diffusion in metal is normally considered to be a function of pressure, temperature and concentration. If the temperature of metal is raised, the diffusion rates are increased and ability to form metallic bonds is facilitated, as for example, in the welding together of two bars of iron raised to the required temperature.

It would seem that there are gaps in the atomic structure, more than sufficient to accommodate the passage of many other moving atoms.

BRAZING

Bonding two similar or dissimilar metal surfaces with a filler metal that has a melting point above 800°F., but lower than those of the metals being bonded is termed "brazing".

In fusion welding both edges of the metal are melted and are allowed to run together with or without a suitable filling material. In brazing the edges of the metal, being joined, are *not* brought to the melting point; but, a low-melting alloy is introduced between the edges of the metal being joined and when the temperature is raised sufficiently a 'tinning' effect

(*Continued from page 59*)

If the above observations point to anything, it is the need for co-operation between the industry and the school. The school will arrange the preliminary training for the students and the industry can provide the additional facilities required such as for apprenticeship in their workshop as part of the course of study. Thus will the student acquire useful knowledge of shop conditions. Furthermore, the welders, after passing out from the training school can be taken up by industrial firms for training on specialised jobs and later on absorbed in their employment. This will help meet the requirements of the industry for skilled welders. Who can deny; "the welder who works with his hands alone is at a disadvantage in competition with one who works with his hands and his head"?

The training programme should aim at producing the latter class of welders. The welding industry in India needs such a programme to-day. The purpose of this article is to focus attention on need for training schools and also on the fundamentals that are necessary for a sound welder training programme. When these fundamentals are understood, it should not be difficult to plan the training on right lines.

CONCLUSION

A lot needs to be done to raise the standard of Indian Welders many or most of whom are called welders by virtue of their having learnt through years to carry out a few specific jobs. Let us then approach the problem with the care and quickness it demands.

It will be in the fitness of things if reference is made here to the efforts of the welding sub-committee of the Indian standards Institution to develop this branch of science in India; the efforts are indeed praise-worthy. The sub-committee is at present engaged in work relating to publication of a "Handbook for Welders" which will be of immense value to the welding industry in general and the welding profession in particular. It is gratifying to see such interest being taken in their advancement. Besides, the welder-training schools, already in existence, such as those at Chittaranjan and Perambur can be mentioned to show how usefully such training centres serve the industry. The people connected with the welding industry and for that matter all who have at heart the interests of Indian industry in general, owe it to themselves to contribute to the success of all such efforts.

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takes place and a joint is produced by adhesion. Most brazing processes are conducted open to atmosphere with the aid of satisfactory fluxing methods; or in a controlled gaseous atmosphere. The filling metal, when molten and in contact with the metals that are being joined and have been raised to a suitable temperature, adheres to the surface by virtue of surface tension and produces the 'tinning effect'. Satisfactory "Wetting" of the metal surfaces by the fused filler metal is one of the pre-requisites for ensuring strong metallic bonds. The alloy characteristics of the filler material appear to determine their wetting qualities or the ability to spread.

THE EUTECTIC ALLOYS

An alloy in a metallic system which possess the lowest transformation point on passing from solid to liquid is called "Eutectic".

Brazing or welding, if carried for excessively long periods at high temperature, may lead to serious deterioration, such as excessive grain growth, porosity, burning etc. EUTECTIC brazing compositions tend to minimize these objectionable physical properties because they solidify or freeze quickly from the fused or molten state.

In solidifying from the fused state, they do not pass through a range of temperature were both solid crystals and liquid phases occur simultaneously prior to complete freezing. However, the use of pure eutectic compositions is often not practical since excessive quenching strains may result in cracking. To minimize these defects, alloy compositions approximating to the eutectic composition are used to provide improved brazing properties. These alloys due to their low melting point, require much less heat input during a bonding operation; thus they far surpass other alloy mixtures which exhibit undesirable post bonding results.

SURFACE CONDITION

In metallic bonding the preparation of the surfaces is of major importance. The surfaces of commercial metals are usually covered with films of varying densities and compositions. Chemical analysis has shown that these films consist mostly of oxides and, in addition, may contain other materials such as sulphides, sulphates and carbonates. The oxide film acts as a barrier in brazing and must be remove either chemically or mechanically to permit satisfactory metallic bonding.

There are three major methods of cleaning metal surfaces prior to brazing. These are: (1) fluxing with salts that dissolve and absorb the oxide films; (2) reducing the oxide films with reducing gases; (3) immersing in molten baths of flux that combine both absorption of the oxides and an oxide-reducing action. To do a satisfactory job, the molten flux must possess proper physical as well as chemical properties. The flux should blanket the brazing alloy upon liquefying, thereby minimizing oxidation. It should be sufficiently viscous to serve as a blanket and not run off or spread too thin. It should also be clear to allow the operator to examine his work. This last property is convenient but not absolutely essential.

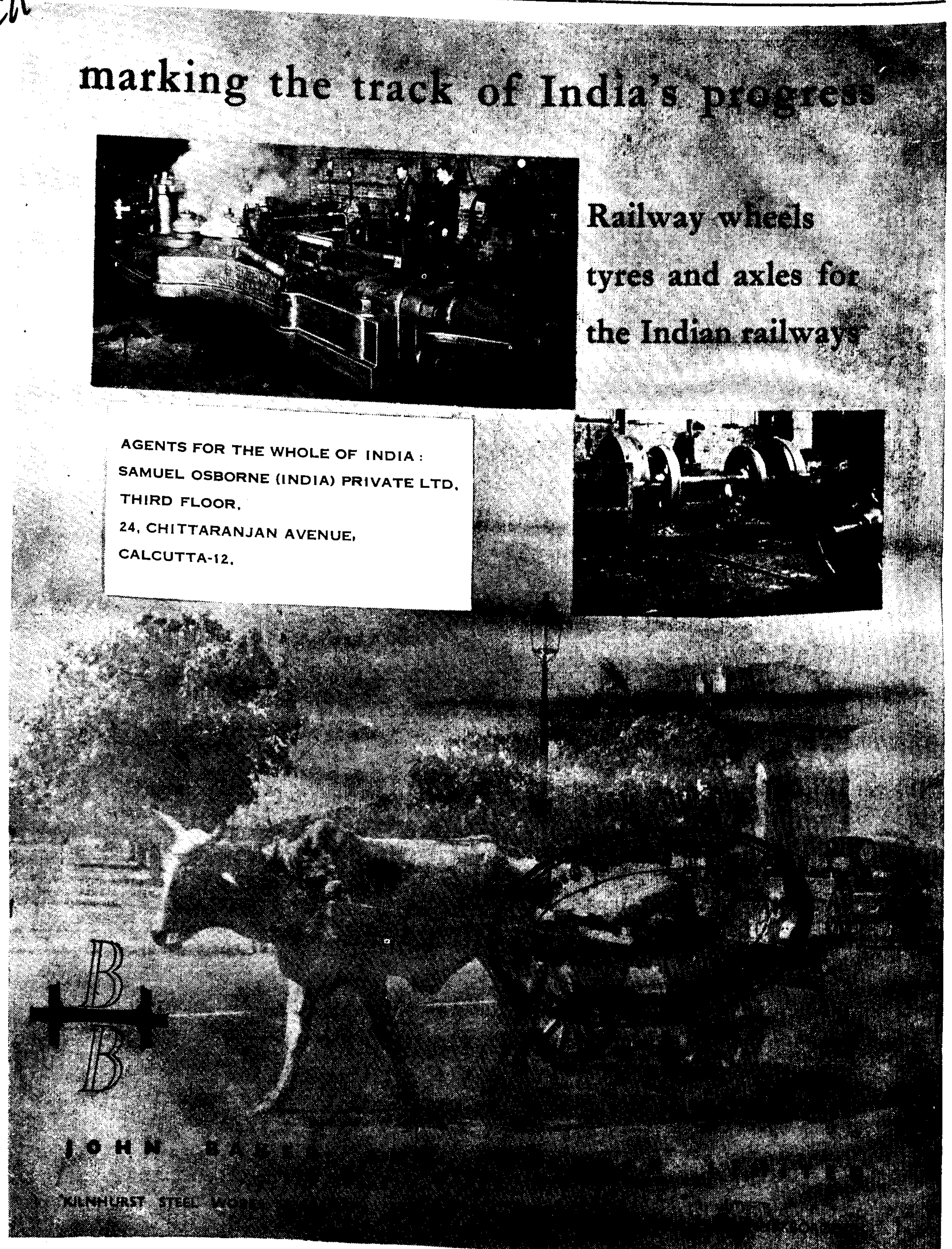
A good flux should be durable, water soluble and capable of being applied by brushing, dipping or spraying methods. In addition, it should wet the metallic surfaces and should not streak or spread in lumps.

Oxides and other contaminations on the base metal and brazing alloy should be dissolved and absorbed by the molten flux. The unsaturated portion of the flux should be adequate to permit through metallic cleaning during the brazing operations. A clean surface can also be obtained by reducing the oxides to the metallic condition.

NEW FLUXES WITH DETERGENTS

Certain chemical compounds possess the properties of reducing the surface tension of liquids, enabling them to wet completely foreign surfaces. They are called "detergents". Similarly, certain activating compounds are often added to brazing fluxes, enabling them to produce similar effects. A well-balanced flux usually contains fluorides, chlorides, borates and small quantities of these activators. The flux should have the following characteristics:

1. produce no excessive run off,
2. melt at temperatures below the melting point of the brazing alloy,
3. reduce or dissolve the oxide films,
4. wet completely both the base metal and the brazing alloy,
5. protect the base metal against oxidation during heating,
6. activate or clean the surface prior to brazing,
7. be displaced by the brazing alloy when liquid.



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