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THE INDIAN RAILWAY ENGINEER

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Managing Editor T. S. N. Rao

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Carriage and Wagon Shops Supplement

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Managing Editor
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The Rôle of the Indian Railway Mechanical Engineer in a Changing World

OUR whole Railway System was started by Englishmen about 100 years ago, and practically until our Independence it was controlled by them. Originally the main railways of India were owned by companies which were formed in England with British Capital. These companies appointed their own Agents in India who saw to it that sufficient profits were made to give the Shareholders a fair dividend on their investments. Short bits of Railways were also owned by the Indian Princely Order and took the name of the State which they served. These too were run by Englishmen for their Indian masters.

After the formation of the Railway Ministry and the Railway Board, conditions began to change and the Indian Government gradually purchased these Railways one by one by paying off the Shareholders and calling these Railways Indian State Railways, but the control was still in the hands of Englishmen, and they saw to it that sufficient locomotives, carriages, wagons, machinery, spare parts etc. were purchased from England by the system known as "Home Indents" which kept the home fires burning.

Up to about 30 years ago Indian Mechanical Engineers even if they had fully qualified and worked in Railway Workshops in England were not considered fit to hold an official grade position in Indian Railway Workshops. With the pressure for Indianisation of the services of the Indian Government exercised by the Indian National Congress, the Railway Ministry had to give in and very reluctantly appointed Indian Officers to the Traffic Department and the Engineering Department of State Railways.

It was not till December 1929 that four Indians were found qualified and experienced enough to be appointed to the Superior Revenue Establishment of State Railways. Two of these were appointed by the Secretary of State for India in London and two were selected by the Public Service Commission.

Since that time much water has flowed under the Railway Bridge and today practically 99.9% Indians now man the Indian Railways in the Mechanical Department.

The pace of Indianisation was tremendously accelerated by the achievement of Independence and the offer made to all covenanted officers to retire with maximum benefits of their service conditions.

The Englishmen left the shores of India with the full hope that Indians with comparatively little experience of running Indian Railways would fail in their task as Egypt did and recall the officers and senior subordinates who had held key positions. But their hopes were shattered when comparatively junior officers with very few years of experience rose magnificiently to the task and kept the wheels rolling getting experience to shoulder responsibility at the same time. This was amply demonstrated by their tenacity and devotion to duty during the nerve racking days of "Partition" when refugees in unprecedented numbers had to be transported from one side of the border to the other in a holocaust of murders, looting, pillaging and destruction. When humanity just disappeared and bestiality held sway for a few months, Young Indian Officers and senior subordinates stuck to their posts of duty and carried out their tasks undaunted by what they saw and experienced.

From August 1947 a gradual build up of Indian Officers from the lowest to the highest took place until every General Manager was an Indian and the whole Railway Board was Indianised and functioned as a team, to work out policies for the Indian Railways. It was decided to make India self-sufficient in its rolling stock and so the Locomotive Factory at Chittaranjan and later the Integral Coach Factory at Perambur took shape. In the mean time Tatas were granted a licence to put a factory to build metre gauge locomotives and boilers. In the Private Sector the well known Structural Steel firms of Burns, Jessops, Braithwaites and Indian Standard Wagon were encouraged to build the wagons required by the Indian Railways. Orders absorbing their maximum capacity were placed on them and when this still fell short of Railway requirements other small firms like Texmaco, Balmer Lawrie, McKenzies and a few others were roped in by the Railway Equipment Committee in their search for capacity.

Machinery and equipment for Railways were in the old days purchased from England only, but now with freedom to exercise their choice orders for machinery plant and equipment went to Germany, Poland, Czechoslavakia, Switzerland, USA, Sweden, Japan, etc.

Orders for coaching stock were placed on local firms like Hindustan Aircraft, Jessops etc., while the Railways themselves built their Air-conditioned and luxury stock, like dining cars, tourist cars, etc.

Workshop machinery like Lathes Drilling Machines are now being purchased from the Government controlled Hindustan Machine Tool Factory, Mysore Kirloskar Ltd., Investa Machine Tools and a few others.

Orders for spare parts of rolling stock are now being regularly placed on private industry in bulk by the D. G. S. & D. and for lesser numbers by the individual Controller of Stores of Railways.

Orders placed a few years ago are now materialising for Diesel Locomotives to replace steam locomotives which are now becoming out-moded.

Electrification is being expanded on the Central Railway where it has been in existence for nearly 30 years and newly introduced on the Eastern Railway on the Calcutta side.

Many Indian Officers are being sent abroad to America, England, Germany etc. to pick up the latest techniques in Railway Mechanical Engineering, Training within Industry for the Supervisory Staff, Time and Motion studies, work studies, training of technicians are all being undertaken with a view to improve the efficiency of workshops.

With the change in the political position of India since Independence the scope and the vision of the Railway Mechanical Engineer has widened considerably and opportunities to consider new ideas, new methods, improved techniques, smoother labour relations and top grade management are now knocking at their doors.

And what of the future? Undoubtedly if we base our knowledge and experience on those of other countries like U. S. A., England, France, Germany etc., who are many years ahead of us and anticipate our requirements during this our 2nd Five Year Plan and the next few five year plans then we will have to prepare for the utilisation of atomic power, the use of

more powerful diesel or electric locomotives, longer freight trains carrying three times the volume of traffic to what we do now, centre couplers, more and better equipped coaching stock and at least three times of our present number of wagon stock.

With the joining up of our Northern and Southern Metre Gauge systems at Khandwa-Hingoli we will have to consider pooled metre gauge wagons which will run from Peshawar to Cape Comorin and from Bombay to Assam.

The speed of trains will have to be considerably augmented and the introduction of roller bearings on locomotives, coaching, and wagon stock is on the cards for consideration in the near future.

For higher speeds our tracks will have to be considerably strengthened to carry heavier loads at higher speeds. The signal interlocking system with colour light push button signals will keep our tracks at near saturation point and speed up the work of marshalling yards and interchange Junctions.

In all these plans of the future the Indian Railway Mechanical Engineer will have to play a predominant part and he must therefore keep himself abreast with modern trends so that when the time comes, his contribution to the safe and economic working of our railways may be an honourable one.

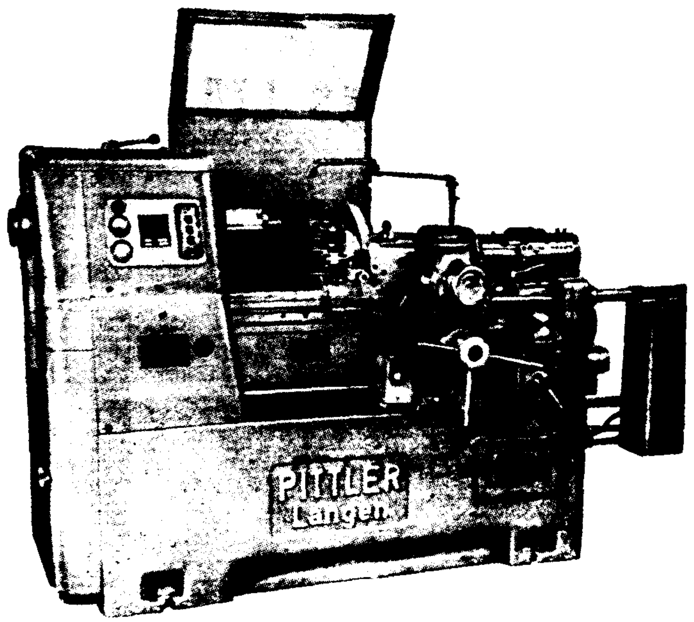
———

"PITTLER" (German Make) 'Pirofa' 45/200 Drum Type Turret Lathe

(Courtesy by Francis Klein & Co. Ltd., Calcutta-1)

THIS type of lathe is in use at various workshops in India as they are ideally suited for non-ferrous manufacturing units. The special advantages of the Pittler Turret Lathes are—

(1) A total number of 16 toolholes enables setting of the machine for the most complicated components. Besides the 16 toolholes in the drum type turret head additional tools can be utilized, e. g., thread chasing attachment suitable for external and internal thread chasing of threads, extra size die hole arm located apart from the turret head thus providing additional tool space, separate cutting-off attachment which can be mounted over the main spindle thus again providing extra tooling capacity. On request, the turret lathe can be provided with extra removable turret heads to enable special setting for large lots without interference with the standard toolings. The complete turret head can be removed from the position within a few minutes.



Pittler Turret Lathe PIROFA 45/200 with hand-operated three-jaw chuck and automatic cycle speed selector mechanism.

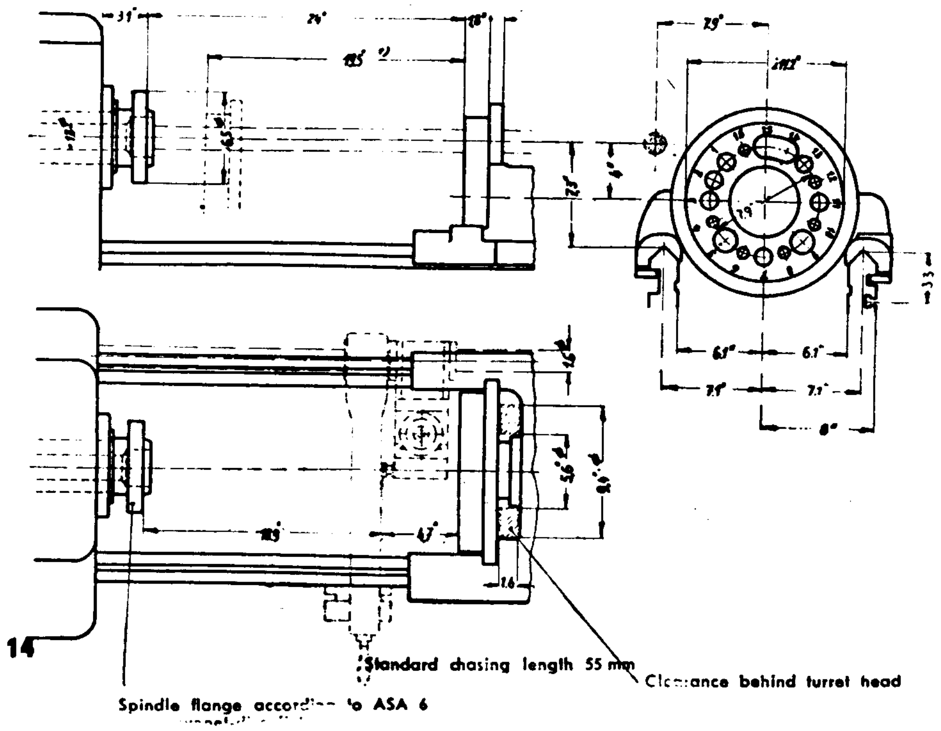
(2) Because of table 'V' hardened slide track and the generally rigid construction of the machine, maximum cutting capacity either with tungsten carbide or with high speed steel tools is possible. Due to this feature it has been proved in practice that upto three times larger output can be obtained on the PITTLER turret lathe than on the conventional type Capstan or brass finishing turret lathes.

(3) A number of special longitudinal stops that can be supplied with the machine enables the application of one tool on different lengths and diameters of a workpiece. Because of this feature a number of indexing can be eliminated, and therefore the workpiece can be produced faster than it is possible on the conventional type of turret lathe where such special longitudinal stops are not applicable.

(4) Precision longitudinal feedstops dial gauge enables finishing those components which may require ten-thousandth of an inch limit.

(5) Precision transverse feed stop: Because of this feature it is possible on PITTLER drum type turret lathes to machine with the same tool any recesses inside the workpiece simply by rotating the turret drum into the required direction. The depth of the recess can be accurately measured with the dial gauge.

(6) The machine can be provided with longitudinal copying attachment which enables turning different profiles with single-pointed tool in longitudinal direction. At the same time the machine can also be provided with transverse copying attachment enabling machining of profiles on the face of the component. This is possible because the drum type turret lathe is provided with automatic feed in transverse direction

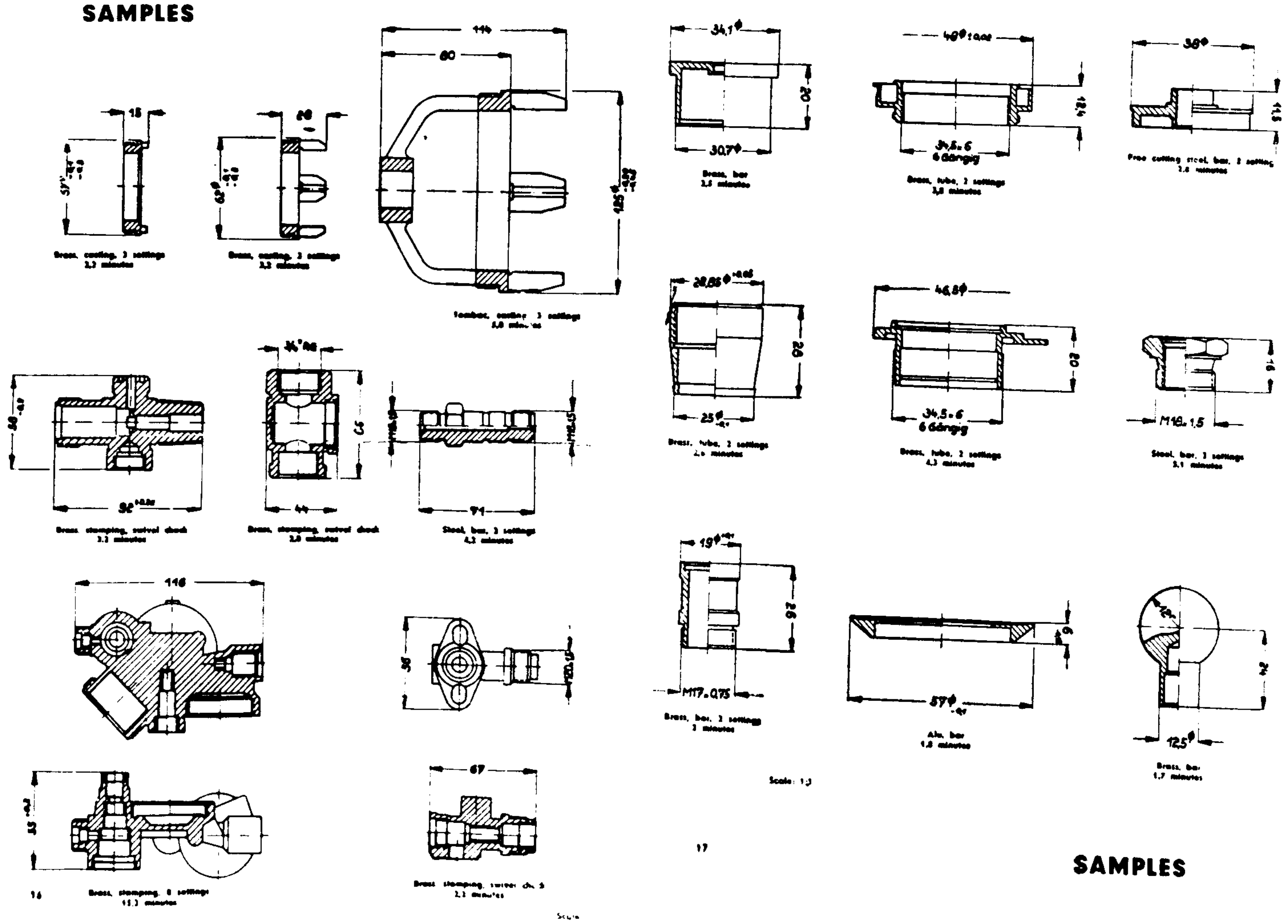


WORKING SPACE OF THE PITTLER TURRET LATHES PIROFA 45/200

Hole 5, 9, 14, 15	= 1.57"
Hole 1, 2, 3, 7, 11, 13	= 1.18"
Hole 4, 6, 8, 10, 12, 16	= .78"

1) Working range of automatic release

SAMPLES



SAMPLES

(7) One of the most important advantages incorporated in the PITTLER drum type turret lathes is the automatic cycle speed mechanism. As already demonstrated to you at the Binani Metal Works, it is possible to switch over instantaneously from the top speed of 1800 r. p. m. to the lowest speed of 14 r. p. m. without operating any change levers or without having to pre-select the speeds with each component.

1. Binani Metal Works manufacture large quantities of Railway components with this; Texmaco for their wagon factory as also Raymon Engineering Works Ltd. and National Instrument Factory in Calcutta use large number of these lathes. The machine costs about Rs. 32,000/- excluding motors and other accessories.

2. A 4-6 Horse Power motor suitable for 400/440 volts, 50 cycles, 3 phase will cost about Rs. 5,200/-. The cost of other accessories suitable both for bar and chuck work including chasing attachment, adjustable tail centre, Swing-over guide arm to hold Pittler die heads with drive shaft, automatic cycle speed selector mechanism including spindle reversing attachment would come to about Rs. 14,000/-. Complete set of chucking tools with guide ring and clamping plates for bar feed for machining round bars from 15 to 45 m. m. rising in steps of 1 m. m. will cost about Rs. 3,500/-

3. A general view of the lathe is shown in Fig. 'A'. The working space required for the lathe is given in sketch 'B'. 'C' gives details of samples with approximate time for finishing. ('D' shows close details of transverse feed-stop.)

ERNAKULAM-QUILON RAILWAY

Deputy Minister Commends Work

Shri Shah Nawaz Khan, Deputy Minister for Railways, said that the construction of the rail link between Quilon and Kottayam was a difficult piece of engineering work. He was speaking at the inauguration of the rail link by the Governor of Kerala, Dr. B. Ramakrishna Rao, on 6th January, 1958.

Shri Shah Nawaz Khan said that about 100 bridges had to be constructed. Normally on new constructions of this nature higher mileage charges for passenger and goods traffic was levied. But in the case of the Quilon-Ernakulam link, keeping in view certain economic factors, a departure had been made from the usual practice and it had been decided to charge only the normal fares and tariff. It was anticipated that over this railway line there would be goods traffic to the extent of 400,000 tons annually. He hoped that the opening of the line would bring prosperity to this area. Amenities not found in other new lines were provided here in view of the intensity of population and the anticipated high traffic.

The Deputy Minister congratulated the 'very able and energetic General Manager, Shri T. A. Joseph, and the engineers and workers on the work they had done.'

Shri Shah Nawaz Khan appealed to the public to patronise the new line and protect the amenities from misuse.

Shri Karnail Singh, Member, Engineering Railway Board, said the Board wished that it would serve every town post and important place of pilgrimage in the country by the railway route from all directions. The gap between Quilon and Kottayam was now being closed. In the last ten years a large number of railway connections had been provided. Despite limitations, the railway authorities had tried their best with firm determination and dedication to the service of the country and within a few years "We are as good as builders of locomotives, coaches and rolling stocks as any one else in the world."

The construction of Quilon-Ernakulam line was a difficult task and yet it was well performed. He complimented Shri Warrier, Construction Engineer, a son of Kerala, on his excellent work.

The inaugural function was held in an artistically decorated spacious pandal, put up near the railway station. About 3,000 special invitees were present.

A short trip by train along the new route from Quilon to Mavelikara was arranged to mark the occasion. The Governor and the Chief Minister travelled in the train, besides a large number of invitees. There was a reception at Mavelikara station arranged by the Municipal Council.

Materials for Overhead Current Collection

By A Special Engineer
THE MORGAN CRUCIBLE CO., LTD., U. K.

Possibilities of carbon for 25-kV electrification suggested by experience on other systems and voltages

THE present rapid development of railway electrification has thrown into relief various associated problems, particularly since the adoption of the 25,000-V. single-phase a.c. industrial frequency system by British Railways and elsewhere. One of these problems is current collection from the overhead contact wire. Since the 25,000-V. a c. system was proposed, it has been remarked in various quarters that the problem of current collection would to all intents and purposes solve itself, since the maximum current to be collected would be about 15 times smaller than with 1,500-V. d.c. and overhead current collection as in use at present.

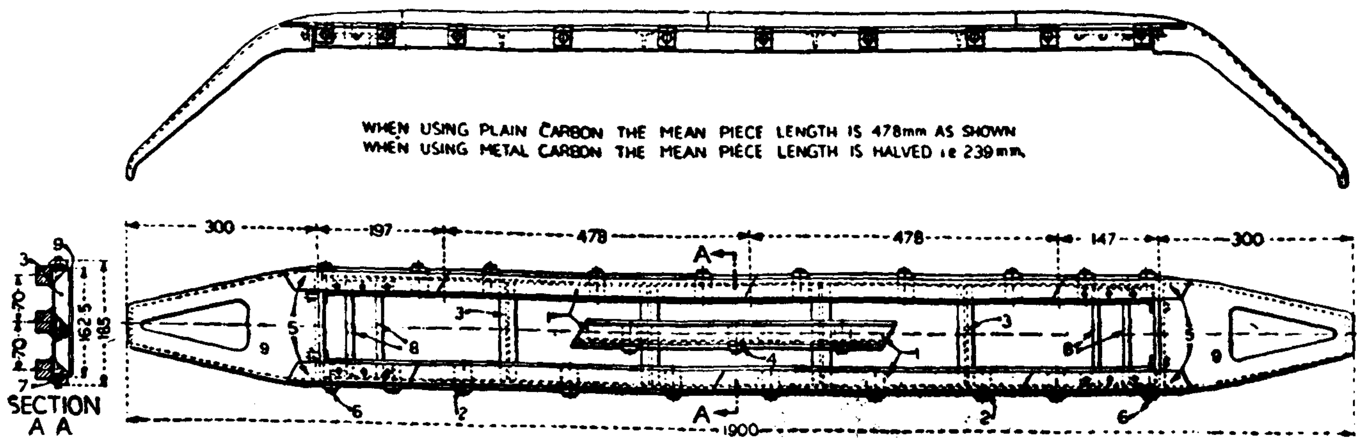
However, since one of the major advantages claimed for the 25,000-V. system is the considerable economy in cost and weight of overhead equipment, some care will still be necessary if full advantage of the reduced current loading is to be obtained.

CHARACTERISTICS OF COLLECTOR MATERIALS

Various materials are employed as contacts with the overhead wire-copper, steel, aluminium, and carbon. Copper collectors are employed on a number of railways, particularly on very large locomotives collecting heavy currents. To reduce the considerable collector and wire wear which results from running copper against copper, some graphite lubricant is necessary, the graphite being carried by a grease or resin bond applied between the copper collecting strips. On occasions steel is employed, alone or additional to the copper, in order to exert a smoothing effect on the roughened wire. Aluminium is also used extensively as a collector material and does not abrade the wire so heavily as copper. However, the average life of aluminium collectors is relatively limited and calls for considerable maintenance. Carbon, particularly metal carbon, can cope with the current-carrying requirements and is equal in capacity to any of the above-mentioned metals, with the further advantage of providing a long life for both wire and collector and ensuring low maintenance costs when suitably applied.

In Europe, where the use of the overhead system has predominated throughout the development of electric traction the application of carbon as a current-collecting material with pantographs has a history of some 30 years.

At the present time the Netherlands, Belgian National, Danish State, Austrian Federal, and German Federal Railways use this material exclusively on their systems. On the Swedish State Railways carbon is being applied increasingly and this system will be changed over to carbon completely in the course of the next few years. The field of application to-day therefore covers both 1,500-V. d.c., 3,000-V. d.c., and low-frequency a.c. systems operating at 12,000 to 16,000 V. It has already been decided to adopt carbon collectors for the Portuguese Railways 25-kV. Lisbon-Oporto electrification.



1. Carbon
2. Steel clamp
3. Welded steel frame
4. Centre clamp
5. Aluminium endpiece
6. Hex-headed screw
7. Steel support gusset tapped to receive (6)
8. Steel support brackets welded into angle frame
9. Aluminium end shield

Fig 1—Carbon-lined pan for Netherlands Railways pantograph

ADVANTAGES OF CARBON

The advantages in the use of carbon are reduced wire wear, considerably increased life of the current collectors, reduced maintenance costs, and reduced radio and television interference—all in consequence of the high polish developed on the wire and the resultant improved contact stability, compared with conditions when the wire is roughened by metal collectors. These features would therefore become a necessary support to the economies in overhead line running costs envisaged by The British Transport Commission in its recent report on the adoption of the 25-kV. a.c. single-phase system for British Railways.

Much experience has been gained already in the performance of carbon on d.c. systems where heavy currents both for traction and auxiliary services have to be collected. Recent commentators have foreseen the possibility of wider use for this material in 25-kV. a.c. electrification, where the conditions of collection will be less severe as far as current is concerned.*

Various methods are used for the attachment of carbon collectors, to pantograph pans or bows. Fig. 1 shows the arrangement of a Netherlands Railways pan wherein the carbon is clamped in position by means of numerous positive clamps along its length. In such a wide pan current is collected at two instantaneous pressure points per contact wire, the effect of the central carbon strip being to provide increased wear capacity. It will be noticed that the pan is of open construction, which, together with the width over the carbons of 8 in., reduces the tendency to tilting or flutter due to windage.

The carbon material employed on the Netherlands Railway system, both on multiple-unit trains and locomotives, is Morganite Link MY7D, a hard carbon incorporating copper-lead. Spray-coppering of the base of the carbon is employed to reduce contact drop and possible electrolytic corrosion between the metal support and the carbon. The overhead system on the Netherlands Railways has a double contact wire. On the multiple-unit sets single pans per pantograph are employed whilst on the locomotives, each with two pantographs, there are two pans per pantograph; thus the current capacity per pantograph when running is 1,600 amp. on a locomotive and 800 amp. on a motor coach.

CURRENT CAPACITY

An assessment drawn from operating experience with the Link MY7D carbon by the maker, The Morgan Crucible Co. Ltd., gives the maximum permissable steady current-carrying capacity of this material per single pressure contact as 100 amp. in static and 200 amp. in running conditions; hence with twin contact wires and a wide pan the number of independent pressure contacts is assessed as four, one at each edge of the pan per wire. The centre carbon strip does not count as a contact point since with the wire bearing at the two edges the centre strip is relieved of pressure. Should the pressure, by movement or wear, come on the central strip, then one or the other of the edges will be relieved of pressure so that the sum total of pressure points per wire at any instant remains two.

Of the two conditions mentioned, static and running, the former is by far the more onerous because the small amount of wire involved in the stationary contact is only able to dissipate a limited amount of heat. The curves in Fig. 2 show contact drop and temperature rise between Link MY7D carbon and a 107 mm.² cadmium copper conductor at various contact pressures. It should be mentioned that with

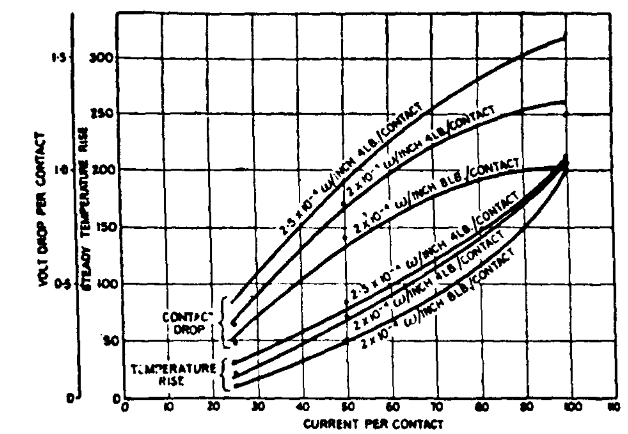


Fig. 2—Contact drop and temperature rise with Link MY7D carbon in static contact with 107 mm² cadmium copper wire

* R. Brookes, "Electric Traction Handbook (Control)," p. 98, chap. 8 (Pitman). E. H. Croft, "Overhead Current Collectors," The Railway Gazette, May 18 and 25, 1956.

non-metallised plain carbon the contact drop for a given current is roughly doubled and the current-carrying capacity more than halved under similar conditions.

On the Swedish State Railways, where 15,000 V. a.c. at 16 2/3 cycles is employed, a single carbon bow is used with a single contact wire of 107 mm.*. On this system plain carbon is used.

WEAR OF WIRE AND PANS

Although carbon has been employed for many years now, the rate of wear of the wire has been found to be so small that it is difficult to give a definite figure. However, the wire is known to wear more rapidly at certain positions than others, and even at these less favourable positions the life of the contact wire has been found to be at least three times that obtained when metal collectors were used. The life of the pans or bows is about 70,000 miles on train units, and about 50,000 miles on locomotives.

The life of the carbon is very dependent on the overhead conditions and, since by far the greater proportion of wear is due to electrical causes, any condition or arrangement which contributes towards a uniform contact pressure assists the contact stability and therefore reduces the rate of wear.

The contact wire stagger which is normally adopted to stabilise the sideways location of the wire has been found to be very beneficial in distributing the wear over the carbon collector. On the Netherlands Railways the stagger has been purposely increased to 22 in. (550 mm.) in order to assist this wear feature of the carbon, and in this case the wear factor of the carbon (volume of carbon worn over the total volume of carbon) is of the order of 70 per cent. A more usual stagger is 12 in. (300 mm.) and, where this cannot conveniently be increased, a similar effect could be achieved on successive sections of the contact wire by displacing the mean position of the wire by 6 in. in alternate directions from the centre-line of the track, thereby doubling the overall stagger of the wire to 2×12 in. (2×300 mm.) for the system.

COLLECTION AT HIGH SPEEDS

The adoption of the 25 kV. a.c. system in Great Britain and France has caused much attention to be focused on the possibility of economy by using a very light overhead system. So far lines electrified at 25 kV. have carried only relatively slow traffic, but already attention is having to be given to the conditions of current collection at higher speeds. Experiments are being made with light-weight pantographs and pans for high-speed running on main 25-kV. routes, such as that from Paris to Lille, which is now being electrified. However, it would appear that above 80 m.p.h.

Swedish State Railways 1-C-1 locomotive (16,000 V., $16\frac{2}{3}$ cycles) equipped with carbon current collectors.

there is a limit to which continuous and positive contact at speed can be assured on a very light overhead system simply by reducing the inertia of the pantograph, and it may well be necessary to increase the weights of the overhead wire above the values now used or proposed for 25-kV. systems, in order to permit the use of higher contact pressure to meet higher speeds. In this connection it is of interest that experience has shown that with carbon collectors the wear of collector and wire is reduced with increased contact pressure.

The carbon collector is self-lubricating; in fact it is actually detrimental to employ grease lubrication of the contact wire when carbon is in use, as this collects abrasive dust.

Swing-Over Transfer-Finger Loading

Versatile Method for Automatic Loading of Centreless Plunge-Ground Pieces

AMONGST the numerous methods which have been evolved for the automatic loading of shouldered and similar pieces to the work-plate of a centreless grinder, the swing-over transfer-finger method which is now being considerably used by Arthur Scrivener Ltd., of Tyburn Road, Birmingham, has a number of points of interest. The photograph Fig. 1 shows this type of loading mechanism applied to a No. 2 Scrivener controlled-cycle machine, and it will be seen that the action bears a certain resemblance to that of a human hand selecting a piece from a tray or chute and transferring it to the grinding throat of the machine.

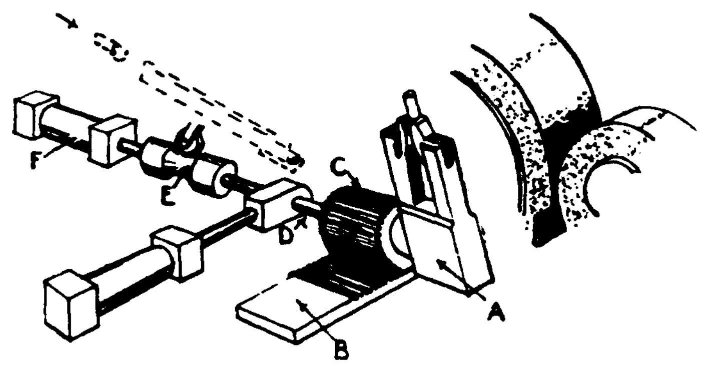


Fig. 2. Diagram showing principle of mechanism.

The simplified diagram Fig. 2 will serve to explain more clearly the action of the mechanism. The headed pieces are first of all placed in an inclined workchute correctly positioned, that is, with the heads downwards, the end of the chute being fitted with a hook stop. From this chute, the end piece is picked up by the spring-loaded transfer fingers which grip the end of the piece, and under the action of the pinion " C " and the fixed rack " B " swing it over to the workplate between the wheels of the centreless machine. As soon as the piece is in position on the workplate, the forward movement of the piston of cylinder " F " and the push rod " D " open the fingers to free the piece, while

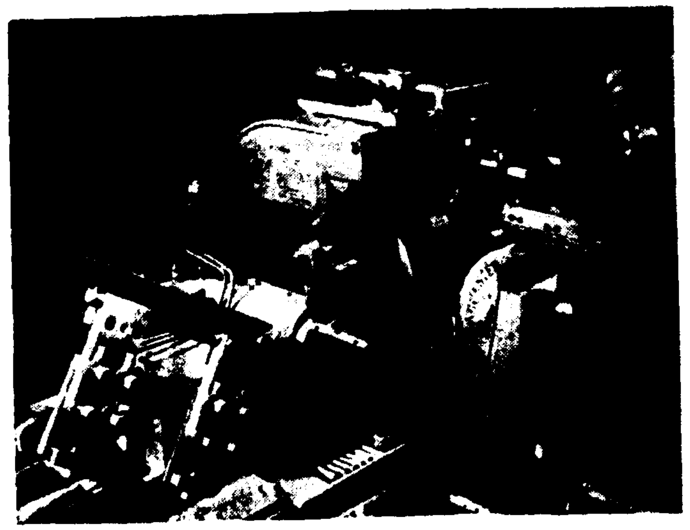


Fig. 1. Automatic transfer-finger loading applied to Scrivener No. 2 controlled-cycle centreless grinder.

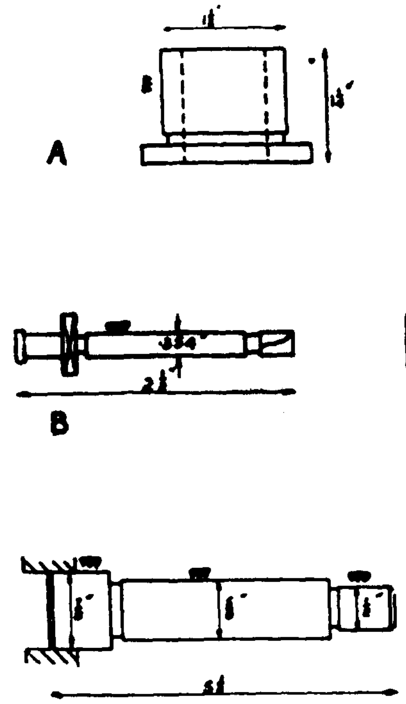


Fig. 3. Some typical pieces and their difficulties.

at the same time the forward movement of cam " E " actuates a limit switch setting in motion the controlled-cycle of the machine which causes the control wheel to close in, thus advancing the piece on to the grinding wheel. While the grinding operation is proceeding, the transfer fingers swing back to the delivery end of the inclined workchute, and when the grinding operation is finished they grip the next piece, while simultaneously the wheels of the machine open again to allow the ground piece to be ejected, thus completing the cycle.

One of the main advantages of the method is its versatility, as a mere change of the removable jaws enables it to be used for a wide range of pieces differing widely in characteristics, such as the types shown by Fig. 3, all of which present certain difficulties for loading by a normal push feed. The piece "A", for instance, has a square shape (diameter and length approximately equal) which is always troublesome to locate or handle automatically; "B" has a head which would rule out the possibility of rolling it into position into the path of a push feed; "C" which is a multi-diameter piece, when handled by the swing-over method, is laid on the workplate with the large diameter slightly over the edge of the workplate clear of the wheels, and is fed forward into position by the so-called "plunge-and-run" process of centreless grinding, the piece being fed into position by the pulling action of the tilted control wheel.

On pieces of the types shown, assuming a stock removal of some .004" and a tolerance for size and roundness of .0002" the normal setting is a 10-second cycle.

"HUNSLET" DIESEL LOCOMOTIVES FOR MADRAS PORT TRUST

Against strong British and foreign competition The Hunslet Engine Co. Ltd., have secured an order for four 274 H. P. 0—6—0 type diesel-hydraulic locomotives for Madras Port Trust. These 5' 6" gauge locomotives are required for haulage of goods wagons inside the Madras Port Area, and will incorporate a Paxman 6 RPH diesel engine developing 257 H. P. at 1,500 r. p. m. under site conditions. Weight in working order is 35 tons and maximum tractive effort with 3.3 to 1 adhesion is 23,800 lbs.

Road Failures of Steam Locomotives and How to Tackle the Problem

By ***Sunil Chandra Banerjee,*** ***G. I. Mech. E. (Lond.), A. M. I. E. (India)***

WITH the growing need for more and more transport, the locomotives are nowadays used for more Steam-hours than before, and for a developing country like India, the locomotives are used to the maximum limit and often beyond same. Although more number of running hours for locomotives add a good commercial gain, the locomotives nowadays have very little time for getting attended to by the repairing gangs in the depots in India. As a result, there is a considerable deterioration in the maintenance of locomotives of our Railways. Owing to the financial difficulties faced by the Government in executing the large projects there is a general exodus of technically trained personnel from the Railways to the private sector where lucrative salaries are offered. This derth of suitably trained technicians has caused a definite drop in the maintenance of the locomotives. The locomotives are, nowadays, not attended to properly. Road failures of locomotives are very common. The following few lines may be useful to the locomotive people who are directly responsible for tackling such problems.

Before taking up the point one after the other, a very important definition is necessary.

How to test, whether the engine is Right handed or Left handed

With both the crossheads placed opposit each other at the motion end of the guide bar, the cranks will be pointing towards the fire-box, in this configuration the uppermost crank will denote the hand of the engine when looked from the trailing end of the locomotive.

BOILER—A number of failures may occur with the boiler of a locomotive.

(a) *Tubes*—When any tube gets cracked while on run, it indicates a heavy and continuous blow. In such a case the tube may be plugged with cast iron plugs put in the tube ends with long tools.

(b) *Fusible Plug*—When the plugs leak at the thread the boiler can be run with high water; complete failure of fusible plug takes place due to—

(i) Water shortness:

(ii) Faulty material;

(iii) Faulty powering.

(c) *Stays*—Cracked or leaky stays show similar indications as leaky tubes; but a leaky stay, (if it leaks inside the fire box) can not be attended to.

(d) *Superheater tubes*—A leaky or cracked superheater element tube gives a continuous heavy blowing while on run. This can only be tackled by cutting off the steam supply to the particular element in a locomotive depot. While the engine is on run the flue tube housing the element should be dummied with a cast iron plug.

Eccentric Straps— A shifted eccentric would be indicated by irregular valve beats, and the beats are very prominent when the reversing lever is placed under the control of the faulty eccentric. The eccentric can get shifted due to a number of reasons e. g. loose cotter, excessive friction in the valve and valve gear, bent axles etc. For a foregear eccentric, place the lever in full forward gear with the crank in front centre and open the regulator slightly with the brakes harden and the cylinder cocks open; move the loose eccentric forward i. e. the advance of the crank until steam appears at the front drain cock, secure the eccentric with screw and cotter making care to see that the motion-work pins and slide valves etc. are perfectly free before starting.

Valve Spindle—The valve beat gets irregular due to a bent valve spindle which results in an altered valve lead and the irregular beats appear on the faulty side of the engine. The valve generally remains at the front end of the steam chest with a broken valve spindle, and a constant admission to one end of the cylinder occurs, thus putting the engine up. For testing a failure inside the steam-chest, first place the crank on the top centre with the brakes hard on and the cylinder draincocks open. Open the regulator slightly and by working the reversing lever forward and backward it can be noticed from the drain-cocks whether the steam admission to the cylinder is in accordance with the position of the lever. When the valve spindle fails inside the steam-chest, disconnect the valve spindle at the outer end, tighten against internal position and secure the position with the gland thus holding the valve at the front end of the steam-chest. The eccentric and connecting rods must be taken down. (The straps may be left on the sheaves if these are clear of the fire-box or bottom of the boiler. This can easily be ascertained by swinging the straps round, taking care to have one of the eccentric sheaves with full throw pointing directly towards the firebox. Now push the piston to front end of cylinder and secure by means of the slide bar clips (which are usually carried). If there are no clips at hand, fix a piece of fence rail or some such material between the slide bars and secure with spun yarn or cord. In the case of an engine with a rocking shaft valve motion the connecting rod only need be taken down, the eccentric rods being kept intact after disconnecting the valve link or short arm. The piston rod would however require to be secured as described before unless the failure was outside the steam-chest, in which case both the connecting and eccentric rods may be left intact by working with the valve fixed in the middle position after thoroughly flushing the cylinder with oil and taking and lubricator valve.

Valve Leakage

This can be detected by a continuous blow through the chimney. For slide valves it may be due to the buckled spindle causing the valve withheld from its face. With brakes hard on and reversing lever at the full mid-gear if there is a continuous blow the above defect has come in. The continuous blow may also be due to the broken lap pieces. By working the reversing lever with the cranks at top centre when the other crank is at the back dead centre if stiffness is obtained the valve of the top crankside is defective. For a large leakage it is a case of total failure.

ken slipper for Joys valve gear—Slipper blocks y's valve gear are bored through the centre for ıment to the swing links and therefore usually across this, the wickest part, in which case the m portion is usually lost. This, however does ··rent the engine being worked in a careful to its destination, since the upper portion is retained in position by the slipper block slides, and will therefore perform the work of the whole block temporarily. In the event of a slipper block breaking in such a manner that it is impossible to work forward, the slide valve on the faulty engine side will require fixing in the middle position with cylinder drain cocks open, brakes hard on and connecting rod on bottom centre for taking down the valve gear. First uncouple the sewing links from the stirrup links and slipper blocks as high as possible, in which position they may be secured by means of a rope to the boiler handrail or the framing. The bottom of the swing links should then be moved toward to motion plate and the reversing lever moved to find the most suitable position for taking out the valve rod pin. After detaching the valve rod, the swing links and slipper blocks may be steadily lowered down the slipper block slides and thus liberated. The connecting rod and remaining links may by left in position for working with one side to depot, care being taken to lubricate thoroughly the faulty engine side.

Broken swing link—is to be dealt with as in the case of a broken slipper block.

Broken anchor links—after fixing the valve in middle position proceed by first taking down the swing links and the position of anchor link connected thereto. Disconnect the stirrup link which was thus left hanging on to the connecting rod and proceed to depot with a single engine.

Broken reversing lever—Cause—(1) Excessive valve friction (2) too tight gland (3) faulty material. The links by their own weight fall in fore gear. To work the engine in back gear raise links by pinch bar, and jam the motion shaft then with tin or leather etc.

For a broken or uncoupled regulator—the admission to the cylinder can be done by the reversing lever and proceeded to depot

Seizing of reversing screw thrust gland—This is generally accompanied by a gradually increasing stiffness when reversing, and would probably be due to dirty or choked up oil holes preventing proper lubrication to thrust collars. To remedy, remove nuts from gland which may then be forced out by turning the screw. Relieve the catch plate by taking off handle, thereby also releasing the bolts, and the gland, being in halves, will then leave the screw. Clean all parts, smooth over with file where rough and lubricate before replacing.

Testing *Engine for faulty valves, pistons, or rings, broken front or back, lap pieces or a broken valve cavity*:

First place crank of the engine on the top centre with brakes hard on and cylinder cocks open. If the piston and rings are in good condition steam will issue from the back drain cock only, when the lever is placed in full forward gear and the regulator opened. If however either piston or rings are broken steam will discharge through both the drain cocks. The test may be repeated by placing the lever in full backward gear, thus admitting steam to the front end of the cylinder and through the front drain cock only if the piston and rings are in proper working order. When testing for broken lap pieces the lever should be placed in mid gear thus entirely shutting off steam from the cylinder if the valve is in good condition. With the valve in this position the broken lap piece will be indicated by the corresponding drain cock issuing steam out. A broken valve cavity will discharge steam through the blast pipe in all the positions of the reversing lever. These tests could also be carried out with the cranks at the bottom centre and in this case the steam is admitted to the opposite ends of the cylinder and will issue out from the drain cock accordingly.

Broken port bridge—It can be observed by the occurrence of one strong blow to the every third beats of the valves or to one revolution of the driving wheel. This strong blow is caused by the steam following the line of least resistance, thus passing directly through the broken port bridge and up the blast pipe immediately the faulty port is open to steam. To locate the fault slowly move the engine forward with the reversing lever in forward gear, assuming the engine to be right hand. If the blow occurs at the time that the R. H. crank is passing through the top front quarter the left hand back port bridge is defective. In a similar manner the broken port bridge can be detected with cranks in the following position :—

R. H. crank passing through bottom back quarter—L. F. port bridge

L. H. Crank passing through top front quarter—R. F. port bridge

L. H. Crank passing through bottom back quarter—R. B. Port Bridge

For a heavy damage to the port bridge the valve should be fixed in mid gear, connecting rod removed and locomotive should be run one engined slowly.

Broken air valve:—In any case the valve lift must not exceed 3/8". Air valve failure is caused by too much lift and faulty material. In case of failure place a piece of timber to make up the thickness on top of valve and insert a piece of iron between timber and valve lift regulating screw. Tighten down securely by means of the screw, and although the valve will be rendered useless the engine may be worked to its destination.

Broken Piston head:—A broken piston head may be due to priming, in which case the water carried over with the steam from the boiler is trapped between the piston head and cylinder cover, the latter being also often damaged at the same time. Pieces of broken piston rings, by becoming jammed against the cylinder walls or between cover and piston or by fouling, as when protruding through the ports may also be sufficient to damage the piston head. When this failure occurs a dangerous knock (which) is transmitted through cylinder and motion parts is usually heard. If, however the knocking is insufficient to attract the attention, the fractured piston head will be denoted by two heavy blows up the blast pipe at every revolution of the driving wheels. The blows will commence with the admission of steam and cease with the point of cut off at each end of the cylinder alternately. Having ascertained by means of the draincocks which is the faulty side, uncouple the engine by taking down the connecting rod and securing the various parts as described. If however the whole of the piston is broken from the rod and the back cover has remained intact the pieces may be removed and the rods retained in position, provided the engine is within reasonable distance from a depot. Should any part of the head remain on the rod or any doubt exist the engine must be uncoupled, and the valve placed in mid gear to shut off steam from the cylinder.

Damaged or broken piston rod:—Uncouple the engine taking other precautions.

Test for cross-head failure:—Connecting rod adjustment should be tested from time to time with cranks on top centre, cylinder drain cocks open and brakes hard on. By opening the regulator a little allow the reversing lever to be worked forward and backward thus allowing steam to enter through both sides—one after another the excessive movement in big or small end will at once be apparent. The slide bars are generally damaged for a broken crosshead and for this the locomotive should run one engined.

Broken piston rod gland:—Check nuts improperly locked or working loose are the most common causes of this failure. If not entirely broken the gland may be fixed in position with a piece of rope or spun yarn securely passed round the gland and slide bar supports for heavy damage the locomotive should go one engined.

Taking down faulty connecting rod for inside cylinder engine:—Pinch the engine until the crank of the faulty side is straight out towards the cylinder. In this position there is ample space over the ballast for stacking back the bigend bolts. Pinch then the engine forward until the crank is midway bit front and bottom centres for removal of the set screws, bolts and cotters, thus releasing the bigend strap. The buttend brass may be set by raising the rod which may then be drawn or pinched towards the fire-box using the crank or journal for support. This will bring the piston against the cylinder back cover with the small-end bolts behind the motion plate, in which position they are easily removed. For a solid small end the rod is removed by taking out the gudgeon pin.

Bent or broken connecting rod:—Causes—any of the causes mentioned for piston or crosshead failure—i. e. excessive knocks etc.—bigend brasses seizing of the crank journal by expansion when too hot etc. For a slightly bent rod the locomotive can go slowly, but for a heavy bend the rod should be changed.

Bigend strap and bolts—Causes—excessive knock due to the brasses having ground away when running hot, or to the various causes mentioned for a bent rod. In the event of both bolts breaking without damaging the strap one bolt can be taken from the other rod and the engine worked lightly. For a broken strap it should go with one side. Care should be taken when working the engine with one side to stop with running crank away from the dead centres, otherwise the engine will have to be moved by means of a pinch bar or lach for a proper admission of steam to the cylinders before a strap can be made.

Connecting rod failure—Eight wheeied. Coupled outside cylinder engines:—

First place the rod half way bet front and bottom centres. Remove brass and allow the rod to motion crank pin. Take out the gudgeon pin. Fit a false bush washer to the crank to keep the side rods in position and fit nuts, work home with the opposite side.

Causes and how to deal with a bent or broken side rod on four six and eight wheeled coupled engines:—

Excessive slipping of the wheels together with faulty sanding may be given as the most common cause of bent or broken side rod, although the failure may also be due to faulty material. In the case of a four wheeled coupled, both rods will require taking down, and the engine may then be worked as single wheeled. With six or eight wheeled coupled engines the side rods are jointed to give more flexibility, and it will usually be found that the eye of the rod is the weakest part, more especially when it has become worn by the coupling pin. These coupling joints should therefore be examined from time to time for the preventions of failure. On six-wheeled coupled engines this joint is almost invariably placed immediately beyond the driving crank-pin at the trailing end, so that should the leading rod become defective, it will be necessary to place down the whole of the rods. If however, a trailing rod was damaged the leading rods could be left intact and the engine run as a four wheeled coupled. In all cases of coupling rod failure it is necessary to remove the corresponding rod on the opposite side for retaining the engine balance, and to prevent dangerous twisting strains that would be set up with one side coupled only. Eight wheeled coupled engines are usually constructed with outside cylinder in which case the connecting rods would also require taking for removing the whole of the rods, since they are connected to the driving crankpins on the outer side of the side rods. In this type of engine the flexibility is usually obtained by constructing the side rods in three positions, and the method of detachment in case of failure becomes somewhat more complicated than with the ordinary four or six-wheeled coupled engines. In the case of a leading or trailing side rod failure, the centre rods should be left intact and the engine placed in a suitable position for taking out the coupling pins through the spokes of the wheels, thus liberating the faulty rod, (always taking care to remove the corresponding rod on the opposite side).

If however the centre rod be defective, it will necessitate taking down the complete set of rods. Before replacing the connecting rods, the space previously taking up by the side rods on the driving

crank pins will require filling up again, by means of packing or temporary wood or metal bushes which should be carried for this purpose on this class of engine. These bushes will keep the connecting rod big-ends in their proper positions on the crank pin journals when working home or to destination. The hauling power of the engine will be reduced according to the number of wheels uncoupled and this together with the load behind will therefore determine whether the whole or only a portion of the train can be taken forward

Axle box fast in horn plates; what might be the cause, how would it be observed, and what remedies:—

A hot journal, which may be due to insufficient lubrication, or to grit picked up when running, may cause an axle box to expand and thus seize in the horn plates. This is perhaps the most common cause although it may perhaps be due to the box being too good and fit when delivered from the repair ship, which, together with insufficient lubrication, might cause it to become fast. When this occurs excessive and dangerous vibration is at once observed. If the horn plates are fitted with a wedge the box may be released by slacking back the adjusting bolt. If however, the horns are fitted with solid plates the box should first be cooled with water to see if it can be liberated by the contraction that will take place. Should this contraction be insufficient for releasing the box the sliding faces will require flushing with oil or paraffin, and the engine run over a fish plate as hard piece of wood to start the box working again. If the box cannot be liberated in this manner the engine must be worked to the nearest siding or depot, and the assistance of other engine obtained. A fast box is a far more dangerous failure than a journal merely running hot, so that the engine must be run as slowly as possible and the journal will be lubricated with a liberal supply of oil or a mixture of oil and plumbage.

How to deal with a broken Leading, Driving or Trailing Spring when a Lifting Jack is most provided

The method of procedure with a broken spring will always depend on the nature of the failure: underhung springs and many others of the laminated type, for instance, are so situated that the additional weight due to a defective spring, such as broken top plate or back, will be distributed over the other bearings and it will therefore be possible to carefully work the engine forward with a reduced speed. Providing it is not a leading spring failure, it is sometimes even possible to work cautiously forward to a siding or depot after a spring has broken through whole of the plates, and which have in consequence been lost on the road. In the event of complete failure due to a broken leading opening, it would be necessary to relieve the weight of the engine by first running the driving wheels on to hard wood wedges or fish plates etc., afterwards placing reversing lever in mid gear, cylinder draincocks open and brakes hard on. Suitable packings should then be placed between the top of the axle box and horn block at the faulty end. After the engine has been run off the wedges it will be found that sufficient weight is borne directly on the bearing near the faulty spring for working home safely. This method would require reversing for a broken driving spring, care being taken to first pack between the trailing axle boxes and horn blocks so as to provide a solid base when lifting the leading end on to the wedges. Many engines are fitted with spiral springs more especially in connection with the driving bearing. In this type of spring it is very rare for more than one or two coils to break on any journey and the centre spring link would therefore be sufficient in most cases to retain the spring in position for working home. In case of potral collapse the method of procedure would be the same as for laminated springs.

Engine derailment and what should be the case for wheel and axle—

The wheels should always be carefully gauged after the engine has been placed on the rails. A staff or gauge should be obtained and the wheels measured at four equal quarters between the runs. Should the wheels vary more than 1/8″ between the runs at any of the quarters the axle must be thoroughly overhauled before proceeding.

Probable cause of broken axle, and how to proceed with this kind of failure—

A broken axle is often due to faulty tyres which by reason of having on excessive mileage without returning, have worn out of truth and therefore vary in dia., at different points of the circumference, thereby setting alternating strains when running. The breakage may also be due to incipient fracture on faults in the material which although not previously desirable, may have gradually developed as the mileage increased until finally failure occur. Much depends on the nature of the fracture as to the methods of procedure. Modern crank axles, for

Fuel and Power Industries in the United Kingdom

By Our Overseas Correspondent

THE main primary sources of energy in Britain are coal, petroleum and, to a small extent, water power; secondary sources, produced from these, are electricity and coal gas.

Coal, mined within the country, supplies 86 per cent of Britain's energy and it must continue to be the main source for many years to come. But it is unlikely that production of coal can be increased sufficiently, even by the very large investments planned, to satisfy increasing demands for energy, which may well double within the next twenty years. For supplies of crude petroleum Britain is almost entirely dependent on overseas imports; water power resources are limited. For these reasons, Britain is investing large sums in the development of nuclear power as an alternative source of energy. But the new source will not start bearing much of the burden for at least ten years, after which time its use should increase rapidly. The fuel and power industries, with the exception of the petroleum industry and coal distribution, are mainly under public ownership.

The Government's fuel and power policy has two principal objectives. The first is to ensure that power supplies are adequate to meet the rapidly growing demands of industry and of the domestic consumer in a country with an expanding national income. The second is to make the maximum possible use of indigenous resources and so lighten the load on the balance of payments.

The Government also aims to reduce air pollution. The Clean Air Act, 1956, makes it an offence to emit dark smoke or to fail to provide industrial premises with equipment to arrest grit and dirt, and empowers local authorities, subject to the approval of the Minister of Housing and Local Government, to declare 'smoke control areas', in which the emission of smoke from chimneys will constitute an offence; provision is made for the payment of grants by local authorities and the Exchequer towards the costs incurred by owners and occupiers of houses in these areas in making necessary changes to appliances. A Clean Air Council, to review progress and to advise the Minister, was set up in May 1957.

COAL

Coal has been worked in Britain for over 700 years and an organised coal-mining industry has been in existence for over 300 years, some 220 years longer than in any other European country. British coal exports dominated the world coal market until about 1910. By 1913—the peak production year—the industry was producing 287 million tons of coal, exporting 94 million tons and employing 1,107,000 workers.

The very fact that the British coal-mining industry was developed so early has meant that many of the best seams of coal are now worked out; every year coal has to be mined from deeper and thinner seams and productivity can be maintained only by increasing efficiency.

The industry declined during the first world war owing to a shortage of man-power and to the shortage of plant and materials necessary for undertaking any mechanical improvement. Moreover, alternative sources of energy and lower prices in continental countries led to a later decline in exports, which had fallen to 67 million tons in 1925.

Attempts at securing economies through amalgamation date from the Sankey Commission of 1919. In 1930, a Coal Mines Act established commissioners to bring about the formation of larger and more efficient units. The Coal Act of 1938 transferred ownership of the mineral coal to the State and made it the statutory responsibility of a Coal Commission to accelerate the integration of the industry by still further reducing the number of separate undertakings. At the outbreak of the second world war in 1939, however, this process was not far advanced.

ORGANISATION UNDER PUBLIC OWNERSHIP

In 1942, the Government assumed full control of the industry's operations, though the colliery undertakings continued to own the coal-mines. In May 1946, the Coal Industry Nationalisation Act received the Royal Assent. On 1st January, 1947, the assets of the industry were vested in the *National*

Coal Board, which was appointed by the then Minister of Fuel and Power and became responsible for the industry's management. Under the Act, the Board consisted of a chairman and eight other members, but this provision was amended by the Coal Industry Act, 1949, and the Board now consists of a chairman and not fewer than eight or more than 11 other members; the number of full-time members must not exceed eight and there must be one, and may be two, deputy chairmen.

The Board's main duties are:

(1) to work and get the coal in Great Britain to the exclusion of any other person;

(2) to secure the efficient development of the coal-mining industry; and

(3) to make supplies of coal available of such qualities and sizes and in such quantities and at such prices as may seem to it best calculated to further the public interest.

The Board is also charged with securing the safety, health and welfare of its employees and the benefit of their practical knowledge and experience. The Board's policies must also be directed to ensure that its revenues shall be not less than its outgoings properly chargeable to revenue account and taking one year with another.

There are minor exceptions to the Board's exclusive monopoly to work coal in Britain: for example, it may license private enterprise to work small mines in which the number of underground workers does not greatly exceed 30. Production on opencast sites, which had been the responsibility of the Ministry of Fuel and Power (as it was then called), was transferred to the Board on 1st April, 1952.

The Board is responsible for its own regional organisation. The collieries, numbering about 900, are grouped into 50 Areas which are the basic units for commercial management. The size of the Areas varies according to geological, geographical and other technical considerations. The Areas are grouped into nine Divisions which roughly correspond to the main coal-bearing regions. A Divisional Board for each Division supervises and co-ordinates the work of the Areas within the Division (except in the small South Eastern Division, which is administered by a General Manager), formulates divisional policy, and is answerable to the National Coal Board, which is responsible for questions of national policy, finance and the co-ordinating of major schemes of development. The day-to-day work of running the collieries is under the direction of colliery managers.

Two Coal Consumers' Councils were set up under the 1946 Act: the *Industrial Coal Consumers' Council*, members of which represent consumers, merchants and suppliers of coal, coke and manufactured fuel for industrial and other purposes, involving supply in bulk; and the *Domestic Coal Consumers' Council*, members of which represent similar groups concerned with coal for domestic use. The most important function of the Councils, which are responsible to the Minister of Power, is the general consideration of the commercial arrangements and activities of the National Coal Board, to ensure that the monopoly in the industry set up by the 1946 Act shall have the maximum practical regard for consumers' interests.

The Coal Industry Nationalisation Act requires the National Coal Board to publish an annual report and statement of accounts which are laid before Parliament.

At the end of 1947 (its first year), the National Coal Board showed a deficit of £ 23.3 million, after paying compensation to the former mine-owners and interest on borrowed capital. In the years 1948, 1949 and 1950 there were surpluses of £ 1.7 million, £ 9.5 million and £ 8.3 million respectively. There were deficits of £ 1.8 million and £ 8.2 million in 1951 and 1952, a surplus of £ 0.4 million in 1953, deficits of £ 3.6 million in 1954 and £ 19.6 million in 1955, and a surplus of £ 12.8 million in 1956.

The National Coal Board raises capital by long-term borrowing direct from the Exchequer, instead of through the issue of stock. There is a statutory limit of £ 650 million at present on such borrowing and special authorisations is needed for borrowing, in any one year, more than £ 75 million in excess of the highest level of aggregate advances in the preceding year.

PRODUCTION

It has been estimated that Britain has workable reserves of coal of 43,000 million tons, more than enough at current rates of consumption to last for 200 years. But certain types such as high quality coking coal will be exhausted long before then unless they are eked out by blending with other types of coal.

The main coal-bearing areas are: (1) the Yorkshire, Derbyshire and Nottinghamshire field which produces about 40 per cent of the total output, (2) the Durham and Northumberland field, (3) the South Wales field, and (4) the Scottish field. Other important coal-bearing areas are those of Lancashire and the West Midlands (Staffordshire and Warwickshire). There are no coalbearing areas in Northern Ireland.

In the years since nationalisation the National Coal Board has been able to secure quick increases in production and productivity by reorganisation, by a wider application of improved working methods and by increased mechanisation of cutting and conveying. As a result, deepmined production increased from 187.2 million tons in 1947 to 214 million tons in 1954 despite a fall of 4,000 in average manpower. In 1956, 210 million tons was produced from deep mines, which, with 12 million tons from opencast workings, gave a total of 222 million tons. Productivity of all workers increased between 1947 and 1956 from 1.074 to 1.232 tons per manshift.

Future progress depends on bringing new mines into production, the development of machines for power-loading the coal at the face on to the face conveyor belt and on the reorganisation of the haulage systems by carrying out major reconstructions. The National Coal Board has launched a large programme of major reconstruction and new sinkings.

Since the war the coal industry has suffered from a shortage of manpower. In 1956 manpower averaged 703,400 about 9,000 fewer than the industry needs.

MARKETING

The principal marketing officials of the Board are also officers of the Minister of Power's Coal Supplies Organisation, whose function is to apportion the coal to consumers according to the Minister's determination of the national interest.

The Board, as sole producer, is bound to make the first sale of coal. It has, however, no monopoly of distribution, though it does act as a wholesaler and, in the colliery areas, makes direct sales to consumers. Retail distribution is for the most part carried on by private firms, but the price structure is controlled by the Ministry of Power.

CONSUMPTION AND EXPORTS

Although the level of coal production has risen appreciably since 1946, inland consumption has risen even faster—mainly because of the expansion of industrial output. In consequence, the proportion of output which is exported has greatly declined, compared with pre-war, in spite of a virtually unlimited demand for exports of British coal. Exports (excluding bunkers) rose from 4.5 million tons in 1946 to 13.9 million tons in 1949. In 1955 and 1956, exports were deliberately cut to 12.0 million tons and 8.4 million tons respectively.

The greater part of exports of British coal is sent to Europe, and especially to Denmark, Sweden, Germany, the Irish Republic and Italy. Nearly all Britain's coal exports since the war have been covered by trade agreements, and the National Coal Board has sought to honour its old customers even when that has meant importing coal at great expense from Europe and the United States and selling at a loss at the prevailing internal prices. Imports in 1955 amounted to 11.4 million tons, in spite of the reduction in exports, but in 1956 were reduced to 5.2 million tons.

LABOUR RELATIONS

Negotiations on wages and conditions of service are conducted through a Joint National Negotiating Committee, consisting of 16 members appointed by the National Coal Board and not more than 16 members of the National Union of Mine-workers. Disputed issues are referred to a National Reference Tribunal consisting of three permanent independent members and four assessors without voting rights, two representing labour and two management. There are also District Joint Negotiating Committees, which deal with the application of national agreements, settle any difficulties and differences that may arise at district level and refer unresolved differences to the national committee.

The Coal Industry Nationalisation Act requires the Board to enter into joint consultation with its employees to discuss such matters as production, safety, health and welfare. At almost every colliery there is a Consultative Committee in which the workmen's representatives are elected by secret ballot. The colliery manager is chairman, and he nominates three colliery officials to be members of the committee. There are also Consultative Councils at the area, divisional and national levels on which the Board and the four staff organisations in the industry —the National Association of Colliery Managers, the British Association of Colliery Management, the

National Association of Colliery Overmen, Deputies and Short-firers, and the National Union of Mine-workers—are represented.

SAFETY, HEALTH AND WELFARE

The safety, health and welfare of miners are safeguarded by comprehensive legislation, which was consolidated and brought up to date by the Mines and Quarries Act, 1954. Responsibility for the enforcement of safety regulations lies with the Mines and Quarries Inspectorate of the Ministry of Power.

The National Coal Board has its own safety organisation and, in accordance with the Nationalisation Act, follows a policy directed towards securing the safety, health and welfare of its employees, examples of voluntary action by the Board to reduce risks are the installation of fire-resistant conveyor belts, the replacement of light alloy supports (which has been found to be liable to produce dangerous sparks) and the wide-spread introduction of courses for training for various classes of officials and workmen. The Board has also continued to strengthen the medical services which existed before nationalisation. Chief Divisional and Area Medical Officers have been appointed and Assistant Medical Officers are being appointed in areas with a labour force of more than 15,000 men. Medical centres are being set up at the pit head.

The Board is responsible for its employees' welfare at their work-places, for example, by the provision of pithead baths and canteens, which the social welfare of coal-miners and their families has, since 1952, been the responsibility of the Coal Industry Social Welfare Organisation, which is controlled by the Board and the miners' trade unions.

Research into problems of safety and health is carried out also at the Ministry of Power's Safety in Mines Research Establishment, which maintains a close liaison with the Mines Inspectorate and the National Coal Board's research organisation.

DEVELOPMENT AND RESEARCH

Contraction and curtailment of development in the industry since the peak year, 1913, had led to a position in which less than one-third of current output was coming from pits started in the twentieth century. Large-scale development was therefore essential.

In 1950, the National Coal Board announced its long-term plan of development for the industry, involving the reorganisation and increased mechanisation of existing mines and the sinking of new ones. The plan envisaged a capital investment of £ 635 million at 1949 prices between 1950 and 1965, when it was estimated that the annual output of coal would have risen to about 240 million tons. The plan was not a rigid blueprint, room being left for modifications in the light of changing circumstances and new knowledge. Actual capital expenditure in the years 1950—54 was £ 258 million at current prices. Under a revised plan issued in May 1956, the Board provides for an output of 228 million tons in 1960 and 240 million tons in 1965. An annual output of 250 million tons is not thought possible before 1970. Opencast production is expected to continue at a rate of about 10 million tons a year. The capital cost of achieving these output figures, and of providing the money for major schemes to be completed after 1965, is estimated at £ 860 million for collieries and their associated activities. In addition, the Board proposes to spend £ 140 million on ancillary activities. A total of £ 590 million will be spent between 1956 and 1960 and £ 410 million in 1951—65. Manpower requirements are estimated at 682,000 with an output-per-man-year of 319 tons in 1960, and 672,000 with an output-per-man-year of 342 tons in 1965. When the programme is completed, four-fifths of Britain's coal will be coming from virtually new mines.

The mechanical cutting and conveying of coal are now the general practice: in 1956, 87 per cent of total deepmined output was mechanically cut and 93 per cent was mechanically conveyed. The loading of coal at the working face offers, at present, the next most important possibility for increased coalface mechanisation. In 1956, 36.4 million tons were power loaded, compared with 13 million tons in 1953 and 5 million tons in 1947.

In 1947, the National Coal Board took over, with other assets, the Coal Survey, a national organisation for surveying coal resources within Britain, and 70 laboratories in the various coalfields, which it has since extended and modernised.

In 1948, the Board established a central research organisation at Stoke Orchard, near Cheltenham, Gloucestershire, to provide facilities for fundamental research in the coalmining industry, as distinct from the day-to-day scientific control exercised by the divisional and area scientific organisation. This is now known as the Coal Research Establishment. A second

EDITORIAL NOTICE

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central research organisation for the investigation of underground problems, known as the Mining Research Establishment, was formed in 1952 by the Board at Isleworth, Middlesex, and a Central Engineering Establishment is now operating near Bretby in Derbyshire for developing new machines and testing equipment.

The Board also subscribes to a number of autonomous research associations in receipt of grants from the Department of Scientific and Industrial Research (DSIR), including the British Coal Utilisation Research Association, the British Coke Research Association and the Coal Tar Research Association. In addition much of the work of other bodies, such as the Safety in Mines Research Establishment of the Ministry of Power and the Fuel Research Station of DSIR, is closely related to the Board's problems.

From 1st July 1956, the National Coal Board and the Central Electricity Authority have accepted responsibility for the planning and construction of a pilot plant for the underground gasification of coal. This is a process for converting coal in the ground into gas for use in generating electricity and it has reached the stage of being demonstrated on a small scale after 6 years of work by the Ministry of Power in co-operation with the National Coal Board. Exploitation of the process on a commercial scale is being undertaken. The National Coal Board has set up an Underground Gasification Executive to carry out its part in the project.

PETROLEUM

The petroleum industry in Britain dates back to 1850, when Dr. James Young, a Glasgow chemist, succeeded in obtaining lamp oil and lubricants from natural mineral oil occurring in the Derbyshire coal measures. The Scottish shale deposits, yielding similar products, were first worked in 1858.

INDIGENOUS PRODUCTION

Sources of crude oil within Britain (including shale oil) supply altogether less than one per cent of total United Kingdom requirements, the remainder being imported from overseas.

Current output of shale oil is drawn from 7 shale mines and one opencast quarry, retorted in four crude oil works, and the crude products are refined in a central refinery at Pumpherston, near Edinburgh. Output of shale reached a peak of 3.4 million tons in 1913, but the cost of the processes and other economic difficulties led to a reduction of output. This amounted to over 1 million tons in 1956, yielding some 79,000 tons of crude shale oil. From the latter, some 63,000 tons of refined products were obtained. In 1956, some 84,000 tons of motor and aviation spirit were obtained from coal by hydrogenation, and 314,500 tons of refined benzole from coke ovens and gas works. Prospecting for crude petroleum has so far led to the establishment of oilfields in Nottinghamshire (small amounts of oil were found in further borings at Plungar in Leicestershire in 1953), and one in Lancashire. Production of crude oil in 1956 was 66,000 tons.

INTERNATIONAL TRADE

British and British-Dutch oil companies have been responsible for developing the oil resources of many countries to mutual advantage, especially in the Middle East, Far East and Caribbean areas.

Today they produce one-third of all oil entering into international trade, with a tanker fleet (part owned by them and part on charter) amounting to nearly one-third of the world's tanker tonnage. (United Kingdom registered tanker tonnage is nearly one-fifth of the world's total.)

CONSUMPTION

Consumption of petroleum products in the United Kingdom has risen from almost one million tons in 1900 (mostly kerosene for lamps, and lubricants) to over 25 million tons in 1956 (predominantly gas, diesel and fuel oils and motor spirit).

REFINERIES

Up to 1939, three-quarters of the United Kingdom's supply of petroleum products was refined overseas, in accordance with the view, commonly held in the world oil industry at that time, that it was more economical to refine at the source of production. Since the second world war, however, the industry has come to favour the siting of refineries in the consuming areas. In this it has had Government support, both because of the need to save foreign exchange and because of the extra employment and other advantages to the economy resulting from the new development. The expansion programme in the United Kingdom carried out by the major oil companies was a substantial one, costing over the years 1947 to 1954 very nearly £ 200 million.

At the end of May 1957, refinery capacity in the United Kingdom amounted to almost 31 million tons a year. Plans for a second major phase of expansion to bring this up to at least 39 million tons by 1958 have been announced by some of the leading companies. Actual production of refined products rose from about 5 million tons in 1948—49 to 26.7 million tons in 1956. Exports of refined products became possible, and their value reached £ 84 million in 1954 and £ 99 million in 1956. Imports of refined products were valued at £ 87 million in 1954 and £ 126 million in 1956, compared with £ 141 million in 1951.

RESEARCH

Research into problems of petroleum technology is carried out mainly by the leading oil companies, which have also endowed research at the universities on a substantial scale. Some work on the production of oil products from coal is done at the Fuel Research Station of the Department of Scientific and Industrial Research.

ELECTRICITY SUPPLY

Public supply of electricity was first provided at Godalming, Surrey, in 1881, though there were earlier demonstrations of its use to consumers, such as the former Metropolitan Board of Works, in the lighting of the Thames Embankment. From the earliest days a measure of public control has been a feature of the industry, and the Electric Lighting Act of 1882 authorised the Board of Trade to grant licences for the establishment of electricity undertakings by local authorities or by companies (which the local authorities might compulsorily purchase after a given period of time) to supply consumers in given areas. By the turn of the century, technical developments, including the introduction of the electric motor as a source of motive power, had led to a large increase in the scale of distribution of electricity, and a variety of independent supply systems had grown up all over the country.

It was not until after the first world war that steps were taken to reorganise the industry on a national scale in oder to realise the benefits of concentration, integration and standardisation in electricity supply. In 1919, the Electricity Commissioners were set up as a supervisory body and to promote reorganisation through voluntary agreement. Then, in 1926, the Central Electricity Board was established to co-ordinate more efficiently the generation of electricity. Its main duties were to concentrate the output of electricity in certain stations, selected for their efficiency and low operating costs, and to connect these selected stations with one another and with local distribution undertakings by means of a national system of main transmission lines, known as the Grid. Thenceforward, steady progress was made in putting this plan into effect and, by March 1948, 143 selected stations, out of some 300, were supplying 95 per cent of the electricity generated for public supply.

ORGANISATION UNDER PUBLIC OWNERSHIP

With the exception of a few small non-statutory undertakings accounting for less than one per cent of the electricity consumption, the public supply of electricity in Great Britain is now exclusively in the hands of public corporations: in England and Wales, the Central Electricity Authority is responsible for generation, and 12 Area Boards for distribution; and in Scotland, the North of Scotland Hydro-Electric Board and the South of Scotland Electricity Board are each responsible for generation and distribution in their respective areas. In Northern Ireland, electricity is supplied by two municipal undertakings and one public board.

Under the Electricity Act of 1947, a central authority, then known as the British Electricity Authority, and 14 Area Electricity Boards, took over in April 1948 the assets of former municipal and private electricity supply undertakings throughout Great Britain, except in the area already served by the North of Scotland Hydro-Electric Board (see below). Under the Electricity Reorganisation (Scotland) Act of 1954, the Authority's functions in Scotland were taken over in April 1955 by the South of Scotland Electricity Board (see below) and the name of the Authority was changed from British Electricity Authority to Central Electricity Authority.

Over 200,000 people are employed in the electricity supply industry.

ENGLAND AND WALES

The *Central Electricity Authority* is appointed by the Minister of Power and is responsible to him for the general policy of the whole electricity supply industry in England and Wales. Its main function is to develop and maintain an efficient co-ordinated and economical system of electricity supply, and it is responsible for the generation and bulk supply of electricity to the Area Boards.

The *Area Boards* (of which there are at present 12) are responsible for the distribution of electricity in England and Wales. Each consists of a full-time chairman and deputy chairman and four to six part-time members, appointed, as are the members of the Central Authority, by the Minister of Power.

Area Consultative Councils have been set up in the area of each Area Board to represent the interests of consumers. They each consist of between 20 and 30 members, of whom between 50 and 60 per cent are nominated by local authority associations. The chairman of each Area Consultative Council is an *ex officio* member of the corresponding Area Board. There are also Consultative Councils for each of the districts of the two Scottish Electricity Boards and the chairman of each is a member of the respective Board.

Finance. The Central Authority and Area Boards, taken together, have made a consolidated net surplus on their operations in each of the years since they were established. Up to and including the financial year 1955-56, these surpluses amounted in the aggregate to over £ 70 million.

Labour Relations. Under the Electricity Act, 1947, the Central Authority is required to devise a satisfactory procedure for collective bargaining and joint consultation with its employees. In each of the three main groups of workers (administrative, technical and manual), there is a separate National Joint Industrial Council or Board, which negotiates terms and conditions of employment. A National Joint Advisory Council, drawn from management and employees, has been set up to discuss the health, welfare and safety of all groups of employees. There are also separate district councils and local works and advisory committees forming part of the negotiating and conciliatory machinery.

Proposals for Reorganisation. In November 1956, the Government published a White Paper (Cmnd. 27), putting forward proposals, based on the report of the Committee of Inquiry into the Electricity Supply Industry (Cmd. 9672), for the reorganisation of the electricity supply industry in England and Wales. These proposals have been embodied in the Electricity Act, 1957, and will take effect on 1st April, 1958. The Central Electricity Authority will then be replaced by an Electricity Council, which will advise the Minister of Power on questions affecting the electricity supply industry and promote and assist the maintenance and development, by a new Central Electricity Generating Board and by Area Boards, of 'an efficient co-ordinated and economical system of electricity supply'. The responsibility for generating and supplying electricity in bulk will be placed on the Generating Board. Appointments to the Council and Board were announced in August, 1957.

Greater autonomy for Area Boards is proposed. The Generating Board and each Area Board will be required by law to balance their accounts individually, in order to encourage financial responsibility and a critical attitude towards costs. The industry's central reserve fund will be wound up and distributed to the Area Boards, each of which will maintain its own reserve fund.

The most important functions of the Minister, under the new arrangements, will be to appoint the chairman and deputy chairman of the Electricity Council and the members of the Generating Board (the other members of the Council will be the chairman of the Area Boards and one other member representing the Generating Board); to approve each Area Board's capital development plans and the industry's research programme; and to approve, in consultation with the Treasury, the Board's borrowing requirements, having regard to the development programmes submitted by the industry. The Minister also has power to issue general directions to the Council and the Boards if he considers this necessary in the national interest. It is also proposed to strengthen the Consultative Councils.

SCOTLAND

The *North of Scotland Hydro-Electric Board* was set up in 1943 as a non-profit-making body to develop the water power resources of the Highlands and Islands and to distribute electricity in the more sparsely populated parts of Scotland not covered by existing undertakings. It is a non-functional board, consisting of a chairman, deputy chairman and not fewer than three nor more than seven other membersl who are all part-time members without departmenta, responsibilities, appointed by the Secretary of State for Scotland.

The Act of 1947 made the North of Scotland Hydro-Electric Board solely responsible to the Secretary of State for Scotland for all generation and distribution in its area. This area was extended under the Act to include that part of Scotland north and west of a line running roughly from Dumbarton on

the Firth of Clyde to Newburgh on the Firth of Tay. In the rest of Scotland, the Central Authority, then known as the British Electricity Authority, together with the South-East and South-west Scotland Electricity Boards, was responsible to the then Minister of Fuel and Power in all electricity matters.

On 1st April, 1955, the *South of Scotland Electricity Board*, answerable to the Secretary of State for Scotland, took over the Central Authority's functions in Scotland, and also the functions of the two Scottish Area Boards, which were dissolved. The Board consists of a chairman, deputy chairman, two full-time and five part-time members. Under the Electricity Reorganisation (Scotland) Act, 1954, the then Minister of Fuel and Power retained only three functions in regard to electricity in Scotland, namely, to act jointly with the Secretary of State in regard to staff pensions and safety measures, and to remain solely responsible for the certification of meters.

NORTHERN IRELAND

In Northern Ireland, the bulk of electricity is acquired by the *Northern Ireland Joint Electricity Committee* set up by statute in 1948, for sale to statutory distribution undertakings. Of these the *Electricity Board for Northern Ireland* distributes electricity throughout the country with the exception of the cities of Belfast and Londonderry, where it is carried out by municipal undertakings.

GENERATION

Almost the whole of Britain's electricity is produced in coal-fired steam generating stations. Abundant supplies of coal, together with good rail and water transport for moving it, in contrast with the remote and scattered location of relatively small water power resources, led to this preponderant development of electricity supplies from thermal generating stations. The development of hydro-electricity on any scale is comparatively recent.

The setting up of the North of Scotland Hydro-Electric Board in 1943 marked the beginning of a new era of intensive water power development in the Highlands of Scotland. A development scheme drawn up by the Board in 1944, showing the water power resources which it proposed to examine, listed 102 hydro-electric projects with an estimated annual output of 6,274 million units of electricity The ultimate output of Highland hydro-electric power is expected to be substantially higher and eventually may exceed 10,000 million units. In 1956, 1,282 million units were generated from water power compared with 322 million in 1949.

In 1956, 85,326 million units (one unit = one kilowatt-hour), or nearly 98 per cent of the public supply in Great Britain, was generated at steam stations, 1,667 million units, or 1.8 per cent, from water power, and 168 million units by other means, e. g., diesel and waste heat and refuse destruction. The high rate of expansion of output, which has been a feature of the industry since its earliest years, has been continued since the war. Total production in 1956 was eight times what it was in 1930 and has increased in nearly every year and especially since 1953.

The installed generating capacity of the electricity authorities (including the North of Scotland Hydro-Electric Board) in Great Britain at the end of 1956 totalled 24.615 megawatts (maximum continuous rating) compared with 12,546 megawatts at the end of 1948. The Central Electricity Authority is planning a large-scale programme of capital investment for the regions it controls, which makes provision for an increase, between the years 1957 and 1961, of 9,400 megawatts (sent out).

Sales of electricity in Northern Ireland (where the total generating capacity of 391 megawatts is in coal-fired thermal stations) amounted to 956 million kilowatt-hours in 1956, when the maximum load sustained was 335 megawatts. Further plant installations, with a generating capacity of 60 megawatts, are due to be completed in 1957—58.

The Central Electricity Authority is the largest consumer of primary fuel in Britain and in the year ended 31st March, 1957, it used just over 42.7 million tons, consisting mainly of coal. Average thermal efficiency of steam stations (i. e. the ratio of power output to the coal consumed) rose from 20.91 per cent in 1947—48 to 24.93 per cent in 1955—56 as new plant was brought into use. Twenty stations containing much of the newest plant had an average efficiency of 29.14 per cent in that year.

To meet increasing demands for electricity and to save coal, generation from alternative fuels is being actively promoted. The chief alternatives are expected to be oil, to a small extent peat, and nuclear energy. As regards oil, dual firing apparatus able to use either coal or oil has been fitted to a new power station at Marchwood, on Southampton Water, and similar apparatus is to be installed in other power stations similarly situated on river estuaries and thus able to be fed conveniently from nearby oil refineries. The use of peat has been advocated in Scotland, as in Northern Ireland, as a source of power and as a means of making land available for agriculture. In July 1953, the Government announced that it had accepted a recommendation of the Scottish Peat Committee, appointed in 1949 to advise on the development of Scottish peat deposits, that an experimental peat-burning station for generating electricity should be established in Caithness. A pilot project covering some 300 acres at Altnabreac, Caithness, has been started. A peat-burning gas turbine, developed by a Scottish firm with assistance from the Development Fund is coming into operation in 1957. As the peat is cleared from the bog, the land is made available for farming.

NUCLEAR POWER STATIONS

Nuclear power stations are being built for both the United Kingdom Atomic Energy Authority (UKAEA) and for the Electricity Authorities.

As an extension of its experimental work and to produce plutonium, the UKAEA has built and is building a number of reactors which also produce electricity on a reasonably large scale. Most notable of these is the Calder Hall nuclear energy establishment in Cumberland which, since 17th October, 1956, when it was officially opened by the Queen, has been the first large-scale nuclear power station in the world to supply electricity to a national electrical network. Calder Hall A, consisting of two reactors, has an installed capacity of 92 megawatts (MW); Calder Hall B, due for completion in 1958, will double the installed capacity. Four more similar reactors are being built at Chapel Cross, near Annan in Dumfriesshire, Scotland. A further establishment at Dounreay, Caithness, Scotland, started in 1954 and now on the way to completion, houses breeder reactors which will produce electricity.

A provisional programme of commercial nuclear power stations for the Electricity Authorities was published in a White Paper (Cmd. 9389) by the Government in February 1955. This envisaged spending £ 300 million on building 12 nuclear power stations, together with the necessary ancillary services, uranium and prototype development in the ten years 1955—65. Between 1,500 and 2,000 megawatts of electricity would be produced by this means by 1965, saving 5—6 million tons of coal a year.

Since the publication of the 1955 programme, two factors have led to a reassessment of the targets provisionally set: rapid technological advance, which has already made possible stations of more than four times the installed capacity of Calder Hall; and increased imports of fuel, chiefly oil, to meet increasing energy requirements accentuating the burden on the balance of payments.

Accordingly, on 5th March, 1957, the Government announced a revised programme of nuclear power, under which nuclear energy would be providing 5,000—6,000 megawatts of electricity by 1965, instead of 1,500—2,000 megawatts as originally planned, the equivalent of 18 million tons of coal (or ten million tons of oil) a year used in conventional stations for a similar output. During the decade ending in the year 1965-6 the total capital investment by the Electricity Authorities of fulfil the combined nuclear and conventional power station programme (including ancillary transmission facilities) might be of the order of £ 3,350 million. This would compare with an estimate of £ 2,600 million during the decade for purely conventional stations; of the difference of £ 750 million, some £ 200 million might be accounted for by the procurement of the initial charges of uranium.

By the end of August 1957, work on two stations—at Bradwell in Essex (300 MW installed capacity) and at Berkeley in Gloucestershire (275 MW)—was well advanced. At Hunterston in Ayrshire, Scotland, work had begun on a site for a third station. The building, at Hinkley Point, Somerset, of a fourth station (500 MW) was under negotiation, and sites in North Wales for two further stations were being considered. The Northern Ireland Electricity Board had decided to build a station of 150 MW. for which sites were then being examined.

TRANSMISSION AND DISTRIBUTION

Main electricity transmission lines—the Grid—cover most of the country. Those of the Central Authority totalled at 31st March, 1957, 5,500 route miles (8,602 circuit miles) of which 415 miles were operated at 275,000 volts, 4,635 miles were operated at 132,000 volts and the remainder at 66,000 volts and below. The reduction over the previous year was due to the transfer of a section to the South of Scotland Electricity Board. In the North of Scotland district there were 1,480 circuit miles of main transmission lines at the end of 1956, all operated at 132,000 volts. Control of energy movements on the Grid in England and Wales is managed through the eight operational areas, set up by the Authority for that purpose and distinct from the divisions in which the generating side of the industry is organised; each area has a central control station and the operations are co-ordinated by a control station in London. The Grid in Scotland is operated from the North of Scotland control centre at Tummel Bridge and the South of Scotland control centre at Glasgow.

The new Supergrid of main transmission lines at 275,000 volts will assist in meeting the growing demand for electricity during the next 20 years with the greatest economy and will make the British electricity supply the most closely integrated power network in the world. The first stage was completed in 1954.

In September 1956, a joint committee of the Central Electricity Authority and Electricite de France recommended the adoption of a scheme for interchange of energy by direct current by means of a single cable capable of transmitting between 120,000 and 150,000 kilowatts at 200,000 volts, and the scheme is being undertaken. It was hoped to begin work on the project in 1957 and to complete it by 1960 at a cost of about £ 5 million. The object of the scheme is to take advantage of the differences in the incidence of peak periods in the two countries.

The Area Electricity Boards distribute to consumers electricity acquired mainly from the Authority, but in part from other sources, e. g. collieries. There were 14.5 million consumers in December 1956, and increase of about 5 million on those supplied in December 1939. Industrial users are the group of consumers with the highest consumption, and demand from this sector is increasing rapidly. The principal domestic uses of electricity are for lighting, cooking, and for space and water heating, but the demand for numerous other domestic purposes is increasing.

The development of electricity supplies for rural areas has been facilitated by the change in the structure of the industry under the 1947 Act. During the year ended 31st March, 1957, supplies were provided for a further 13,135 farms which raised the number of farms provided with electricity to over 188,059 out of a total of 272,000 farms.

The North of Scotland Hydro-Electric Board has also pressed ahead with the distribution of electricity to consumers in the North of Scotland. At the end of 1956, there were 351,524 consumers of electricity in the Board's district and 55.5 per cent of the farms and 55.4 of crofts in the district had a supply of electricity.

DEVELOPMENT AND RESEARCH

The comprehensive capital development plan to bridge the gap between ever increasing demand and supply is limited by shortages of equipment and finance. The borrowing powers of the Central Electricity Authority and Area Electricity Boards were originally limited to a maximum of £ 700 million, but in 1954 were extended to £ 1,400 million. Capital expenditure during 1956 by the Authority and Area Boards was about £ 209 million and approved expenditure for 1957 amounted to £ 233 million. The original investment plans of the Authority have been considerably modified by the programme of nuclear power development, outlined on pp. 10—11 inasmuch as it is conceivable that, from the middle of the 1960s, most new plant will consist of nuclear-powered stations.

Borrowing by the North of Scotland Hydro-Electric Board is limited by the Electricity Act, 1947, as amended by the Hydro-Electric Development (Scotland) Act, 1952, to a maximum of £ 200 million. Borrowing by the South of Scotland Electricity Board is limited by the Electricity Reorganisation (Scotland) Act, 1954, to a maximum of £ 75 million.

The Central Electricity Authority undertakes research on its own account and helps to finance research through its membership of the British Electrical and Allied Industries Research Association, an organisation to which manufacturing firms and large consumers of electricity also belong and which was established before the supply industry passed into public ownership. This Association is one of the 44 autonomous research associations in receipt of grants from the Department of Scientific and Industrial Research. The Central Electricity Authority also has an Electrical Supply Research Council including independent experts to advise it and the Area Boards, and can consult the Minister of Power's Scientific Advisory Council on problems affecting the supply and use of electricity. Direct research on a laboratory scale takes place at the Central Electricity Laboratories at Leatherhead, Surrey, extensions to which were opened by the Authority in July 1950. Examples of research include gas turbine generation and experiments in the use of wind power for generation.

As part of its programme of power station construction for 1962, the Central Electricity Authority plans to install a turbo-generator of 550,000 kilowatt capacity—much larger than any now in operation, or, as far as is known, than any at present projected anywhere in the world. The decision to build a machine of this large capacity is the latest step in a programme aimed at reducing cost of generation by increasing the size of generating sets and boilers. Work is in progress on even more advanced machines for subsequent programmes.

GAS SUPPLY

Public supply of gas in Britain dates from 1807, when Pall Mall, London, was first lighted with gas. In 1812 the London and Westminster Gas Light and Coke Company received a Royal Charter to supply gaslight in London. In the early years of the industry, gas was used almost exclusively for lighting and was provided by a growing number of company and municipal undertakings. Then, after the middle of the century and the invention of the Bunsen burner in 1855, gas was used increasingly as a source of heat for many purposes, such as domestic cooking and space and water heating, in addition to a number of industrial uses. After 1880, however, gas for lighting purposes was subjected to increasing competition from the new electricity supply industry; but the invention of the Welsbach incandescent mantle in 1887, which raised the efficiency of gas lighting very considerably, enabled the industry to hold its own while the supply of gas for purposes other than lighting increased.

The gas industry in its present form developed in the main during the period between the wars when increasing competition from electricity had to be met and when changes in social habits and outlook were taking place. The industry undertook a large-scale programme of modernisation of production and distribution and launched wide-spread sales promotion campaigns especially for the numerous uses of gas in the home. By 1939 the industry had become mainly a supplier of heating instead of a supplier of lighting.

ORGANISATION UNDER PUBLIC OWNERSHIP

Under the Gas Act, 1948, the gas industry was brought under public ownership and control on 1st May, 1949. The assets of 991 undertakings, of which 269 belonged to local authorities, were vested in 12 Area Gas Boards. Together they cover the whole of Great Britain and are charged with a statutory duty to develop and maintain an efficient, co-ordinated and economical system of gas supply to domestic, industrial and other consumers. The national body is the *Gas Council*, which is appointed by the Minister of Power and is responsible *inter alia* for advising him on questions affecting the gas industry. It is a co-ordinating council, not a trading body. It consists of a full-time chairman and deputy chairman and the twelve chairmen of the Area Boards.

The *Area Gas Boards*, which have a large measure of financial and operational responsibility and are similar in most respects to the central bodies of the other publicly owned corporations, are charged *inter alia* with the responsibility of manufacturing and distributing gas to consumers. Thus, their powers differ from those of the Electricity Area Boards, which are limited to the distribution and sale of current, while the central executive body—the Central Electricity Authority—is charged with the duties o generation and transmission. Each of the Area Ga Boards which, like the Gas Council are appointed b the Minister of Power, consists of a full-tim chairman and deputy chairman, in some cases one and in one case two, full-time members, and alway five or six part-time members including the chairma of the Area Consultative Council. There is n common pattern of organisation; each Board ,, fully independent and has devised its own subordinate structure.

A link between the industry and the consuming public was established under the nationalisation scheme by the creation of a *Consultative Council* in each board area. These councils consist of not fewer than 20 and not more than 30 members, of whom between 50 and 75 per cent are chosen from panels of persons nominated by the local authority associations.

In Northern Ireland, the gas supply industry remains in the hands of a number of municipal undertakings and statutory and non-statutory companies.

As has been said, the Gas Council is not a trading body, but the operations of the Area Boards have resulted in the seven years up to 31st March, 1956, in an aggregate disposable surplus of over £ 13.5 million.

LABOUR RELATIONS

Under the Gas Act, 1948, the Gas Council is responsible for arranging satisfactory procedures of collective bargaining and a system of joint consultation with its employees. There are separate Joint Industrial Councils at the national level for manual workers and salaried staffs, and subordinated regional councils and local committees. At national and regional levels the councils combine negotiating and consultative functions, but there are in some cases separate Consultative Committees at the local level.

PRODUCTION

In 1956, in Great Britain 27.7 million tons of coal were carbonised by gas undertakings and 29.5 million tons by coke ovens operated outside the gas industry. About one-quarter of the output of gas from coke ovens is sold to gas undertakings for general distribution; the remainder is mainly consumed at the ovens or at collieries or steelworks.

In 1921, 250,300 million cubic feet of gas was manufactured by authorised gas undertakings or acquired from coke ovens, and the number of consumers was 7.6 million. By 1955, gas manufactured and acquired from coke ovens for distribution had risen to 2,912 million therms and the number of consumers had risen to about 12.8 million, an increase of 140 per cent in the volume of gas available and of about 67 per cent in the number of consumers.

In 1956, the quantity of gas produced in Northern Ireland was 7,625 million cubic feet, most of it for household use.

The total number of persons employed in the gas industry in March 1957 was 140,300.

CONSUMPTION

Half of all gas produced is sold for household use and the remainder for industry, commerce and public services.

Domestic Use While an accurate statistical analysis of the domestic load is not possible, evidence given before the Ridley Committee (on Fuel and Power Policy), appointed by the then Minister of Fuel and Power in 1951, suggested that about 70 per cent of the domestic load was used for cooking, the remaining 30 per cent being spread over space heating, water heating and other installations. Most homes in Britain are now supplied with gas, except in some rural areas where, owing to difficulties in storage and transmission, gas is not economic. These difficulties have been overcome to some extent by the use of local high-pressure storage tanks but this development is unlikely to grow, owing to the steady extension of rural electricity supplies. Bottled gas, derived from petroleum, is widely used in rural areas.

Industrial and Commercial Use Gas is used extensively in industries which require a simple control of temperature to a fine degree of accuracy. Among such industries are pottery and certain processes in the manufacture of iron and steel products. Industrial use of gas increased greatly during the second world war and reached 103,000 million cubic feet in 1943. By 1956 industrial consumption is estimated to have reached 759 million therms.

BY-PRODUCTS

With the rapid increase in the volume of gas produced, the problems of the disposal of substances which were regarded originally as the 'waste' products of the carbonisation of coal (notably tar, benzole, sulphur and ammonia) became increasingly important.

Production of coke at gas works in 1956 was 12.7 million tons, and at coke ovens 19.5 million tons. The gas industry and coke ovens jointly produce over 2.9 million tons of crude coal tar and about 110 million gallons of crude benzole a year. These products, together with those of the sulphur and ammonia type, provide a source for the manufacture of a long and ever-growing list of essential derivatives which include dyestuffs (of which Britain now produces most of its own requirements), fertilisers, plastics, germicides (the sulphonamides and sulphanilamides), insecticides, refrigerants, perfumes, and synthetic yarns.

With further research and development, more especially in the field of organic chemistry, the production of coal carbonisation derivatives is becoming of increasing importance to the economy of the industry.

DEVELOPMENTS AND RESEARCH

The chief objects of capital expenditure in the years immediately after the war were to overtake arrears of plant renewal. Plans for further expansion were approved by the then Minister of Fuel and Power in 1954 and are outlined in the Gas Council's publication *Fuel for the Nation.*

Under the Gas Act, 1948, borrowing by the Gas Council and the Area Gas Boards was limited to £ 250 million. Borrowings to a total of £ 235 million had been authorised up to 30th June, 1954. The Gas and Electricity (Borrowing Powers) Act, 1954, extended these borrowing powers to £ 450 million.

Capital expenditure in the year ended 31st March, 1956, was £ 61 million, compared, with £ 46 million in 1952—53 and £ 36 million in 1950—51.

The post-war structure of the industry has already permitted considerable integration by the linking of undertakings for the transmission of gas (through gas grids and long-distance mains), enabling production to be concentrated in the most efficient units. Progress is also being made in interconnection for the reception of gas from coke ovens, notably in Wales, Durham and Yorkshire.

Supplies of suitable coal to meet a steadily increasing gas consumption are becoming more difficult to obtain. Investigations into alternative sources of gas are being actively undertaken by the Gas Council. Gases from oil refineries (butane or propane) are used in several installations in smaller towns remote from large gas works or the grid systems. Progress has also been made with the possible use of methane, drained from coal mines. In agreement with the National Coal Board, Area Gas Boards have agreed to schemes for using methane from Point of Ayr Colliery in North Wales and from Haig Pit at Whitehaven, in Cumberland.

Eight oil gasification plants are at present in operation and 20 additional plants are on order. These plants will be capable of producing 82 million cubic feet of gas per day and of saving 850,000 tons of carbonising coal a year. The South Eastern Gas Board and the British Petroleum Company are jointly building a plant to convert petroleum products from the company's Kent oil refinery to gas of acceptable quality. It is expected that the initial installation, which will convert some 50,000 tons of petroleum products a year to gas and will have a daily output of 18 million cubic feet of gas, should be completed by the summer of 1958.

The Gas Council is investing £ 1 million in a five-year survey for natural gas within Britain.

The research organisation established by the Gas Council consists of a research committee, which advises the Council on policy and sees that it is carried out; and two research stations, one in London and one at Solihull, near Birmingham. Research is also carried out on behalf of the Gas Council at Leeds University and by the British Ceramic Research Association (an autonomous research association grant-aided by the Department of Scientific and Industrial Research). Further, the Council and Area Boards support a number of research associations, the work of which has a bearing on the gas industry. These include the Coal Tar Research Association, the British Coal Utilisation Research Association and the National Benzole Association. The underlying aim of the Council's research programme is to 'make the most economic use of the natural resources available to the nation, whether by improvements in existing processes of gas manufacture, by seeking new processes or new sources of supply of gas and by the extraction and use of other products of gasmaking'.

FUEL EFFICIENCY

The Government has for a number of years sought to promote efficiency in the use of fuel, among both industrial and domestic users, and has been assisted by various bodies representative of producers and consumers.

The *Coal Utilisation Council* consists of representatives of the National Coal Board, coal distributors and coal appliance manufacturers. It was formed in 1932 to give information and advice on the best use of solid fuel, including the choice of installation and operation of solid fuel appliances, to domestic consumers and to retailers of appliances. During the second world war, the reduction in coal production and the demands of war industry made economy imperative. When the Ministry of Fuel and Power was formed in 1942, an industrial fuel advisory service with regional branches was incorporated within it. In 1943 the *Women's Advisory Council on Solid Fuel*, consisting mainly of representatives of appliance manufacturers, women's organisations and others interested in the housewife's point of view on domestic fuel arrangements, was formed to advise women on the use of solid fuel for heating and cooking.

Further measures have been taken during the last few years. Under a scheme introduced in 1952, loans on favourable terms are available from the Exchequer to industrialists for financing approved fuel-saving schemes. At present these loans are interest-free for the first two years, repayment may be spread over a maximum period of twenty years and no security is required. In October 1953, a non-profit-making company, known as the *National Industrial Fuel Efficiency Service*, and sponsored by the British Productivity Council, was formed to promote fuel-saving in industry. This company, which largely replaced the industrial fuel advisory service of the then Ministry of Fuel and Power, came into operation on 1st May, 1954. It provides advice and services to all non-domestic fuel users in a variety of forms, from 'spot' inspection to full-scale heat and power surveys and regular visits on a contract basis. A survey of the generation and use of steam carried out by the Ministry has been employed to show the possibilities in the increased uses of back-pressure steam in the generation of electricity. The electricity and gas industries, the largest consumers of primary fuel, are succeeding each year in obtaining more energy from each ton of coal they use, by increasing the thermal efficiency of their plants. The campaign for fuel efficiency is closely linked with the campaign for the reduction of smoke.

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Asia's Largest Rubber Factory Comes of Age

INDIA'S rubber manufacturing industry is destined to play a key part in fulfilling the country's Five Year Plans. Not only in motor transport, but in industry generally and for the supply of consumer goods, the rubber manufacturing industry is today called on to play a responsible part as one of India's basic industries. It is a matter for satisfaction, therefore, that the range of rubber products manufactured in India is continually widening and thus helping the industry to meet the vital requirements of numerous branches of the country's economy.

The growth of this infant industry has been truly remarkable. Barely 20 years ago, India imported the bulk of her requirements of manufactured rubber goods. In 1935 — 36, these imports were to the value of Rs. 2 crores; by 1950-51, they had dropped to a mere Rs. 33 lakhs and in the same year, goods to the value of Rs. 1.66 crores were exported. The Government of India has permitted the import of tyres and tubes to meet the recent shortages arising out of the greatly increased demand for these products. It is expected, however, that the expansion programmes now under way will help to correct this position in the not too distant a future.

The tempo of economic activity in the country is rising at a rate not known before. This development is very largely due to the growth of heavy industries, power transmission and agriculture, all of which are making increasing demands for rubber products such as rubber covered cables, transmission and vee-belts, conveyor bolting and hoses. But the tyre manufacturing section of the industry will have to face the heaviest demand. It is estimated that a fleet of 1,60,000 trucks will be necessary by the end of the Second Plan period to handle the growing goods traffic by road. The production of motor vehicles and bicycles will also increase. By 1960, 57,000 cars and trucks, 12,000 motorcycles and scooters and 12,50,000 bicycles will be manufactured in India per annum. The tyre industry will be required to meet the original equipment and replacement requirements, and it is estimated that by 1960, the demand for automobile tyres will be 16,00,000 and for bicycle tyres 110,00,000 as against the actual production in 1956 of 9,38,400 and 63,20,400 respectively. Besides tyres and tubes, the industry supplies a large number of vital components required for the modern automobile such as fan belts, radiator hoses, adhesives for body building, latex foam cushioning, etc.

The first rubber factory in India was established almost 32 years after that venerable figure John Boyd Dunlop, invented the first practicable pneumatic tyre. India is the only country in the world where the rubber manufacturing industry is largely fed with indigenous natural rubber. As a result, the industry has firmly taken root within a short period of two decades. The tyre manufacturing section is the mainstay of the industry and large scale tyre manufacture in the country was pioneered by Dunlop in 1936 when they set up a factory in Sahaganj near Calcutta which comes of age this year. The factory was officially opened by Sir John Anderson, then Governor of Bengal, on the 28th November, 1936. Since then, new plant and machinery have been added from time to time to expand the volume and range of products. This factory is now the largest rubber manufacturing enterprise in Asia.

The resiliency of a Dunlopillo mattress being tested mechanically.

During the Second World War, the Dunlop Sahaganj factory gave a creditable account of itself and apart from the rapid expansion in the production of tyres and tubes for cars and trucks, aero tyres and tubes were added to the range. The first major post-War development at Sahaganj was the production of quality cycle rims which was of particular significance in view of the setting up of the many new bicycle factories soon after.

Production of Dunlopillo Latex Foam cushioning commenced in 1951 and in course of the last five years output has gone up four-fold. The increasing use of this material in transport, Assembly Houses, cinemas, hotels, hospitals as well as in the home, promises a great future for this product.

The recent extensions to the Sahaganj factory are of particular interest in relation to the Five Year Plans. The belting and hose plants were officially opened by Dr. B. C. Roy, Chief Minister of West Bengal, in December 1952, and it is now turning out conveyor and elevator belting, transmission and industrial vee belts of the best quality which were mostly imported until recently. Long length braided hose by the lead press moulded process, and a number of special types of hoses, hitherto imported, have been added to the range. Recently, Dunlop initiated an anti-corrosion and abrasion resistant rubber lining service which has already enabled the Railways and other enterprises to save valuable foreign exchange.

In the first Five Year Plan period Sahaganj undertook the manufacture, for the first time in India, of tyres for jet aircraft. Another important project now under way is the installation of plant for the production of large earthmover tyres. Numerous expansion schemes are being implemented at Sahaganj to meet the growing demand and a considerable increase in the output of truck and bus tyres, cycle tyres, cycle rims, industrial rubber products and Dunlopillo is planned.

Twenty-one years after the founding of India's first tyre factory, Dunlop are putting up another at Ambattur near Madras which is expected to go into production by the end of 1958. Truck, bus and cycle tyres will be produced here primarily for the needs of the South Indian market.

Deluxe Trains Have Ordinary Third Class Coaches Now

With effect from the first week of February, the air-conditioned Deluxe trains running between Delhi and Bombay, Delhi and Calcutta and Delhi and Madras have in their composition ordinary third class coaches as well.

In each of the New Delhi-Bombay Central and New Delhi-Howrah trains there are now two such coaches and in the New Delhi-Madras Central trains there are three ordinary third class coaches.

This arrangement has come into effect on the Delhi-Calcutta run from Howrah on February 4th and from New Delhi on February 5th, on the Delhi-Bombay run from Bombay on February 2nd and from New Delhi on February 3rd, and on the Delhi-Madras run from Madras on February 3rd and from New Delhi on February 5th.

As these trains are the fastest on their respective routes, it means that on these routes, besides abating the overgrowding in third class in the long distance trains, the new arrangement will provide the third class passengers with a substantially faster service than hitherto.

* * *

NEW III CLASS MAINLINE BOOKING OFFICE AT VICTORIA TERMINUS

The Central Railway opened to public use its fine new III Class Mainline Booking Office and Waiting Hall at Victoria Terminus on Republic Day.

The new building which adjoins the Mainline station building is a fine airy and well-lighted structure of four stories. The ground and first floor have been set aside for the use of Third Class passengers, the two upper floors being utilised for much-needed office accommodation. New features include six fully furnished single-bed Retiring Rooms, a modern Cafetaria and Bathing Rooms all located on the first floor.

The new building has 13 booking windows as against 7 in the old permanent booking office which was situated on the Dadabhoy Naoroji Road. Additional waiting hall space with extensive modern sanitary facilities has been provided in the new building. The old waiting hall-cum-booking office had a combined area of 8,400 sq. ft. whereas, in the new building, these facilities are spread out over an area of 17,000 sq. ft.

Type 410 Stainless Hopper Cars have Long Service Life

By W. E. McFee
Supervisor, Product Information Service, The Armco International Corporation

TWO American stainless steel hopper cars were recently inspected after more than 20 years of continuous coal hauling service. Both show negligible corrosion damage. It is expected that many additional years of active service life remain.

Interior members of each car were made of Type 410 Armco stainless steel. Both riveting and welding were used as methods of joining. Baltimore and Ohio 633002 rolled out of Mt. Clare shops in March 1935, while New York Central 850141 left the Beech Grove shops in August 1936. Their present over-all appearance is shown in Figures 1 and 2.

Fig. 1. B & O hopper car 633002 after more than 21 years' service. (A-27601)

The .093" thick sides of the B & O car were corrugated while the NYC car used 1/8" thick pan-type side panels. Specific design details are shown in Table 1.

The floor sheets in the B & O car were free of corrosion and generally in excellent condition as shown in Figure 3. Dents that can be observed in the photograph were undoubtedly caused by heavy loading equipment, but are not severe. Several small tears in the floor had been repaired by welding before a 1948 inspection. There is no evidence of corrosion or cracking in the vicinity of these welds.

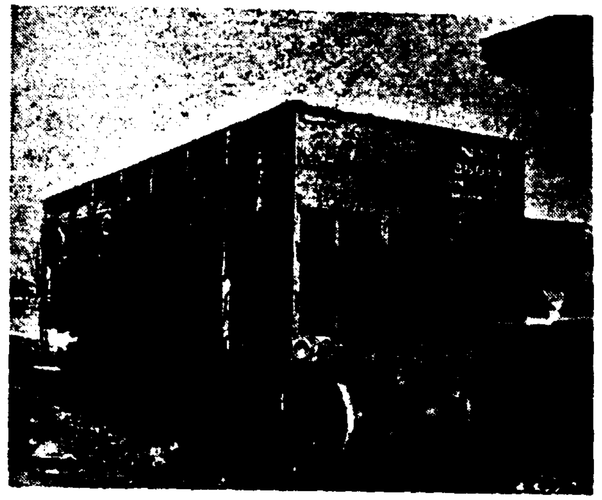

Fig. 2. NYC hopper car 850141 after more than 20 years' service. (A-26619)

Figure 3 also shows the over-all condition of the " B " end of the B & O car (the end on which the hand brake is located). One end sheet had been replaced before 1948 due to demage by " cornering ". Similar mechanical damage also was repaired at the " A " end. The excellent performance of the stainless steel strength-wise and corrosion-wise is very much in evidence in Figure 3.

Fig. 3. "B" half of B & O 633002. Note excellent condition of car. (A-27604)

Fig. 4. Close-up of "A" end hopper, B&O car. (A-27602)

Condition of the cross ridge sheet, the longitudinal hood sheet, and the hopper doors in the " A " portion of the B & O car are shown in Figure 4. The excellent condition of the floor and side hopper sheets is apparent although evidence of hammering to dislodge frozen coal can be seen in the outer hopper sheets. No major repairs have been required in these locations. The hopper doors in the " B " end had been replaced due to mechanical damage in 1948.

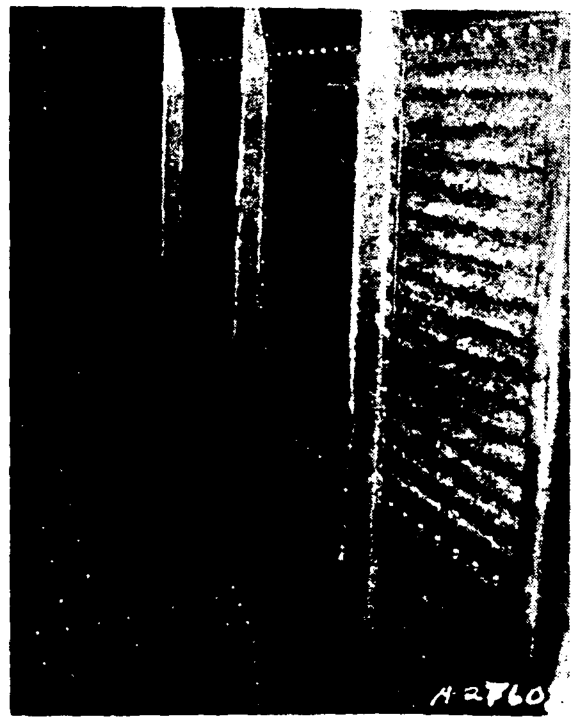

Fig. 5. Condition of sides of B & O car. (A-27603)

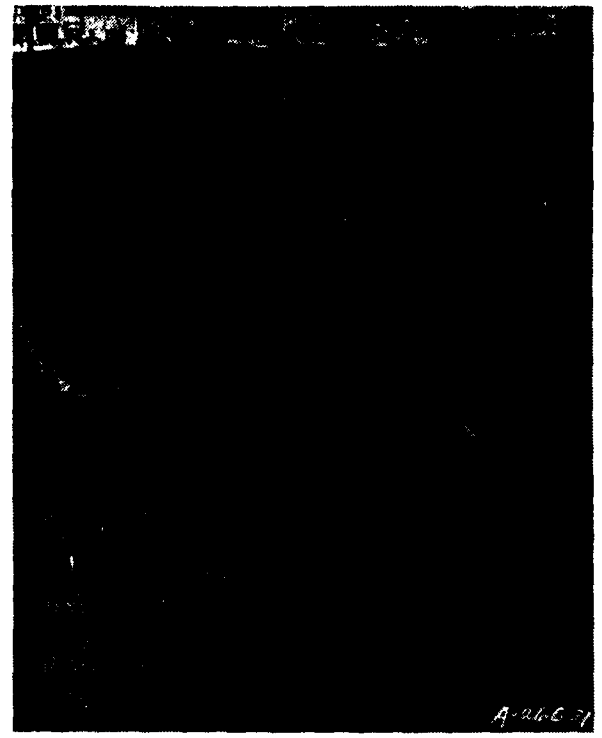

Fig. 6. " B " end of NYC car. (A-26621)

The excellent condition of the inside of the sides is shown in Figure 5. While occasional cracks are

Fig. 7. Condition of sides of NYC car. (A-26620)

(Continued on page 46)

Electric Furnaces for use in Railway Workshops

By A Technical Correspondent

INTRODUCTION

WHEN considering the scope of a railway's activity, it is probably true to say that there are few standard furnaces for which an application could not be found. In such circumstances, this article would merely comprise a list of equipments from small muffles to the large production furnaces for hardening springs etc. An attempt will therefore be made to deal with a suitable selection of equipments which by their versatility cover a fairly wide field of applications, and as the title of the article refers specifically to electric furnaces—meaning in this case electric resistance furnaces—some details of the advantages of such equipments over others heated by other means may fairly be included.

ADVANTAGES OF ELECTRIC FURNACES

The requirements of a heat-treatment furnace can be quite simply stated. It must be capable of working at temperature for long spells if necessary, and the temperature must be controllable within fairly close limits. Furthermore, the uniformity of temperature within the chamber must be good to ensure that all parts of a charge receive the same treatment. In addition, adequate provision must be made for the supply of controlled atmosphere within the chamber when required. Naturally, construction must be robust to enable the equipment to withstand arduous conditions, and the design such that maintenance is easily carried out. Adequate safety devices should be incorporated to protect operator and equipment, and the modern trend is also to provide furnaces that lend towards cleaner working conditions.

Bearing the foregoing in mind, it will be apparent that electric resistance furnaces combine all the requirements to a greater degree than equipments heated by other means. By the readiness with which they can be disposed within a furnace chamber, electric resistance elements enable good temperature uniformity to be attained and maintained, while the ease and flexibility of control inherent in electrical equipment means that a high degree of control may

(Continued from page 45)

present at stressed locations in the side stakes, the sides still remain straight and trouble-free.

Condition of the B & O car has been discussed here in more detail as it was constructed of the lighter gage material. Performance of the NYC car is comparable to the excellent service being given by the B & O car. This is borne out by the interior condition as shown in Figures 6 and 7.

During the 1948 inspection it was noted that the NYC car exhibited a pitted condition over much of the interior. As two similar cars (since wrecked) did not show this condition, it is surmised that the car had at sometime in its early life transported a particularly corrosive loading. In any event, the most recent inspection indicates that these pits have not progressed.

The performance of these stainless hopper cars bears out the contention that Type 410 stainless steel will out perform lesser alloyed materials to a marked degree.

Owing to its high degree of corrosion resistance, it should be possible to employ material thicknesses for hopper car service more nearly on the basis of required strength than with heavy allowance for corrosion wastage.

TABLE I

	B & O 633002	NYC 850141
Light Weight	32,900 lbs.	36,400 lbs.
Load Limit	136,900 lbs.	132,600 lbs.
Volume (level full)	2,070 cu. ft.	1,982 cu. ft.
Side sheets	3/32"	1/8"
End sheets	3/32"	1/8"
Floor sheets	1/8"	5/32"
Longitudinal Hood	1/8"	5/32"
Transverse Ridge	1/8"	5/32"
Hopper sheets	1/8"	3/16"
Doors	1/8"	3/16"

Fig. 1. Small Horizontal General Purpose Furnace.

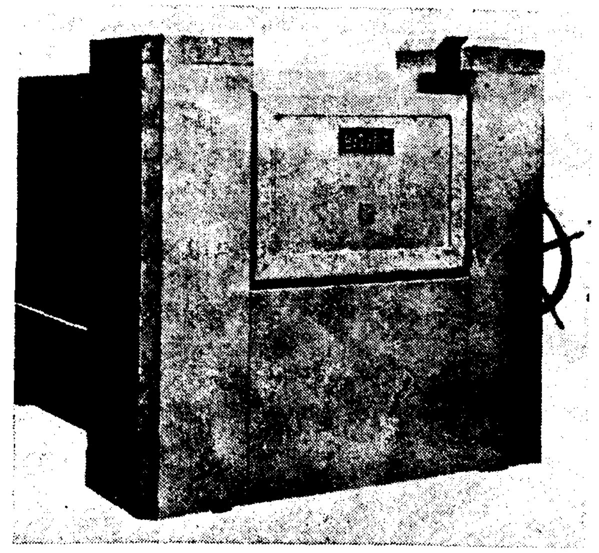

Fig. 2. Large Horizontal General Purpose Furnace.

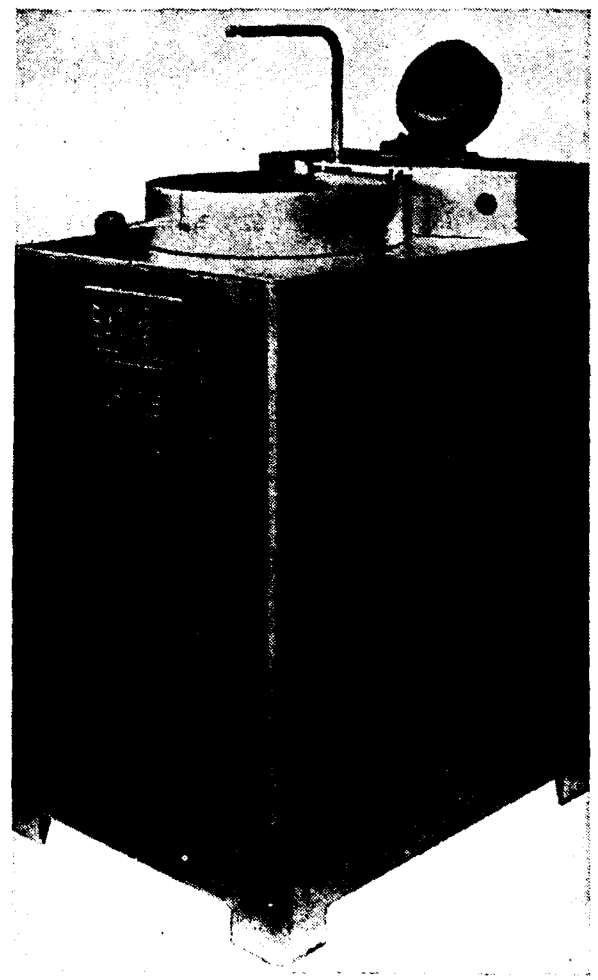

Fig. 3. Small Vertical General Purpose Furnace.

be relied upon. Maintenance of electric furnaces presents no great problems. There are no deleterious gases of combustion to act adversely upon the chamber refractories, the life of which is extended in consequence. Changing a heating element is not difficult should that become necessary. Finally, the cleanliness of electrically heated furnaces ensures very good working conditions.

TYPES OF EQUIPMENT

Broadly speaking, furnaces may be divided into several types, batch, semi-continuous and continuous. These may be further sub-divided so that there are horizontal and vertical batch type furnaces; rotary hearth, bell type and other semi-continuous equipments and various continuous furnaces such as mesh belt conveyors, rotary drum furnaces etc. The choice of any particular equipment naturally depends upon the nature of the treatment, size of components.

output required and so on. This article will deal with furnaces small and furnaces large, but it is obviously not practicable with space limitations to deal with every kind of equipment, but no doubt suitable applications for the furnaces covered will occur to the reader.

HORIZONTAL BATCH TYPE FURNACE

There are many workshop applications for an equipment that bridges the gap between small muffles and full scale production furnaces. Such an equipment is illustrated in figure 1. It has a chamber

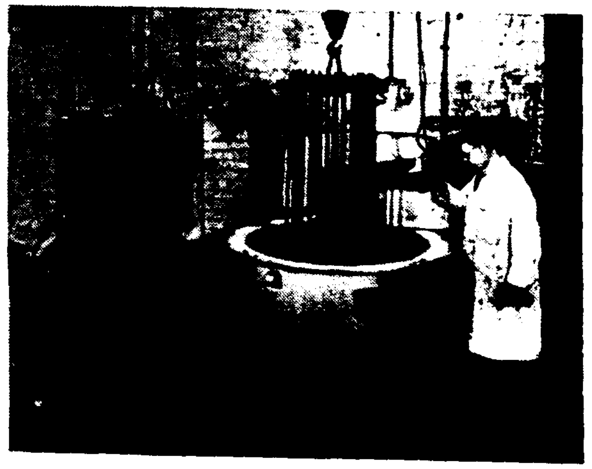

Fig. 4. Large Vertical Furnace for full scale production work.

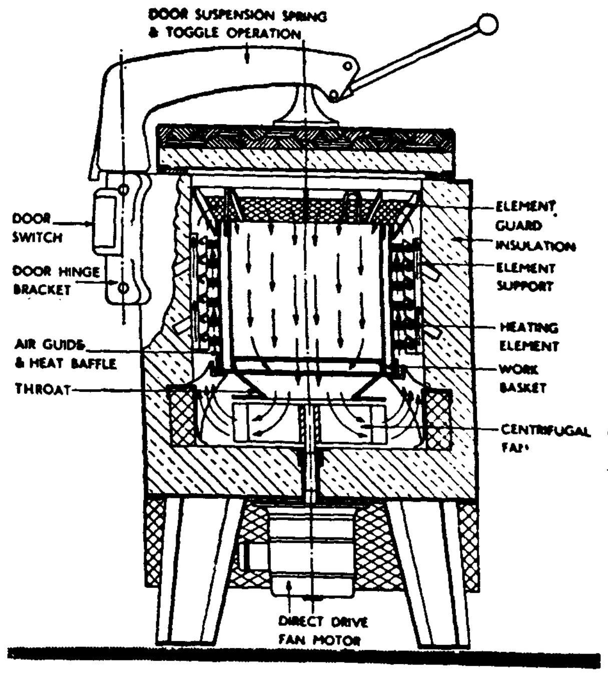

Fig. 5. Diagram Shewing General Arrangement of Forced Air Circulation Furnace.

length of 18" with a door opening measuring 9"×5", and is completely self-contained. A door switch safeguards the operator and a fusible pattern excess temperature cut-out the equipment. The furnace is robustly constructed and eminently suitable for workshop use up to temperatures of the order of 1050°C. Temperature control is effected by a hand operated energy regulator type control panel but automatic temperature control can be fitted if required. Heating elements of nickel-chromium alloy are in the form of coils and are shaped like "hairpins". The equipment is rated at 10 kW., and has a temperature range covering preheating, normalising, hardening, annealing and pack carburising.

Certain articles, such as long leaf springs and the like are frequently treated in large horizontal batch type equipments of which figure 2 is an example. Heating elements follow the same form as those of the equipment featured as figure 1. With this larger type of furnace, the heating is normally arranged in two or more separately controlled zones, and heating elements are also placed in the door. Temperature control is effected by automatic temperature controllers—one for each zone—and accidental overheating leads to isolation of the heating elements by the use of fusible pattern excess temperature cut-outs. Generally speaking, the maximum operating temperature is of the order of 1050°C. In some cases, however, heavy tubular heating elements can be fitted which raises the figure to 1150°C. With the former type, as has been stated no transformer is necessary for the equipments are supplied by mains voltage direct; with the latter tubular elements, low voltage supply is required and thus a suitable transformer must be incorporated in the installation.

Fig. 6. Installation View Shewing three vertical Forced Air Circulation Furnaces.

Fig. 7. Rotary Hearth Furnace in course of construction.

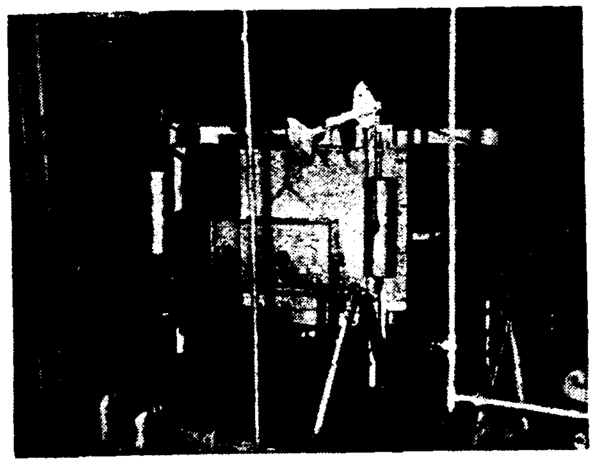

Fig. 8. Rotary Hearth Furnace.

Fig. 9. Entry end of Pusher Furnace.

VERTICAL BATCH TYPE FURNACES

Long slender work that is liable to distort if lifted horizontally is usually far better treated in vertical furnaces, the components being suitably jigged so that they may be removed by hoist and quenched as a complete charge. Figure 3 indicates a small vertical batch type equipment for general heat-treatment purposes. It is completely self-contained and may be considered the vertical complement of the furnace shewn in figure 1. The heating element, however, comprises a nickel chromium alloy coil shaped like a helix and mounted in a groove on the inside face of the chamber. As may be seen a toolpost is provided for the suspension of work for treatment.

A larger equipment having a door counterbalanced by a leaf spring is shewn in figure 4. These larger equipments are suitable for full-scale production work and are controlled by automatic temperature controllers. Normal safety devices to safeguard operator and equipment are incorporated.

For such treatments as tempering, and non-ferrous annealing the most efficacious means of heating is probably that of forced air circulation, in which air is rapidly circulated over heating elements and through the work by a centrifugal fan. The air receives heat from the elements and imparts it to the work. An advantage of this system is that no air is drawn into or dispelled from the furnace, and thus heat losses are kept to a minimum, for the same air is constantly circulating. A diagrammatic representation of a forced air circulation furnace is shewn in figure 5, and an installation of such equipments in figure 6.

Apart from such considerations as ease of handling long work etc., vertical furnaces also have the advantage of occupying less useful floor space than horizontal equipments of comparable capacity, and are nearly always sunk below ground level to an extent that brings the vestibule to a convenient working height.

SEMI-CONTINUOUS FURNACES

There are quite a number of semi-continuous types of furnace, but those most widely used are rotary hearth, pusher and bell types.

Figures 7 and 8 illustrate two typical rotary hearth furnaces, the former being in course of construction and shewing how the hearth may be lowered for inspection and maintenance purposes: the furnace is designed to operate at a temperature of 950°C. and is rated at 40 kW. The equipment depicted in figure 6 is used for hardening and refining gear wheels, pinions and the like. Such furnaces offer a ready means of carrying out heat-treatment work in a comparatively confined space such as that occupied by a production line. They are designed with an overall treatment cycle in mind, work being charged in one door and being carried around in a series of indexing movements — other work being charged the while — until the initial charge is treated and ready for removal when opposite the unloading door. A point to bear in mind is that one operator only is usually required. Generally the hearth driving unit provides variable speeds so that different charges with different process cycle characteristics may be accommodated. Thus a batch of, say, castings, may be treated one day and perhaps billets or gear wheels on another.

Many different types of work can be treated in pusher furnaces, an example of which is shewn as figure 9. This particular equipment is used for heat-treating billets which are seen with the pusher mechanism at the entry end of the furnace. Six rows of free running diabolo shaped rollers are fitted in the furnace hearth to carry the cylindrical charge pieces. This unit can operate up to 600°C. and has an unusual air circulating system comprising two double entry type fans (one at each end of the furnace roof) which give longitudinal air circulation and ensure rapid heating and a high degree of temperature uniformity, but other equipments are in operation for such applications as copper brazing at temperature up to 1200°C.

In some treatments, notably bright annealing, where, after treatment, charges have to cool before being exposed to the air, bell furnaces provide a useful and economical means of carrying them out. An installation comprises essentially a heating chamber, usually cylindrical in form and open at the bottom, with a hoist for moving it, and a number of fixed bases over which the 'bell' may be placed. For bright annealing, work is placed beneath gas tight covers which stand in a suitable seal on the bases. The bell is lowered over each base in turn as necessary to heat the charge. Thus, in effect, one inverted vertical furnace can be employed for a varying number of charges and work on loading and unloading untreated and treated charges respectively may be carried out while another is being treated. A typical two-base rectangular bell furnace is shewn in figure 10. It is rated at 160 kW. and is used for stress relieving welded fabrications. In this instance, a lightly insulated hood is placed over the retort after the bell has been removed to reduce the rate of cooling.

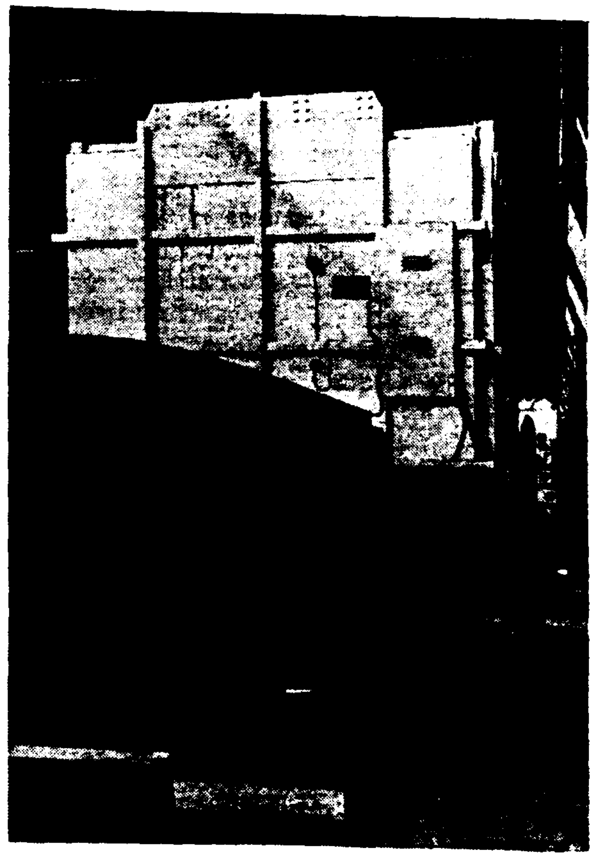

Fig. 10. Two Base Bell Furnace.

CONTINUOUS FURNACES

Certain factors mitigate against the use of very large continuous furnaces of certain types for very heavy work. In the first place, some equipments would have large unproductive areas that would require heating but would not contribute to the output. This would be so, for instance, with a very large rotary drum furnace, for work naturally moves through the drum at the bottom of the helices. Secondly, large masses of metal would be more susceptible to distortion at temperature, and this might well occur in an outsize shaker hearth equipment.

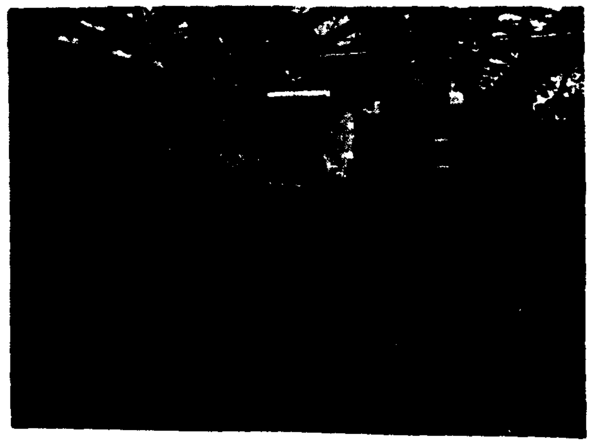

Fig. 11. Walking Beam Furnace for Heat-treating Crown Wheels.

Fig. 12. Mesh Belt Conveyor Furnace for Bright Annealing Small Pressings.

There are however, designs of continuous furnaces developed specifically to handle heavy charges, and figure 11 illustrates one such. It is a walking beam furnace of the type that has been used for a number of years for annealing and normalising steel sheets, and more recently for preheating billets and for hardening and refining such items as driving gears, crown-wheels and the like. Applications of the walking beam design are not confined to ferrous heat-treatment, since brass slabs and heavy coils of strip are successfully catered for. Protective atmospheres may be employed in equipments designed for that purpose.

The hearth in this particular type of furnace comprises a series of horizontal longitudinal beams, two or more of which are arranged to "walk". The moving beams, at all times horizontal, have a motion as nearly rectangular as possible. By this means, the items being treated are lifted clear of the stationary hearth beams, carried forward and lowered again while walking beams sink below hearth level and return to their former position, thus completing the rectangle. Two separate motor-driven mechanisms provide the vertical and horizontal movements, this method being generally superior to the eccentric cam system sometimes employed. Particularly is this so in the case of relatively long installations, and for those occasions then it is undesirable for the charge to be subjected to abrasive action. The equipment illustrated is used for preheating wheel blanks prior to swaging, and deals with an output of 3 tons per hour. The maximum operating temperature is 950°C. and the equipment is rated at 720 kW.

Another type of continuous furnace frequently used for large articles is the mesh belt conveyor, an example of which is shown in figure 12. Applications of such equipments include brazing, annealing and sintering. They lend themselves particularly to operations requiring a protective atmosphere, suitable sealing arrangements being incorporated in models using such. For completely automatic operation when small parts are being treated, vibratory type loaders and belt type continuous quench extractors are frequently employed.

So far, these notes have covered only the larger type of continuous equipment, for such furnaces are most likely to find applications for use in railway workshops where castings and other components are generally on a large scale, but smaller types of continuous furnaces are available for hardening bolts, carbonitriding self-tapping screws and like operations.

SUMMARY

With so vast a field to cover and with such a multiplicity of applications to consider, it is not pretended that these notes deal with all, but it is hoped that sufficient indication has been given to shew that there are electric furnaces for most of the heat-treatment demands likely to be encountered in railway workshops. Furthermore, the advantages of electric furnaces mentioned earlier are applicable throughout the whole range of types and models available and their use undoubtedly brings to the heat-treatment shop a degree of repetition of results with cleanliness of operation that cannot be bettered by equipments heated by other means.

Aluminium Plant for Kerala

Kerala will have an aluminium manufacturing plant with 10,000 ton annual production capacity, to be established shortly with the technical assistance of a Hungarian firm. Mr. L. Oliser, representative of the Nikex Foreign Trade Company, Hungary, who had already visited Kerala to study the possibilities of giving help to start new industries and help discussions with the Ministers and officials of the Government and industrialists in the State, stated that it had not been decided as to whether the plan would be in the private or public sector.

Rubber Suspensions for Railway Rolling Stock

This article provided by Metalastik, Ltd., gives the technical story behind the recent announcement that rubber suspensions were to be used on rolling stock for London's "tube".

ONE of the features of the new seven-coach sets shortly going into service on the London Underground is the rubber suspension which has been developed by the Chief Mechanical Engineer (Railways) of the London Transport Executive and Metalastik Ltd. The first Underground train in Britain to be suspended on rubber is shown in Fig. 1. This is, incidentally, one of the new "all silver" tube trains with a body made of unpainted aluminium alloy.

The object of rubber suspension is to reduce maintenance costs by eliminating lubrication and all wearing parts such as rubbing plates, hanger pins, bushes and steel springs and, at the same time, to provide a more comfortable ride with reduction of noise. Weight, and consequently power or fuel consumption, is also reduced.

Work on railway bogie suspension was started by Metalastik towards the end of the war and considerable knowledge of the behaviour of both bolster and axle suspensions has been gained under service conditions on the London Underground system. The decision of the London Transport Executive to fit the suspension on the new seven-coach sets was based on this experience extending over the last 10 years.

Fig. 1. This tube train is the first in Britain to be suspended entirely on rubber.
(Courtesy—London Transport Executive)

Fig. 2. In the Bolster Suspension the upward and inward rake of the springs can be seen clearly.
(Courtesy—London Transport Executive)

BOLSTER SUSPENSION

In the bolster suspension used, the bolster is supported at each end by two rubber-bonded-to-metal springs arranged in an inverted " V " formation. By inclining the rubber springs inwards towards the centre of the bolster it is possible in one simple arrangement to provide for all the loads taken by the bolster *i. e.* the vertical load of the car body plus passenger weight, the longitudinal loads due to traction and braking and the transverse loads due to side movements.

The upward and inward rake of the bolster springs can be seen clearly in Fig. 2.

Fig. 3. The Bolster Spring.

Fig. 4. Axlebox spring with two chevrons.

A different deflection is required from the springs for each of the three directions in which they are loaded. This is achieved by the angle at which the springs are set so that the ratio of shear to compression loading on them varies with the direction of the applied force. The maximum stiffness, or, in other words, the smallest amount of deflection, is required from the springs in a direction parallel with the length of the coach because braking and traction forces must not move the bogie more than a slight amount in relation to the body. The rubber is almost entirely in compression under fore and aft movements and is therefore at its stiffest. For vertical loads the springs have to be more flexible to give a comfortable ride and under the weight of the coach body they operate in shear and compression. Under transverse loads the springs are substantially in shear and are thus most flexible in the direction in which the greatest flexibility is required, permitting side movements between body and bogie up to $1\frac{1}{4}$ in. in the case of the London Transport cars. Larger movements can be provided if required.

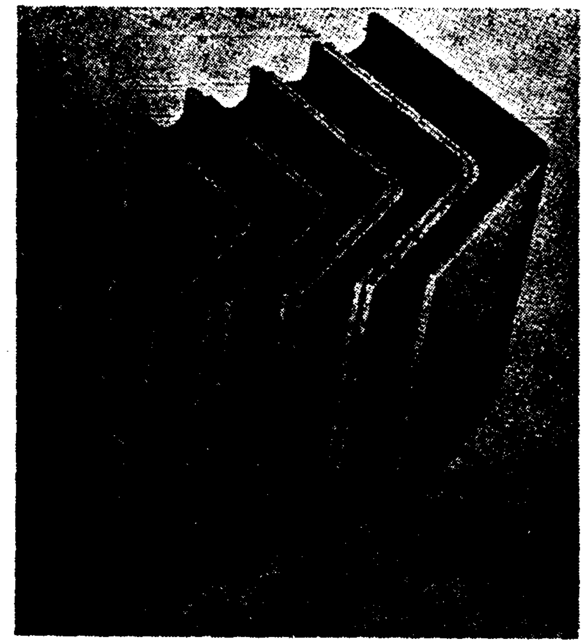

Fig. 5. Axlebox spring with four chevrons.

Fig. 6. Axlebox suspension.
(Courtesy—London Transport Executive)

The design of bolster springs (Fig. 3) is the result of extensive research and testing. The intermediate

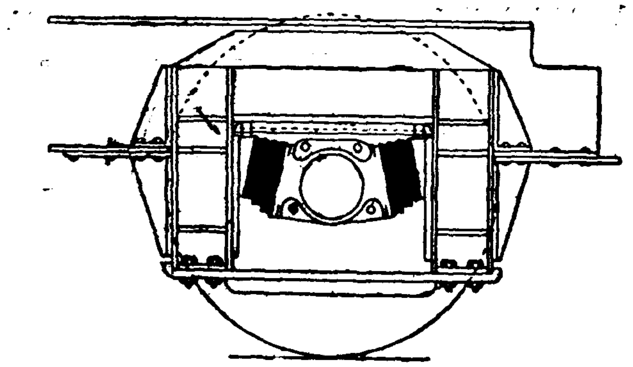

Fig. 7. Axlebox suspension on one of a number of diesel railcars built to the requirements of the Great Northern Railway Board.
(Courtesy—Great Northern Railways)

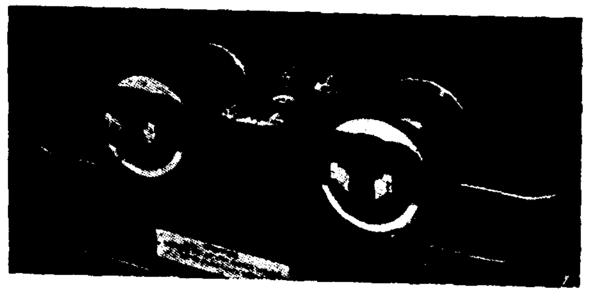

Fig. 8. Model of main line carriage bogie equipped with Metalastik bolster and axlebox suspension, exhibited at the recent Engineering, Marine, Welding and Nuclear Energy Exhibition at Olympia.

steel plates are included to prevent bulging and the rubber "sandwiches" and carefully profiled to obviate high stress points.

AXLEBOX SPRINGING

In conventional axle springing arrangements the bogie is supported on the axles by steel springs and it moves vertically about the axleboxes which are carried in horn guides attached to the bogie frame. The sides of the axleboxes and the horn guides are fitted with manganese steel liners which require greasing and are subject to wear due to the constant sliding action taking place.

In the Metalastik suspension the axlebox is located in the bogie frame by means of rubber-bonded-to-metal springs of special design. (Fig. 4.) Horn guides are not required as all vertical movement between axle and bogie is accommodated by deflection of the rubber springs without metal-to-metal wear.

In axlebox springing the main requirement is adequate flexibility in a vertical direction combined with high fore and aft stiffness to keep the axles parallel. This combination could be provided by the bolster spring but, as too much transverse flexibility is undesirable, the chevron shape is more suitable. In no direction is the rubber in pure shear.

The axlebox springs are of the same basic design but two, three or four chevrons may be used (Fig. 5). The springs for the new railcars on the "Enterprise" service operated by the Great Northern Railway Board between Belfast and Dublin have three chevrons, while those designed for a British Railways coach have four chevrons.

On the London Transport Executive cars the axlebox with its springs is placed in a yoke casting bolted to the bogie side-frame (Fig. 6). The yoke is pivoted at one side so that the whole assembly can be adjusted for wheel wear.

The axlebox suspension arrangement for the Great Northern railcars is illustrated in Fig. 7. Adjustment for wheel wear is made by the inclusion of packing pieces.

Apart from eliminating wear and lubrication, this type of axlebox suspension damps out vibration due to the rail joints. With laminated steel spring suspension the response is not quick enough to absorb this form of vibration.

In bolster and axlebox suspension systems of the kind described, different spring characteristics can be obtained by altering the angle at which the springs are set and the hardness of the rubber used. It is possible therefore to provide bolster or axle suspensions for all types of rolling stock with a few standard units.

Metalastik suspensions are being designed for locomotives, railcars, coaches and wagons for many railway authorities.

PNEUMATIC-TYRED TRAINS ON PARIS METRO

After a period of experiment rubber-tyred trains are now in service on a sizeable section of the Paris underground. The greater acceleration and braking power of trains equipped in this way is enabling a faster and more frequent service to be maintained. The use of rubber tyres has done much to increase the comfort of passengers by reducing noise and giving a smoother ride. The line on which the system is now in operation runs from Chatelet in the centre of Paris, four miles to the Mairie des Lilas, and has 11 stops. We are indebted to *The Railway Gazette*

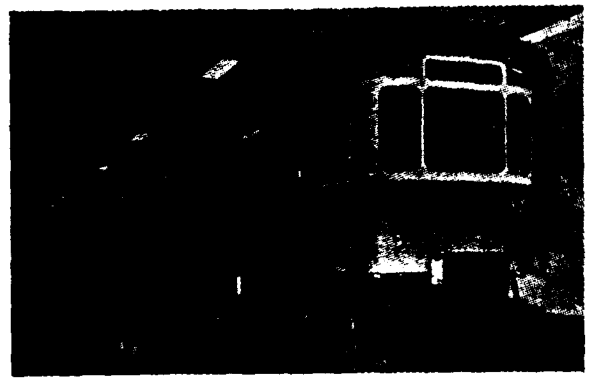

Fig. 9. Complete train on pneumatic tyres.
(Courtesy—Railway Gazette)

Fig. 10. New bogie, showing differential assemblies, guide wheels, brake cylinders and side collector shoe.
(Courtesy—Railway Gazette)

for permission to reproduce, in abridged form, the following account which appeared in their issue of February 15, 1957.

The investigations led to the development of a vehicle running on pneumatic tyres on a modified form of track, and for some time this was operated experimentally on a short single-line shuttle service between Porte des Lilas, Line 11, and Pre St. Gervais, Line 7, of the R. A. T. P. (Regie Autonome des Transports Parisiens). The experimental car having given every satisfaction, it was decided to convert the Line 11 to operate on the new method. Some of the new coaches constructed for this service have been on exhibition recently and the official inauguration of the new train service has now taken place.

Pneumatic-tyred wheels had been known, of course, in France on the "Micheline" rail cars and on some main line stock, but they used steel treads on ordinary permanent way. Such an arrangement was not admissible under the load limitations applying on the Metro. On the other hand the use of pneumatic tyres running not on ordinary rails but on a smooth road-type surface with laterally bearing guide wheels to keep the vehicles in line offers attractive possibilities and was proved to be practicable on the short experimental section. Noise was to all intents and purposes eliminated while the greater adhesion obtained permitted of more rapid acceleration and braking, and enabled a lighter car body to be used, with some reduction in power consumption.

FEATURES OF THE NEW WORKING

The accompanying drawing illustrates the new bogies and form of track used with them. Ordinary rails are still provided but except at points, which are relatively few on the Paris Metro compared with, say, the London Underground, they serve only to carry the return traction and signalling currents or to act as an emergency support should a tyre become irregularly deflated. Inside the pneumatic-tyred running wheels are steel safety wheels with extra deep flanges. Normally these are clear of the steel rails but bear on them if a tyre fails. On each side of the track are "T"-shaped guide rails, carried at intervals on insulating supports and serving as positive conductor rails against which bear the lateral guide wheels—which also have pneumatic tyres—and the side running collector shoes. The negative collector shoes run on the steel safety rails. At points and crossings it is, of course, necessary to have gaps in the guide rails and here the vehicles, are kept in place by the deep flanges on the safety wheels; the construction of the points and their method of operation remain as before. At these locations ordinary transverse sleepers are used and timber runway pieces laid in for the main bogie tyres to travel over. The track circuit signalling arrangements are not interfered with, the negative collector shoes serving to provide the shunt across the steel rails instead of wheels as hitherto.

ENGINEERING DETAILS

A bogie consists of two heavy "lorry back axle" assemblies, with differential and reduction gear, each actuated by a 70-h. p. motor attached through an elastic suspension to an H-shaped framing carrying the lateral positive and vertical negative collector shoes and, at the corners, the guide wheels. The general spring suspension arrangements are somewhat simpler than usual as the tyres provide some initial absorption of running shocks. A cam shaft 25 notch controller governs the four motors of a car in series or series-parallel combination. Normal acceleration

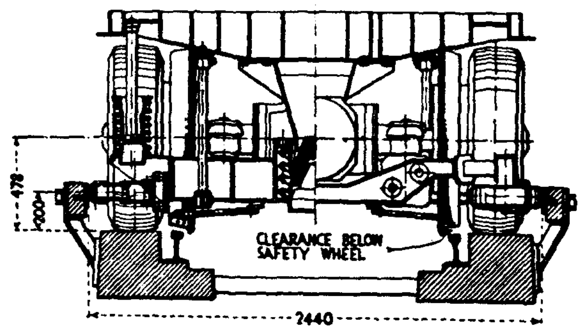

Fig. 11. General arrangement of pneumatic tyred bogie.

rate is nearly 4.43 ft. per sec. Braking is electro-pneumatic, with Westinghouse as a supplement, with hand brake on the motor shafts.

There is considerably less brake rigging than on earlier stock. The service braking deceleration is nearly 4.76 ft. per sec., or 8.2 in an emergency. The end couplings of a train set, which usually will consist of three motor coaches—two with driving cabs—and a trailer, are of standard Metro pattern, but a new simplified form is in use at the intermediate positions.

SOME COMPARISONS

It is to be noted that the new motor bogie weighs 5 tons against 10.2 for ordinary stock and a trailer bogie 2.75 against 4.2. A complete new motor coach weighs from 20.2 to 20.6 tons, compared with 40 previously, and a trailer 14 tons, against 20 in the old trains.

A four-car train of ordinary design weighs as a maximum, empty, 120 tons and can carry 594 passengers. (There is, however, another design of the same formation weighing 111 tons and carrying 570.) With the new pneumatic-tyred stock, however, the weight is 75.2 tons for 650 passengers, giving a saving of 32% total train weight against the lighter weight formation of the old type, with, of course, a saving in power consumption.

We are indebted to Monsieur Georges Ricroch, chairman of the board of the Regie Autonome des Transports Parisiens, for the illustrations and information reproduced in this article.

Portable Automatic Welding Machine

A portable, electric motor-driven, track-guided machine that can be equipped to do automatic welding, cutting and heat treating is to be produced on a commercial scale in the U. S. following the successful use of prototype models in defence work. It is said to be capable of handling most requirements of metal-working shops and of supplementing welding and cutting equipment in large fabrication plants. The new machine including the electric motor, controls a heavy aluminium housing, weighs 47 lbs. and can carry 750 lbs. of welding or cutting equipments.

It will be available in two speed ranges to handle the general run of welding and cutting assignments and is said to facilitate such jobs as the automatic welding, or cutting of steel plates; the cutting of steel billets, or "blooms" to length; the automatic welding of longitudinal tank and pipe joints, railroad car sidings and long sections of sheet steel; and the cutting of heavy scrap and heavy plate steel into scraps of specific sizes. The basic carriages can be equipped to do straight-line, level, and heavy-duty cutting and also "dual shield", argon arc and gas arc welding, as well as flame-hardening, flame-softening, flame-straightening and stress-relieving. One model travels at welding speeds of 9 to 127 inches per minute; the other at from 1 to 14½ inches per minute for cutting.

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U. S. ALLOTMENT FOR DEFENCE

The United States Government is ordering the country's aluminium industry to set aside 108 million lbs. of the metal for defence needs in the second quarter of 1958, according to a Journal of Commerce report.

This figure represents 10 per cent of the anticipated supply of domestic and imported primary aluminium against a 12 per cent set aside—totalling 97 million lbs. —in the current quarter. Aluminium supplies in excess of the Government's set aside order were available for civilian consumption, the report said.

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URANIUM PROCESSING PLANT

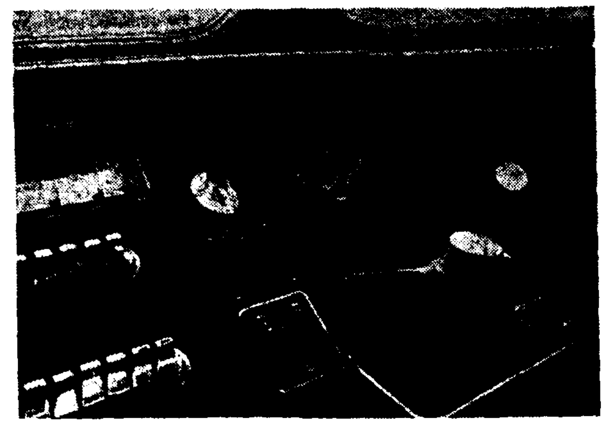
The proposed uranium processing plant in India is likely to go into operation by the end of this year. The approximate expenditure to be incurred on this plant is Rs. 27 lakhs. It will be located at the Atomic Energy Establishment, Trombay.

Hasler's Contribution to an Efficient Transport System

IN these days of keen competition in industry and ever increasing speeds of modern vehicles it is more than ever essential that there be close adherence to timetables and economical operation, coupled with increased margin of safety. An efficient transport system will furnish its operators with the means to provide increased performance of its vehicles and reliability of its services.

HASLER TELEGRAPH WORKS LTD. of 26 Victoria Street, London, S.W.I. whose Agents in India are Messrs. Heatly & Gresham Ltd. of Bombay, Calcutta, etc. have for more than 60 years specialised in the supply of Speed Indicators and Recorders for locomotives and most other forms of traction. The instruments known as "TEL" and "TELOC" have been supplied to more than 200 Railways throughout the world, many of whom have adopted same as standard equipment.

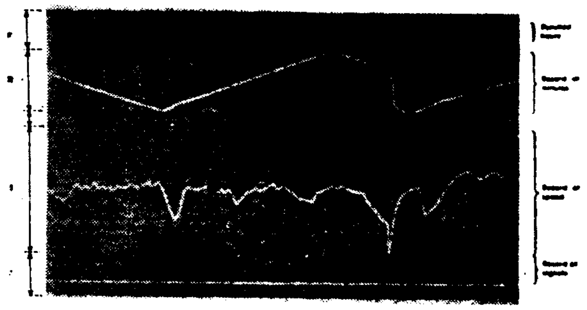
TEL and TELOC instruments are provided with high precision mechanism, having a measuring time of only one second, speed indication thus being given practically instantaneously. They are not influenced by mechanical or magnetic forces or fluctuations in temperature and the modern dust-proof casing in which the apparatus is housed is of compact and robust construction, which facilitates mounting, even when



The Trans-Europe-Express trains running from Holland via Belgium, Luxemburg and France to Switzerland are equipped with the latest model of TELOC instruments.

The Luxury trains of the Italian State Railways covering the 635 km. from Milan via Bologna, Florence to Rome in less than 7 hrs. are equipped with modern TELOC speed recorders.

Axlebox with transmitter for electric remote drive for TELOC speed recorders fitted on Trans-Europe-Express trains.



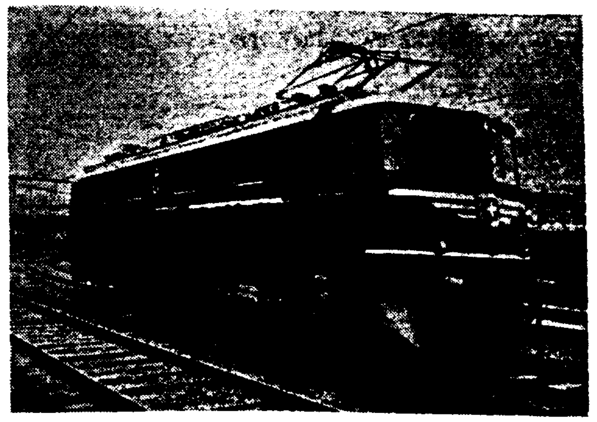
Recording diagram taken from a TELOC instrument to (1/2, 2/3) reduced size, actual width of paper type is 92 mm.

the available space is limited. The clear dials of the instruments with linear scales enable speeds to be read quickly and without effort.

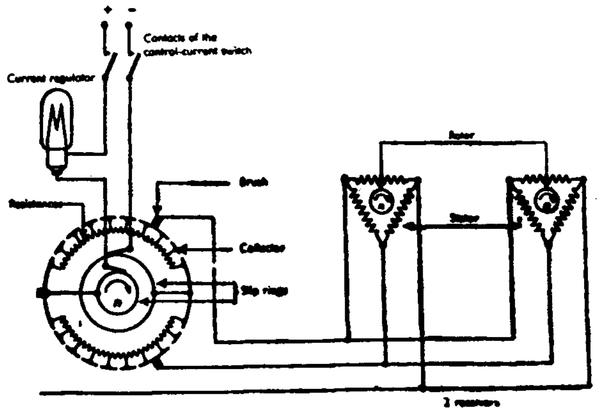
TEL or TELOC Speed Indicators can be provided with total distance counters, whilst the Recording Instruments, which can be equipped with a 24-hour clock and counter totalising miles or kilometers, record in addition to speed, the time of day, distance travelled, the times of travels and stops. These instruments can also be arranged to record signals of train security systems, pressure in brake pipes and interruption of current etc. The records are made on transparent paper diagram rolls in an indelible manner which cannot be falsified without detection.

The instruments are driven by means of flexible shafts or telescopic shafts with cardan joints, the drive generally being taken from an axle of the vehicle by means of a gearbox attached to the axlebox cover or in certain instances directly from a coupling rod gear or engine shaft.

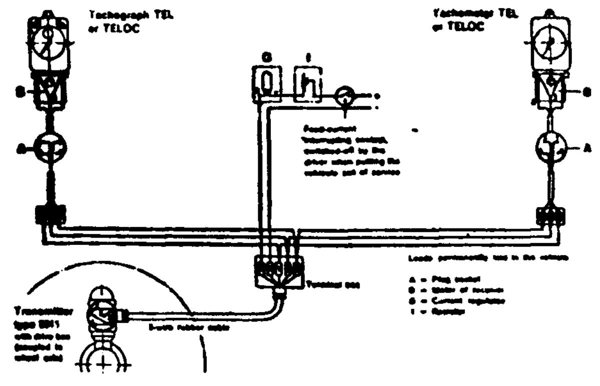
The HASLER COMPANY have recently developed an electric remote drive system which consists of a transmitter unit mounted on the wheel axle or motor



The powerful electric locomotives for the Gotthard line of the Swiss Federal Railways are equipped with TELOC speed recorders and indicators with electric remote drive.



Working principle of the electric remote drive for TELOC speed indicators and recorders.



Arrangement and installation of speed indicators and recorders with electric remote drive on a locomotive with two driver's cabs.

shaft and one or two synchronous receiver motors which are directly coupled to the speed measuring instruments. The direct current which is supplied to the transmitter unit through a current regulator lamp from the battery of the vehicle is converted by the transmitter into three phase current with a frequency proportional to the speed. The power taken from the battery by the remote drive is very small and with installations having a single receiver amounts to approximately 35 W. whilst for plants with two receivers about 70 W. is required. The possibility of utilising one transmitter to operate two receiver motors makes the electric remote drive particularly suitable for application to electric, diesel/electric and diesel locomotives and rail cars with two separate driving cabs. It is usual in these vehicles to mount a speed indicator in one cab and a speed indicator and recorder in the other.

PLASTIC COATED STEEL

An entirely new and revolutionary material, produced by a well-known British steel company, is in the form of a plastic-coated steel, which, it is stated, will have numerous applications in engineering and industry generally.

One of the main features of this material is that it can be worked and treated as ordinary steel sheet, while its outer surface retains all the characteristics of P.V.C. plastic, produced in a varied range of colours and embossed patterns. The outer plastic surface is a permanent, complete finish in itself, being extremely easy to clean and maintain. It is suitable for the manufacture of furniture, motor cars, building materials, electrical goods, and many types of domestic and industrial items, combining the strength and durability of steel with the finish and texture of plastic.

An important point is that there is no need for surface finishing treatments, while the product is cheaper than stainless steel. Essentially the material is strip mill cold-reduced steel with a specially formulated Velbex P.V.C. coating, and the reverse side of the sheet can be either a bonderised steel or electro-zinc-coated surface. It can be bent, formed, seamed, deep drawn, joined and welded without damaging the coating; it is warm and pleasant to the touch and has excellent electrical insulating properties, being resistant also to acids, alkalis, greases, detergents, weather, humidity and to abrasion. It does not support combustion, and is stable at higher temperatures than P.V.C. alone.

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NEW PRODUCT FROM COPPERWELD STEEL COMPANY

Copperweld Steel Company has a new product known as Alumoweld, an aluminium-covered steel rod which can be re-drawn into wire and may become an important new item for the firm's wire and cable division, according to the annual report.

Limited commercial production of Alumoweld is expected to get under way in April, a company spokesman said.

CARRIAGE AND WAGON SHOPS SUPPLEMENT

Role of Coated Abrasives in Railway Workshops

By ***U. Mohan Rao,*** *B.Sc., B.Sc.(Tech.),*
Abrasive Engineer, Carborundum Universal Ltd., Madras.

THE impact of Coated abrasives in their varied forms on modern production methods has been remarkable. Without this modern Engineering tool the fine finishes, interchangeable parts and precision workmanship required for mass production would be seriously handicapped. It is needless to say that in railway workshops, wagon, locomotive and carriage shops—coated abrasives find extensive use from the humble derusting and polishing operation carried out by hand with strips of emery cloth to superfine finishing of crankshafts and journals with latest crankshaft belt grinding machines.

The progress in recent years of manufacture of coated abrasives has been as spectacular as the development of modern grinding methods. Though the coated abrasives were known even in Middle ages, it was not until the discovery and large scale production of synthetic abrasives—Silicon Carbide and Aluminium Oxide—at the turn of last century that they emerged out in the present form. The modern method of 'Electrocoating' whereby the abrasive grains are coated in an upright position on the backing surface in an electrostatic field has transformed the roughly hand coated 'sand paper' into a precision tool capable of removing print from newspapers leaving plain white sheets.

Coated abrasives consist essentially of three components: a) Backing—Usually paper or cloth or fibre or combination of these. b) Bond—glue, varnish or resin. c) Grain—Natural abrasive such as flint, emery or garnet or synthetic abrasive such as Silicon Carbide or Aluminium Oxide. Two methods of coating the grains on the backing are employed. The first method which is the older method but still in practice is the gravity coating where the abrasive grains are allowed to fall freely from a controlled hopper on the adhesive coated backing. Such a coating is not sharp cutting since the abrasive grains lie haphazard on the surface with many of their keen cutting edges embedded in the adhesive layer.

In the modern process of 'Electrocoating' the abrasive grains are carried into an electrostatic field created by high voltage equipment and are negatively charged while the adhesive coated backing moving above the grains is positively charged. The powerful electrostatic field makes the grains move upwards with their broad bases having maximum charge facing the adhesive layer. A coating produced by this method is absolutely uniform and is very sharp since all the keen edges are protruding out. Hence such abrasives remove greater stock, have longer life, are cooler cutting and clog less.

While sand paper and emery cloth find universal use in all workshops for general purpose sanding and polishing operations, the role played by coated abrasives can be measured more aptly by their application on machines.

Different forms of abrasive belt grinding find extensive use in railway workshops. The superiority of a coated abrasive belt to a limited extent over a grinding wheel due to its faster and cooler cutting action and tendency to clog and glaze less has led to its adoption for off hand grinding of castings, both ferrous and non-ferrous etc. The flexibility of a coated abrasive belt has been well exploited in grinding contoured work by using profiled contact wheels and many fitting such as stainless steel wash basins, faucets etc., are finished—ground and polished—on abrasive belts. While the old fashioned 'Linishers' are still popular especially for grinding flat surfaces, backstand idler units using serrated rubber covered contact wheels are more efficient for heavy duty work. Portable belt grinding units and swing frame belt grinders are advantageously used for removing excess welds, for fettling operations etc., where workpieces are too heavy to handle and the machines have to be taken to them. To obtain very fine finishes an axles, spindles, shafts, rolls, calenders and crankshafts, belt grinding units mounted on the tool posts of lathes, boring mills etc., are used.

Coated abrasive discs fixed on portable disc sanders are particularly useful for smoothening out welds, general derusting, removing tool marks on such parts as the big and small ends of connecting rods etc. Small abrasive sleeves from 1" to 4" diameter mounted on rubber mandrels fitted to portable or flexible shaft tools are employed for derusting and descaling of the inside of boiler tubes and for finishing of dies and moulds.

Coated abrasives are just the answer to varied finishing problems encountered in coach and wagon building shops. Raw panels of wood or wood veneer are rough and finish sanded on double or triple drum sanders. These machines consist of two or three drums on which is wound the abrasive paper and the material to be sanded is sent on a short conveyor below these drums. One cannot imagine the amount of time and labour that would otherwise be involved if the surface of thousands of square feet of these panels used for coach building is to be sanded by hand. By using coarse, medium and fine grits on the three drums, large amount of stock can be removed and good finish obtained in a single operation.

Another very useful machine is the overhead belt sander in which a long abrasive belt runs between two or more pulleys and is made to bear against any required portion of the wooden workpiece. Unlike the drum sander, fabricated shapes can be sanded in this machine in addition to sanding large flat surfaces. For profile grinding inflated rubber drums fitted with abrasive sleeves are very convenient while brush backed abrasive strips so arranged as to form a mop, sand difficult and intricate contours accurately.

Prior to primer and paint or lacquer finishes of bodies of wagons and coaches surface blemishes have to be removed for which portable disc sanders are ideally suited. Vibrating and orbital sanders, pneumatic or electrically operated are very convenient for sanding wooden surfaces. They are very fast in their action and leave practically no scrach marks on the surface if suitable abrasives are properly selected.

The use of waterproof abrasive papers is well known in any finishing operation involving painting or lacquering. While a highly glossy surface as necessary in automobile industry may not be required in carriage and wagon shops, a satisfactory surface cannot be obtained unless the primer or sealer coats are properly sanded with waterproof papers before painting or lacquering. Wet sanding in between different coats of paints or lacquers improves the quality of finish and helps removal of bubbles, dirt etc.

The coated abrasive, familiarly known by the name of 'Sand Paper' appears on the surface to have limited use, but it plays a very significant role in the Railway industry as in every other industry. While it is said that industrialisation of a country can be measured by its output of sulphuric acid it would be apt to say that consumption of coated abrasives is a measure to the modernisation of industries of a country.

Hardware from Aluminium Magnesium Alloy

A British firm is producing quality hardware from an aluminium-magnesium alloy combining strength and durability. The alloy is a non-corrosive compound suitable for tropical conditions and has already been used in the buildings of Malta airport and certain fittings in the hall of residence of the new university at Kingston, Jamaica.

The compound contains between 10 and 12 per cent. Magnesium, which produces hardwearing robust alloy suitable for all marine and tropical conditions. Successful tests have been made on the metal by aircraft companies, shipyards, and universities. The company produces a wide range of hardware from the alloy, including coat hooks, door handles, hinges, handrail brackets, and bathroom fittings. The metal weight is approximately one-third of brass. It is immune to oxidization, and the silver anodized finish is of a permanently lasting colour.

Lighting and Productivity in Rolling Stock Workshops

By H. M. Hume

Chief Engineer, Lighting Service Bureau, Philips (India) Ltd., Calcutta.

WITHOUT an adequate, efficient transport system it is impossible to develop the natural, agricultural or industrial resources of a country. The Government, being fully aware of this, have clearly emphasized the essential need of expanding every phase of railway activity. Consequently we are familiar with announcements of achievements in certain branches of railway engineering, achievements in the field of indigenous locomotive manufacture, electrification, new or modernized track coming into operation, station improvement, etc. but these are the more glamourous aspects. What of the more prosaic but equally important sectors?

One such sector is the manufacture of rolling stock, the production of which is proceeding apace in this Country in new and efficient workshops, being no less vitally important than that of the manufacture of locomotives.

In designing these factories, efficiency and economy are, perhaps, the most important factors to be considered and anything which contributes to either, or both, is worthy of investigation. Timely consideration of the provision of suitable conditions of lighting both natural and artificial, for example, may be amply rewarded by the contribution well-designed lighting can make towards both efficiency and economy. This realization has affected, in no small measure, not only the design, but also, in many cases, the materials utilized in the construction of many modern workshops. Witness for example the saw-tooth roof, the use of plastic materials for roof, fenestration etc.

The striking advances made in artificial illumination during the last 25 years have also been incorporated. New and more efficient light sources have revolutionized our ideas regarding illumination intensities, and indeed illumination in general. Scientific investigations into the influence of lighting on operatives, and therefore on production, that have been carried out in a number of countries have been incorporated.

Unfortunately, as yet, little has been done in India by way of investigation into the relationship between illumination and industrial production; the principles applied are, for the most part, the result of foreign experience. One notable exception exists, however—the Textile Industry. This industry has given a lead by carrying out investigations of this nature at the Ahmedabad Textile Industry's Research Association research station at Ahmedabad. Some interesting cogent results of the effect of illumination on textile production are to be found in the A. T. R. I. A. Research Notes that were published in June 1952. Other industries would do well to study this document and to establish this relationship in so far as it applies to them.

The new light sources, to which reference has already been made, are principally of the gas-discharge type, (i. e.) high and medium pressure mercury-vapour gas-discharge lamps, colour-corrected and non-colour-corrected, sodium-vapour gas-discharge lamps and tubular fluorescent lamps. The various lamps enumerated have been utilized in carriage and wagon workshops in many countries, particularly is this the case in the assembly shop, to which application the inherent characteristics of the discharge lamp are particularly suited.

Figures 1 to 4 show views of four different lighting installations in four countries each employing different light sources to solve the same lighting problem.

The installation in Belgium shown in the first figure makes use of 125 W. colour-corrected high-pressure mercury-vapour discharge lamps. In this installation the spacing/height ratio is very low which results in a very even distribution having a low illumination diversity factor, but due to the relatively small unit employed (125 W) their number is somewhat excessive, resulting in high installation and maintenance costs. The use of the 400 W. colour-corrected H. P. M. V. lamp would have increased the spacing of the units thereby reducing the number employed. Reduction of installation and maintenance charges

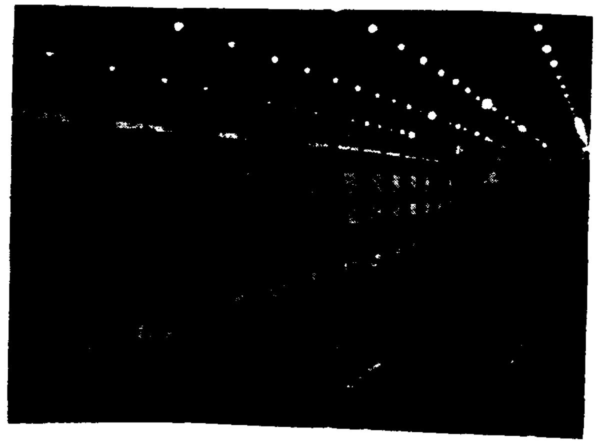


Fig. 1

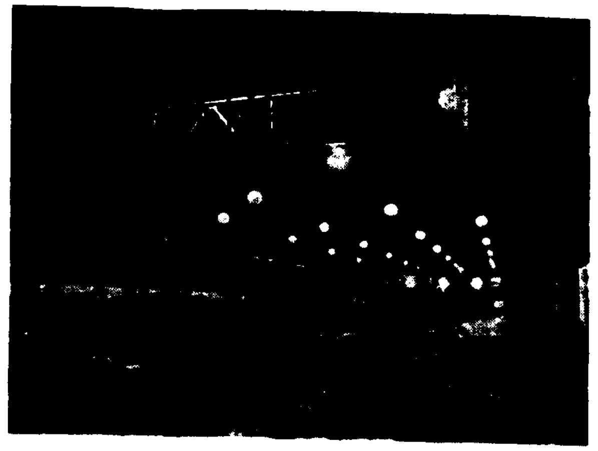


Fig. 3

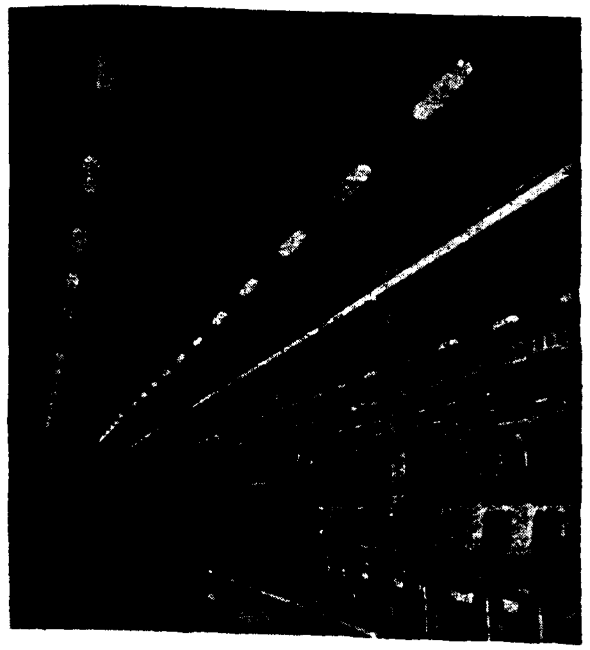


Fig. 2

Fig. 4

would have resulted. One interesting feature of this installation is the light coloured wall which has a high reflection factor thereby reflecting much of the light incident upon it down to the working plane. While this is a desirable feature it should be noted that in this instance, as a result of the dark roof and the dark areas of the wall, it would appear that the brightness ratios are excessive. Visual performance will not be as good as they could be under conditions of greater equality of brightness.

The second figure illustrates how the problem of lighting an assembly shop in a carriage and wagon factory has been solved in Portugal by using 65 W. tubular fluorescent lamps. 3 lamps being housed in each fitting. Once again, as a result of the close spacing of the lighting fittings the intensity of illumination is very even, the colour of the light of excellent quality. From a technical point of view the installation is remarkably successful. Economically, however, this installation is less successful than that of Figure 1. The low unit size of the light source adopted (65 W) necessitates the use of a large number of units, each of which it must be remembered not only utilizes a lamp but also the necessary control gear, and even the use of three lamps per fitting does not compensate sufficiently for the extra expenditure on lamps and control gear. As has already been stated, however, technically this installation is of a high order.

It is interesting to compare the brightness ratios as shown in the figure of this installation with those shown in Figure 1. It is obvious that brightnesses are much more uniform in the case of the Portuguese installation. This is partly due to the attention paid to the colour of structural surfaces, but is, for the greater part, due to the spill

of light on the roof from slots in the fluorescent lamp reflector provided for this purpose. The fluorescent lighting installation will certainly be more congenial to the workmen employed ; a fact which will undoubtedly influence production.

140 W. sodium-vapour gas-discharge lamps mounted at a truss level of 25 ft. provide the illumination in the installation in the Danish factory shown in Figure 3. The high efficiency of the light source and its high unit value (140 W) makes this an efficient and, therefore, an economical installation. The number of units utilized is much less than would be required if the light sources of either of the first two installations were employed. The inevitable result of selecting this light source is the adoption of a wider spacing of the units. The illumination diversity factor is adversely affected thereby. This is not serious in the installation shown, however, since part compensation is made as a result of the mounting height adopted, namely 25 ft. which still ensures a reasonable spacing/height ratio.

There has been a certain opposition to the sodium-vapour lamp as a result of the near monochromatic yellow light emitted by it. In a large number of factories in Europe it has been successfully employed and has won the praise of the employees after the initial prejudice has been overcome. There is no reason why this, the most efficient of commercial light sources, should not be used, unless it may be rejected on account of its colour distortion, in certain cases where it may be necessary to distinguish visually between different metals. Difficulties could arise in these circumstances but there is no other reason why this light source should not be used.

In India, too, gas-discharge lamps have been used in carriage and wagon assembly shops. One such installation is seen in Figure 4. This is the

(Continued on page 6)

LOCO-PAINTING

A reflection on a formulator.

By Nirmal Sen

(Technical Development Department, P. C. Chanda & Co., Ltd.)

TILL early twentieth century, Paint formulation was a secret art and at the present it has become one of the complex developing Science.

When we had to depend upon the foreign-made locomotives, painting problem regarding locomotives was not so acute as it has become after India began to utilise her own resources.

Efficient maintenance of locomotives means efficient running of the nervous system of the Railways. Locomotives as a class are to face the extreme conditions which affect the painting, such as, excess heat, Sulphurous fumes of the smoke, steam, lubricates, alkali water and the dusts in the wind.

Though considerable developments have been achieved by the different Railway research sub-centres, it seems that they have not yet been able to tackle the problem with a easy hand. As there is very little data available regarding the exact nature of the corrosion problem in the Indian condition, we shall have to adopt a "trial and error" means for a certain period of time.

Average painting schedule as has been drawn by the Railway Board for Locomotives may broadly be stated as follows :—

Coal bunker	2 coats Black Japan.
Cab roof (outside)	Black Japan.
Cab roof (inside)	2 coats Green Enamel on primer.
Buffer beams	Signal Red Paints.
Tender bogies	Two coatings of Black Japan.
Inside of the boiler & fire box	2 coats of Lead Paint.
Inside Clothing Plates	2 coats of Red Oxide.
Smoke box, Chimney etc.	Black Japan.
Wheels & Underframes	Lead Paint furnished by Black Japan.
Cylinder lagging sheet	2 coats of lead colour followed by two coats of Black Japan.

(Continued from page 5)

Integral Coach Factory in Madras where 250 W. colour-corrected high-pressure mercury-vapour gas-discharge lamps have been installed. It should be noticed that objects on the floor stand out prominently as a result of the very considerable reflection of light from the light-coloured floor. That spacing of the light fitting adopted, relative to the mounting height, is satisfactory may be seen from the even intensity of illumination which is evident from the figure.

In most assembly shops an overhead travelling crane is in use, resulting in considerable vibration being present. Even with large incandescent lamps of high wattage, having robust filaments, the life is adversely effected as a result. Discharge lamps whose construction and operation are fundamentally different from incandescent lamps are relatively unaffected by vibration, a circumstance which favours their adoption. The long life of the discharge lamp also favours its use since replacement is less frequent at the high location of difficult access in which they are found in assembly shops.

The use of the different types of light sources in the installations discussed may have been dictated by circumstances; for example, the availability of the light sources and accessories, the cost of electrical energy etc. Future installations in this Country will definitely be influenced by the availability of discharge lamps. Their lack of availability may, perforce, result in an increased use of fluorescent lamps, which, as we have seen, are effective, but for this type of installation, where the mounting height is essentially high, costly.

In other departments, of which there are a number in a carriage and wagon factory, the problems encountered are similar to those of similar departments in other industries and, therefore, need not be discussed in detail here. Only one remark may be made and that is to point out the increasing use of fluorescent lamps in these departments.

COAL BUNKER

The present I. S. D. Specification may be suitable but the paint having better hardness and abrasion resistance should be used.

CAB ROOF

A finish of this type should dry hard and elastic and possess resistance to repeated washings with mild cleansing agents. A vehicle for an enamel of this kind is the Spar-Varnish. The property of the paints with the present specification may not be in a position to withstand the drastic condition prevailing there.

For roof-top, if it is at all essential to be white, Titanium Dioxide and Zinc Oxide should be specified in place of White lead, as the latter may be affected by the Sulphurous fumes of the smoke.

TENDER, CLOTHING PLATES, CHIMNEY & FIRE BOX

Straight oil paints are not suitable for these parts of the locomotive where temperature is excessively high. Temperature from the Cab to Chimney ends is about 350°—420°F under working conditions, and the paints generally prepared from Linseed Oil are not suitable. These require vehicle with minimum oxidising tendencies. Alkyds made from saturated oils or fatty acids have been found to be suitable. Recent trend in U. K. is to use a mixture of non-drying and drying oil modified alkyd. Addition of unsaturated oil is essential as most of the metals cannot hold saturated hydro carbon chain but they can do it with unsaturated chain.

For Indian locomotives Cashewnut Shell Oil can be satisfactorily used as its heat resistance property is quite appreciable.

WHEELS AND UNDERFRAMES

A right type of Black Japan will be suitable over the Bitumen Emulsion paint but the same paint should not be used on the frames near the Ash pit.

The author feels that the specification regarding the inside coating of the boiler may cause severe injury to it.

For a lead-Zinc Oxide-graphite pigment having linseed oil as the base, the probability of hydrolysis is predominent at high pressure which will cause the liberation of fatty acid and glycerol which in turn may damage the boiler.

We feel that the outstanding fault of the Railway Board lies in the policy of specifying the exact ingredients of paints. This type of specification can give good results only when the Railway Research laboratories are in a position to tackle the problem with an easy-hand.

Some of the specifications behave strangely. It is very difficult to find out the justification in the use of ordinary iron oxide primer to the locomotives which costs possibly hundred times more than that of tank wagon for which costly Zinc Chromate, Red Oxide Primer has been recommended.

Specifications as a rule become out of date and keep the paint manufacturers out from supplying the superior products which do not contain the specified material.

Since scientific development is the key note of Paint industry, it will be better for the Railway Board to buy from reputable manufacturers who can supply up-to-date products and technical advice through experts who are continuously developing better products. In this respect Indian Standard Institute may play a valuable role for the development of the painting problem in Railways.

A Diesel-Driven passenger rail coach just completed by FIAT, the first of 24 similar rail coaches on order from the *Ferrocarriles Consolidados* concern of Cuba, was on view in Turin recently.

The coach develops a speed of up to 105 km. per hour. It is equipped with 56 passenger seats, a well-stocked cafe-bar, and a postal service booth. Telephone connection with the other carriages in the train is maintained by a radio plant through which communication can be established with radio stations up to 20 miles distant. Synthetic resins, particularly suited to tropical climates, were employed to upholster both the interior and external parts. In addition to the 24 diesel passenger units, 19 coaches without motors are on order, including passenger carriages to seat 68, mixed passenger and luggage coaches with seats for 44, and goods vans. All are pesigned to weigh 35 to 40 tons each.

Products of the Hungarian Railway Carriage and Machine Works, GYŐR—Hungary

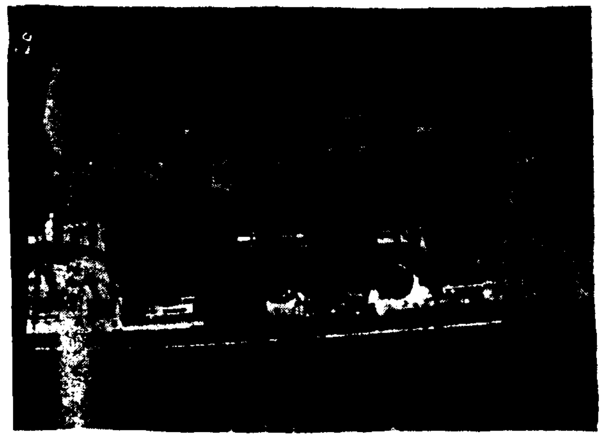
THE Hungarian Railway Carriage and Machine Works were established 60 years ago in an ancient industrial and cultural center of Hungary, and in the course of time developed into one of the most important works of the country. The works have displayed successful export activity from the beginning and it is worth mentioning that about 40% of the 45.000 various railway coaches manufactured in the last 60 years were exported to all parts of the world, making a name also for other products, such as cranes, bridges, steel constructions, etc.

The successful start of the works is revealed by the fact that in 1897, the year following their foundation, rapid progress was guaranteed by orders for several hundred railway coaches. This was followed by continuously increasing orders for export, which still takes up a considerable part of the factory's production.

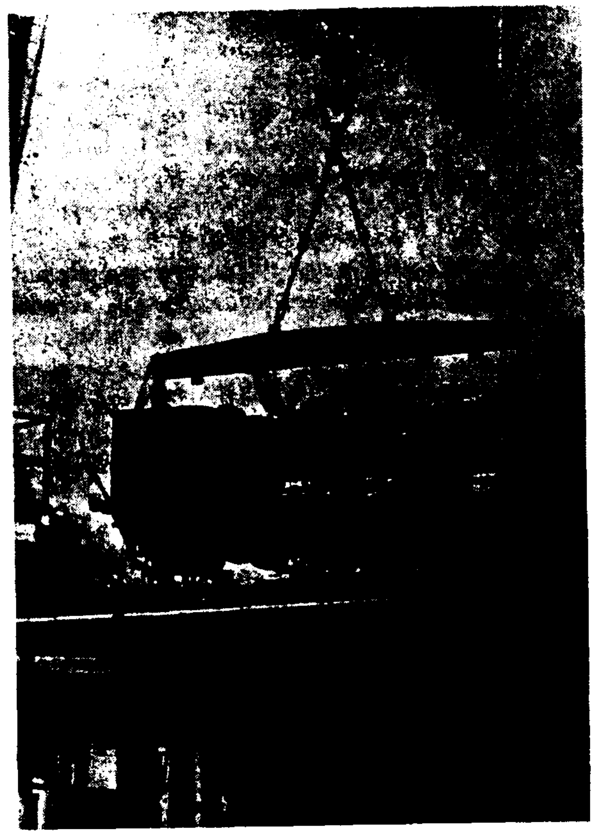
As a curiosity it has to be emphasized that in 1906 the passenger cars of the London Underground Railway were supplied by the Hungarian Railway Carriage and Machine Works. These cars, having been in many regards ahead of their times, were built with all-steel frames and in a sheeted body construction.

The up-to-date execution and excellent quality of already the first railway carriages, as well as the correct observance of delivery dates, acquired such reputation for the works, that their export activity could be continuously extended to further countries and railway association. For the past decades a great part of the export-deliveries was directed to European countries/England, Austria, Belgium, Bulgaria, Czechoslovakia, Germany, Italy, Rumania, Russia and later the Soviet Union and Turkey/but a good many overseas countries were also registered as customers of the works/Argentina, Burma, Chile, Costarica, South Africa, Egypt, East-India, China, etc./and thus the products of the Hungarian Railway Carriage and Machine Works, becoming famous throughout the world, have won full appreciation and a good reputation to the trademark " RABA ".

During World-War II export was broken off and when the war was over the factory was left in ruins.



The year 1945 meant a new stage in its history. In the course of reconstruction the Györ works were not only restored but also enlarged and modernized. Changing over to planned economy, the previous manufacturing program, divided into many branches, was restricted and this ensured the vigorous development of up-to-date wagon-building, which remained



unaltered the main manufacturing branch, based on rich experiences and valuable traditions.

One of the principal customers of late years was the Soviet Union, where the works have been delivering considerable quantities of railway rolling stock, suitable for long distance traffic. For Egypt passenger cars and postal vans of tropical design, with special insulation, were delivered in great numbers.

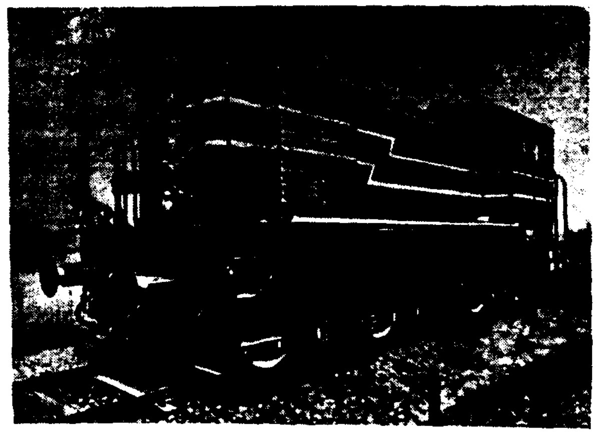
The International Sleeping Car Society (Wagons Lits) has been one of the constant customers of the works and the dining and sleeping cars delivered there won many praises for the factory.

Keeping up with technical progress the governing idea has been to provide for the highest comfort of passengers on one hand, and to increase the speed of railway vehicles, on the other hand. The Hungarian Railway Carriage and Machine Works, recognizing the importance of these tasks have done their best to ensure that customers' requirements can be adhered to in every way and to this end have designed light-weight passenger cars of many types, where trouble-free running is warranted and the most comfortable accommodation provided for. In the new types tare weight is radically reduced by the use of special steels and light-metals of great solidity for the building of running gear and body frame. Several new methods were initiated in the construction of different components; plastic is applied on an always larger scale in the inner panelling of the coaches and the passenger space is extended by resourceful interior arrangement.

At the new types of bogies, construction and springing had to be such as to spare the track even at a maximum speed of 160 km/h and to ensure trouble-free and smooth running in addition to the comfort of the passengers.

Increasingly exacting demands manifest themselves remarkably regarding the precision required in the qualification of the running features. With a view to base these qualifications on correct measurements carried out with precision instruments, the Hungarian Railway Carriage and Machine Works have designed a special measuring equipment built into a universal measuring car, which serves to testing during operation. The universal measuring car is an invaluable standby for the measuring of the output (speed, acceleration, traction, braking, various oscillations, swingings, etc.) of railway carriages and locomotives, i. e. for the simultaneous recording of different particulars.

The eight-wheel bogie measuring car is provided with a 14-channel electronic measuring equipment, controlled from a control-desk in the measuring room, and a dark room provides for the immediate evaluation of the testing results. The power supply of the whole equipment is secured by a separate generating set and, consequently, the measuring car can be coupled to any train, measuring the running features of the respective locomotive or carriage under way. For the staff of the measuring car full comfort is



600 HP. Diesel Electric locomotive for shunting and light track service. Max. speed 50 miles per hour. For the Czechoslovak and Chinese State Railways.

ensured even for a long distance by 3 sleeping compartments with berths, shower room, lavatory, kitchen and a comfortably furnished parlour.

The universal measuring car facilitates essentially the performance of tests and examinations which up to now have been lengthy and circumstancial or could not be carried out at all. Its application means considerable savings by reducing the time necessary for experiments with new constructions and the time of development. This design contributes greatly to the progress of railway vehicles as a security that the carriages given over to transport service by the Hungarian Railway Carriage and Machine Works on the basis of exact measurings, will satisfy requirements in every respect.

Achievements are to be especially accentuated as to the perfection of sound and heat insulation, heating system suitable for the most severe climate, ventilation system proving satisfactory even under tropical conditions, various types of comfortable seats, up-to-date lighting equipments and tasteful arrangement of the passenger space.

The latest novelty in the scope of ensuring the greatest possible comfort, is the application of a modern, trouble-free air-conditioning equipment, which, independently from exterior temperature secures the permanent regulation of interior temperature and vapour contents.

Besides standard open and covered wagons of normal, broad and small-gauge, great quantities of special wagons were supplied for inland use and for export, such as wagons for the transport of poultry, cattle and pigs, refrigerating cars, fruit-transporting wagons, four and eight-wheel tank wagons for spirits, petroleum, wine, sulphuric acid, etc , ore-wagons and sand dump-cars, special transformer cars, metallurgical cars, i. e. hot-metal ladles and slag ladle cars. Customers' requirements can be fully met also in this respect.

The suburban and tramway power-cars and trailers are manufactured in all-metal construction, according to local conditions. Attention has to be drawn to suburban tramways in the most modern execution.

On the basis of the system Ganz-Jendrassik the Hungarian Railway Carriage and Machine Works have developed the manufacture of Diesel engines. Their manufacturing program comprises Diesel engines of 13.5 cm. cylinder bore, with 2 to 12 cylinders and an output of 45–400 HP.

In the interest of economical manufacturing possibilities the main components are interchangeable and can be easily replaced in engines with different numbers of cylinders. The engines are made also in supercharged execution. For the purposes of power cars underfloor engines of 6 and 12 cylinders are used beside the " V " engines of 6 in-line cylinders and 12 cylinders. The engines, depending on their way of application are made with reversing gear / for ship engines / or with remote-control to electrical plants etc.

To the products of the Hungarian Railway Carriage and Machine Works belongs the 130 HP Diesel Shunting Locomotive for light shunting service. It can be supplied—according to specific requirements—with mechanical or hydraulic power transmission, with 4-stage speed gear, 1435 mm. gauge, 19.5 t weight. This type is manufactured also in another alternative for small gauge with the same output.

For many years the works have been leading manufacturers of bridge, steel constructions, portal-, railway steam- and diesel cranes, special tanks, lever constructions. Export-deliveries of these articles have had an equal share in obtaining well-deserved fame. One of the recent supplies has been the Helwan bridge, the longest one across the Nile.

The Hungarian Railway Carriage and Machine Works with their fine tradition and vast experience have taken particular care to maintain the outstanding reputation for quality and service which has been so long established, winning the confidence and appreciation of their customers throughout the world.

"YL" Class Steam Locomotive Type 2-6-2 with Tender Built for the Indian Railways

THE MAVAG Company (the former Hungarian State Iron, Steel & Machine Works) dating back her activity as far as the seventies of the last century has been supplier of locomotive boilers, steam cylinders, motion gears, wheels & axles, locomotive rigging, etc. to the Indian Railways as early as before the World War No. 2

More recently 40 " YL " Class steam locomotives were delivered for the Indian Railways in 1957.

Characteristic data and main particulars of these locomotives are as follows :

1000 mm. gauge, " YL " Class, 2—6—2 wheel arrangement, with tender. This latter is equipped with two " YTA " Class bogies of 2 axles each.

Boiler: coal-fired, riveted construction, with steel firebox and steel staybolts. The boiler is fitted with superheater, and thermal expansion is allowed for by using hinged aft boiler support. Between the throat plate and the outer firebox back plate 2 arch tubes of 3" dia. extend over the firebox.

Fire hazard is virtually eliminated even under hot climatic conditions prevailing through use of ashpan and spark arrester of appropriate design. The boiler is fed by 2 live steam injectors. The main frame is fabricated plate construction. The frame joints are steel castings secured—similarly to other loose joints —by cold-chipped rivets fitted. Brake hangers on the frame, compensating beam brackets and spring hanger carriers as well as steam cylinders are fastened by bolts of close fit.

Axleloads are balanced by compensating beams also with the trucks.

Pony truck and hind truck are designed with Bissel-system self-aligning side control springs. In front on the locomotive cattle guard is arranged.

The 4th wheel is the driven one. The tyres are made of tough manganese-steel of high hardness. Inner hub faces of driving and coupled wheel centres bearing with the axlebox guides are lined with manganese-steel plates. Driving and coupled axlebox bodies are steel castings with bronze bushes pressed in. Axlebox guides on the axlebox body and frame receive manganese-steel slide plates welded on. Lubrication of the driving axleboxes is accomplished by hard grease bricks.

Wheels of pony truck and hind truck as well as those of the tender are fitted with cylindrical roller bearings. Above the axleboxes both with the locomotive and the tender laminated springs are arranged.

The steam cylinder is of cast iron with renewable liners for the same and for the piston valve.

The steam cylinder is equipped with automatic idling gear, safety valves as well as valve type blow-off device.

No front guide is provided for the piston rod. The crosshead is overhead controlled. Lubrication of the steam cylinder is effected by lubricator through inlet pipe.

The connecting and coupling rods have solid eyes with floating bushes, and are grease lubricated. Against the rod bush faces bronze ring inserts are fitted to the wheel centres.

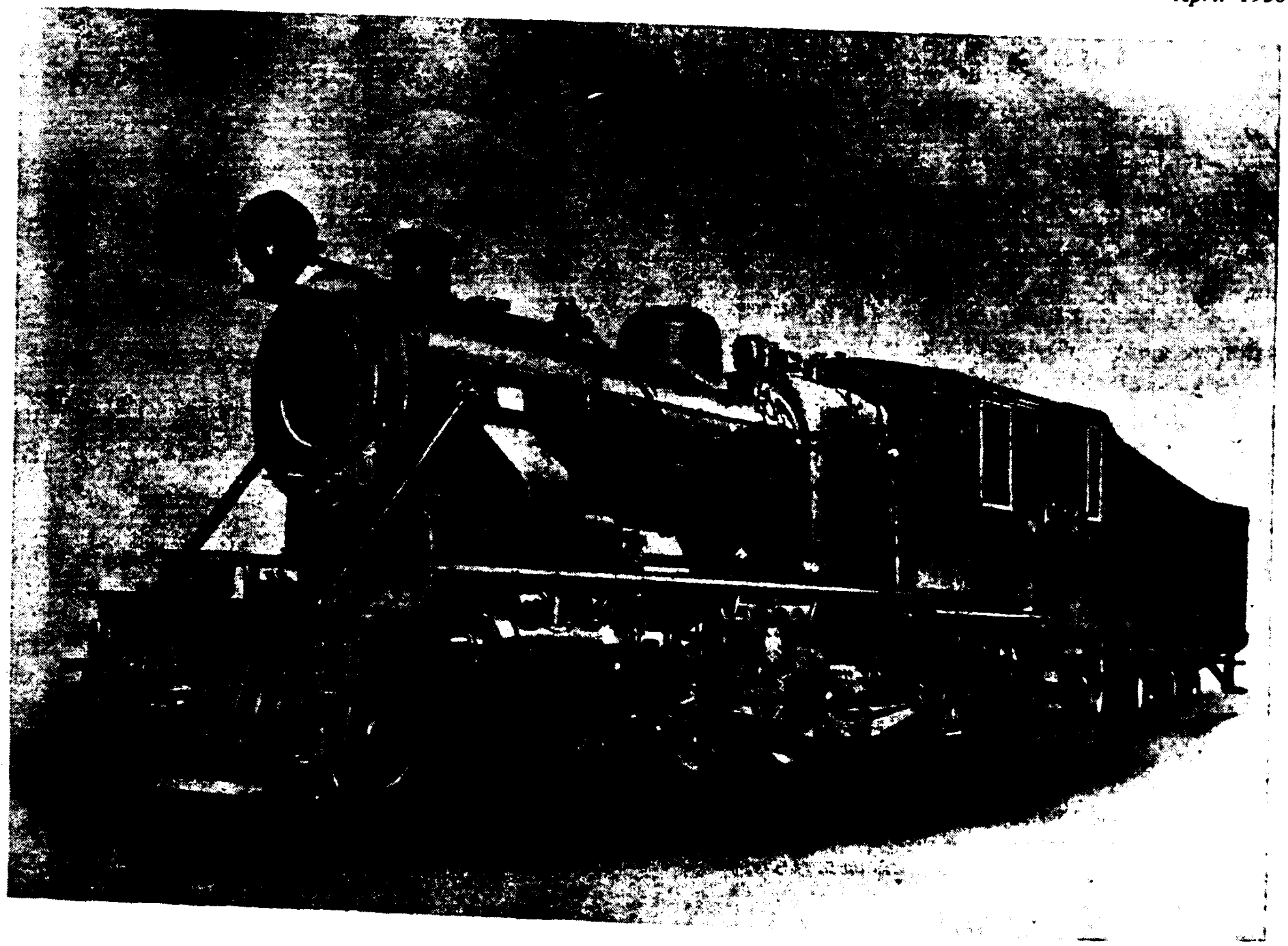
Walschaert's motion is used with piston valve. The eccentric rod big end runs relative to the return crank in roller bearing. Bushed pins of motions rods are case-hardened. Steam stand in cab may be operated by hand wheel through screw spindle.

The loco. is equipped with vacuum brake gear operating through steam ejector. The tender may be braked either by means of the vacuum brake or by applying a hand brake. Belonging to the brake gear a sanding gear is arranged operated by air.

The cab is open only in the rear, towards the tender coal space. Through the door on cab L. H. front wall one may get to the side footplate running all around the locomotive.

Lighting of the locomotive and of the tender is effected by electric current supplied by a turbodynamo.

For drawing purposes buffing and drawgear with automatic couplers are fitted to the locomotive and tender.



Lifting the locomotive and tender may be accomplished by lifting eyes of permanent type.

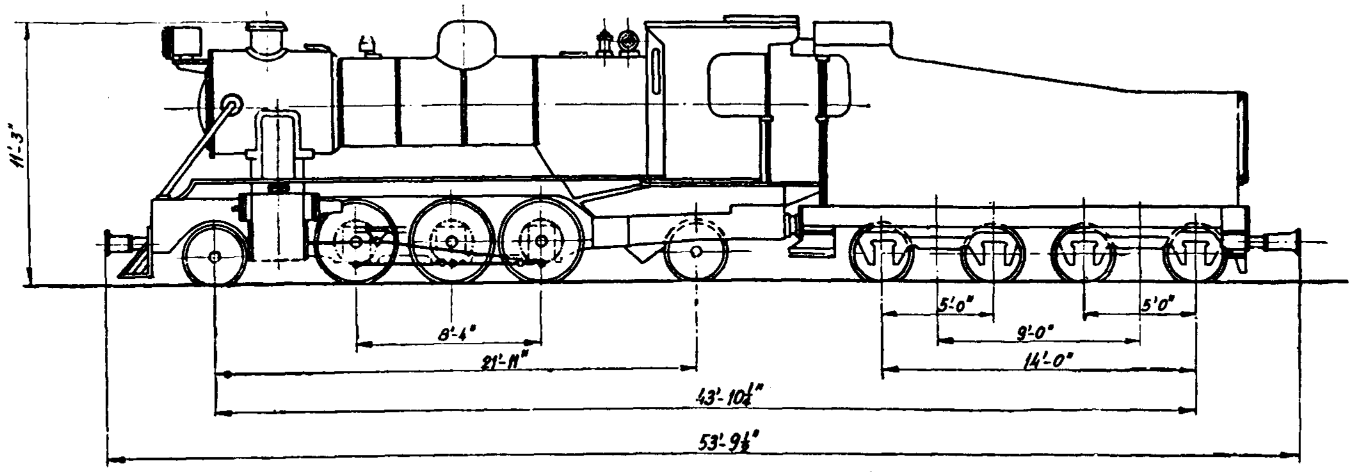
These locomotives as described above were transported from Budapest to Jugoslavia's seaport, Rijeka, dismantled, in 3 railway cars each. Final assembly of the same took place in Rijeka, and then they were forwarded by sea up to Bombay Port in India.

PRINCIPAL DATA

Locomotive

Gauge	1000 mm
Cylinder diameter	12¼ mm
Piston stroke	22 mm
Coupled wheel diameter	43 mm
Running wheel diameter	28¼ mm
Coupled wheel base	100 mm
Total wheelbase	263 mm
Boiler pressure	210 lbs/sq. in

Tubes Nos.	O/S DIA /11 SWG/	42×2"
Flues „	O/S DIA /8 SWG/	13×5¼"
Arch tubes Nos.	O/S DIA /7 SWG/	2×3"
Superheater elements A type Nos.	O/S DIA /9 SWG/	13×1⅜"
Heating Surface		
Tubes, sq ft.		256
Flues, sq. ft.		179
Arch tubes, sq. ft.		8.6
Firebox „ „		78.3
Evaporating, total, sq. ft.		521.9
Superheater „ „		130
Total Heating Surface „ „		651.9
Grate area „ „		17.75
Tractive force @ 85% boiler pressure, lbs.		13.700
Ratio Adhesion to Tractive Force		3.9179
Weight empty		36.7 tons
„ in working order		39 „



Axleload	8.0 „
Overall width	102 „
Overall height	135 „
Maximum speed	65 km/hr

Tender

Wheel diameter	28½"
Overall wheelbase	168"
Water capacity	3000 gallon
Weight empty	16.4 tons
„ in working order	34.0 „

MAVAG strongly hopes that the Indian State Railways will be entirely satisfied with the locomotives delivered by them and soon they will be able to regard the said Railway Company as one of their buyers of diesel hydraulic or diesel electric locomotives too.

U. K. Steel Company Completes Developments

One of Britain's biggest steel producers, Dorman Long and Company, have just completed their £ 60,000,000 post-war expansion programme.

The last stage was the building of a mill at Lackenby, Yorkshire. It cost £ 18,500,000.

Although commercial output does not begin until July, the mill has already turned out the heaviest steel beam to be rolled in Europe. It weighed 20 tons.

When it is working at full capacity, the plant will be able to produce 400,000 tons of universal beams annually.

The mill's mechanical equipment alone cost well over £ 11,000,000, while its electrical equipment added £ 3,000,000 to the bill. Building and civil engineering work took £ 4,000,000.

Nearly £ 2,000,000 was paid out in dollars in order to bring in mechanical equipment from the United States.

* * *

BRITISH OUTPUT

The output of steel in Britain during March worked out at an average of 432,300 tons a week.

This compares with 427,500 tons in February and 431,000 tons in March last year.

But there was a reduction in the case of the first quarter, with output of steel ingots and castings amounting to 5,475,000 tons this year, against 5,532,000 tons in January-March, 1957.

March output of pig-iron averaged 267,600 tons a week, against 272,700 tons in February and 277,200 tons last March.

This brought the total for the opening three months to 3,516,000 tons, against 3.464,000 tons last year.

The Advantages of Punched Card Accounting Machines in Workshops

By S. Francis

Technical Adviser, Powers-Samas Accounting Machines (Sales) Ltd., Bombay.

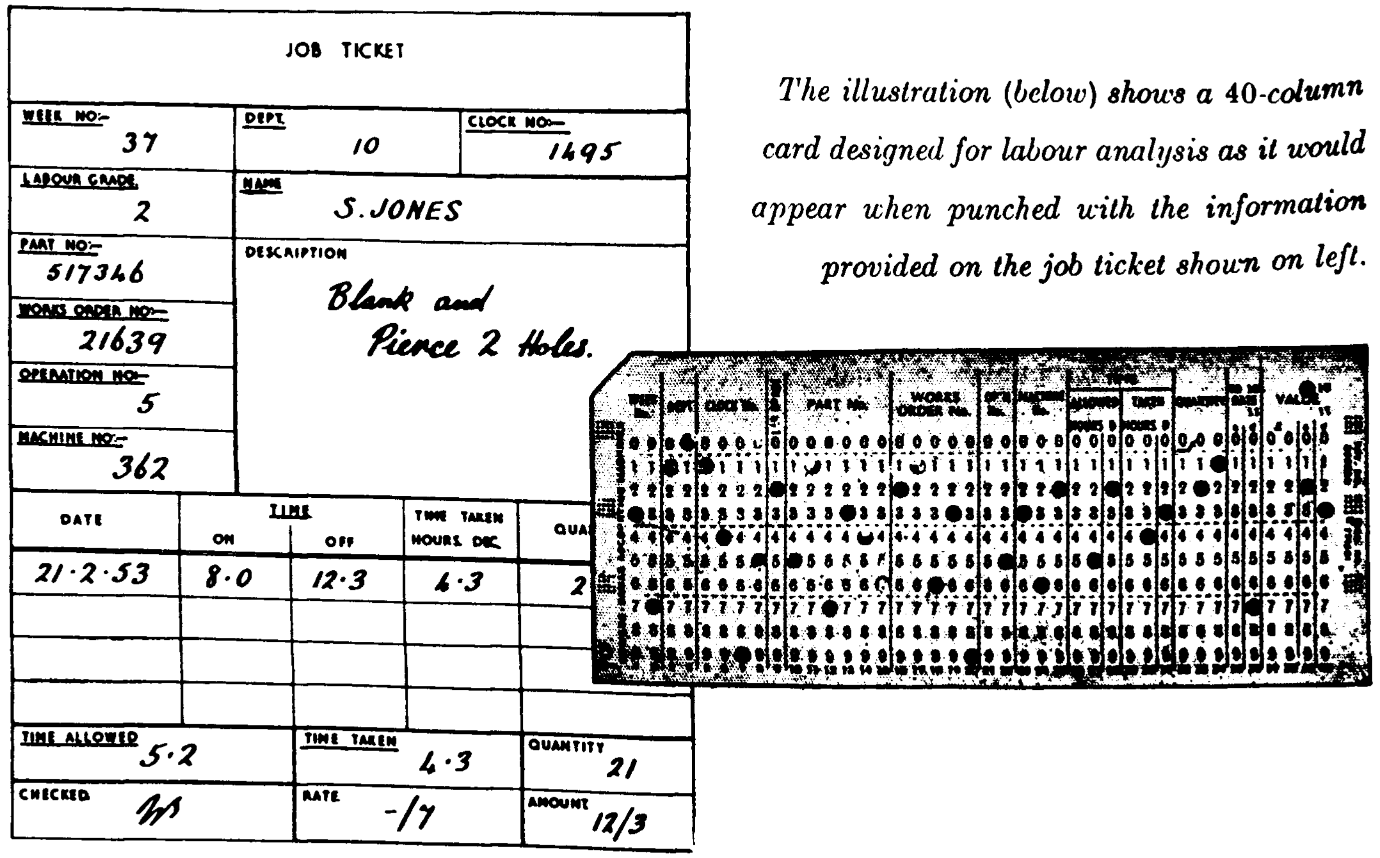
UNTIL recently it was the practice that emphasis in Workshops was laid almost exclusively on the manufacturing and/or repair aspects of the industry, and as it was impossible to extract the necessary information without superhuman efforts, relatively little attention was paid to the study of labour and material costs and to the planning of the most economic production schedules based on the results of this study.

Along with the rapid growth of industry, however, and the consequent necessity of streamlining other processes to keep pace with output, it is fortunate that techniques have also been developed to bring these aspects of workshop organisation within the realms of practicability, and it is in these, and other, connections that the punched card method has now come to be universally acknowledged as the most speedy, accurate, efficient and economical system for obtaining the required results.

In the punched card system, there is created for each accounting transaction, or element of cost, a physical entity, in the form of a punched card record. These punched cards can be "handled" by machines, which by "sensing" the perforations in the cards are able to group the records and to transmit the information they contain on to normal accounting forms in ordinary typewritten characters, automatically providing totals and balances, as required, at a very high speed.

It would be impossible to describe, in an article of this type, the wide range of machines that are available for performing a variety of functions, but the fundamental steps of the system are :—

The illustration (below) shows a 40-column card designed for labour analysis as it would appear when punched with the information provided on the job ticket shown on left.



1. Creating accurate records by punching holes into the cards and verifying their accuracy.
2. Arranging and grouping the cards in the required sequence by sorting them by machine at high speed, and
3. Printing the required results on appropriate stationery by tabulating the cards at machine speeds varying from 80 to 300 lines of print per minute.

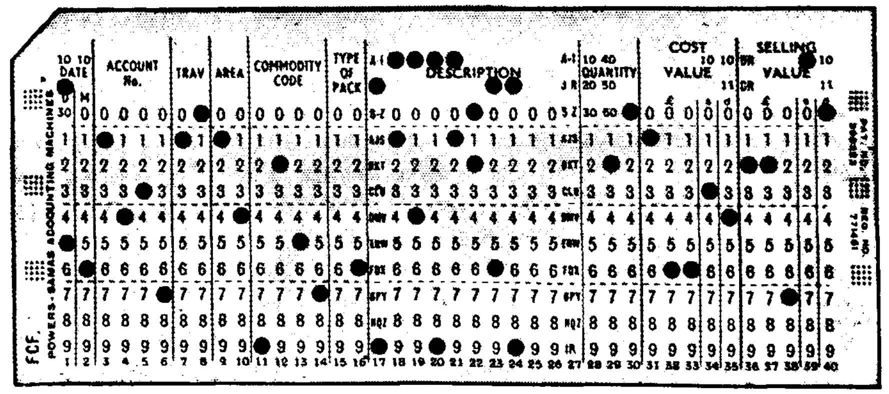
The cards referred to above would form the medium through which the system operates, so a brief description of 'Card Design' would not be out of place. Each card contains a given number of "columns" each having ten standard punching positions 0 to 9. The columns are numbered from 1 upwards starting from the left hand edge of the card, and the recording capacity of the card depends on the number of columns it contains, as each column usually represents one digit or letter of information. To design a card for a particular type of work it is necessary to arrange the columns into groups or "fields" each representing a specific item of information and containing as many columns as there are digits or letters to be recorded.

It will thus be observed that punched card methods have inherent advantages over other procedures leading to speed, accuracy and economy in their application. Whereas in manually posted work, an entry can only serve the single purpose for which it is made, punched card records are mobile entries capable of being automatically arranged in any desired order and inserted into all the procedures requiring the information they contain. Also, as the punched, and fully verified, card remains the unchanging medium for recording the entry on all these occasions, no transposition or error can take place between the entry as recorded on one document, and the corresponding entry appearing on another.

The cards are processed by machines capable of classifying, calculating and tabulating the information punched in the cards, and it is the mobility of the cards combined with the facility of rapid classification and tabulation that makes the system an invaluable one in a modern organisation.

one basic medium
the punched card

one system
punch, sort, tabulate



FROM THE STORES ANGLE

In a large workshop, the question of ordering, manufacturing and stocking apposite quantities of the requisite materials poses a big problem, and though this can be tackled to a certain extent by the painstaking manual maintenance of Bin and Stock Ledger cards, it nevertheless requires a watchful eye in a large stores to avoid the occurrence of shortages, the effects of sudden 'runs' on a particular item, the consequences of delayed deliveries, and over-ordering through lack of the necessary data.

On the other hand, these objectives can very easily be achieved by an installation of Punched Card Accounting Machines, which, in addition to these aspects of Stores Control, can use the same punched cards for obtaining the details of the material cost of any workshop job, or branch of activity.

In the Punched Card System relative to Material Stores, cards are punched with the date, material code, maximum and minimum stock levels required, quantity and value, of every item of stock at the end of a certain period, there being one card for each item of stock. These cards which we shall refer to as Balance cards are filed, and can be tabulated at any time to provide the Stock Position and the Stores Valuation at the particular date in question.

For every item ordered and eventually received into stock, Receipt cards would be progressively punched with the Material Code, Quantity and Value, and such other information as Supplier Number, Date of Order and Date of Despatch. By means of successive sortings into various sequences, these same cards can then be tabulated at any desired time to provide the Schedule of Receipts for any given period, statement of monies due to each Supplier and Schedules of Items to be delivered to stores in date sequence, or by type of material.

For every issue from Stores, which would be in respect of a particular job, cards would be punched with the Department Number, Bin Number, Job Number, Material Code, Quantity, Value and any other information required for subsequent analyses.

From these cards important Costing information can be extracted by sorting them to Job Number Order and tabulating them so that the value of materials spent on each job may be ascertained or the cards may be alternatively sorted to Department Order and tabulated to obtain the cost of materials used by each department. Also, by arranging the cards in Bin Number sequence, a schedule of issues of each item over any given period may be obtained, so that a running physical check of all stores movements can be effected to ensure that documentation does mirror the true material resources of the stores.

At any given period, all the cards referred to in the preceding paragraphs, could be sorted to Material Code Order, and a tabulated statement obtained in which the following information could be obtained in respect of each item of stock :—

a. Opening Balance
b. Total Receipts
c. Orders Outstanding
d. Maximum and Minimum Stock Levels
e. Whether the stock is above or below the minimum level, and if below how much should be ordered.
f. Whether, when taking into consideration the Orders already outstanding, the level is maintained or is still below the minimum level.
g. Closing Balance.

The tabulations would also pinpoint non-moving items of stock, or could be designed to deal with moving items of stock only, thus greatly reducing the amount of time devoted by the storekeeper to the examination of Stock Record sheets which are of no immediate importance.

Thus it will be observed from the foregoing that from the once-and-for-all recording of Balance, Receipt and Issue cards not only are many aspects of the Storekeeper's work made more readily attainable, and in certain aspects, are brought into the realms of practicability for the first time, but also from the same recording of information in the cards a considerable number of additional aims are achieved, and this is done without any extra manual work but entirely by the largely automatic working of machines.

FROM THE LABOUR COSTING ANGLE

In like manner to the cards punched for the Material Costing and Stock Tabulations, labour cards could be punched with the Ticket Number of the man, the number of the Job he is working on, the Time taken, his Hourly Rate of Pay, the Labour Cost, and any other information that may be required to be extracted from the cards at a later date. At any given period, these cards could be sorted on Job Number and the labour cost expended on each job could be tabulated. For jobs of a routine nature the time taken by different workers for the same job could be compared to establish standards. The labour cards could be sorted to department order and tabulated to provide the labour hours utilised for each category of labour and this could be compared with the labour hours available to ascertain the idle time, and to more correctly assess what the strength of the department should be to provide efficient work with the least amount of idle time.

Thus it is possible, soon after completion of a job, by using the labour cards and the Stores Issue cards mentioned above, to produce the complete job costs for costing purposes, and the rapid production of such figures entails obvious attendant advantages to the successful operation of the workshop, and indeed ensures that the management will be armed, in the shortest possible time, with all the facts upon which the profitable planning of production can be based.

Likewise, it will be appreciated that in punching the above labour cost cards with information relative to the labour cost ingredients for each job, cards have at the same time been created which can be used for Payroll purposes, in conjunction with other cards representing the various Allowances and Deductions applicable to each member of the Workshop Staff. By sorting the Labour Cost cards, the Allowance cards, and Deduction cards on Ticket Number, the combined pack of cards can then be

passed through the Tabulator to produce instantaneously, at machine speed the Workshop Payroll in Ticket Number sequence and the Pay Advices for each member of the staff.

In this connection, it would also be noticed that if the labour cost cards contain punched information relative to Hourly Rate and Number of Hours, various extremely fast machine methods exist whereby these calculations can be performed by processing the punched cards and the results can be punched automatically into another 'field' of the cards concerned.

Also, the above cards which produce the Payroll and Pay Advices can be utilised for the posting of Pay Ledgers for every member of the staff, and this, again, would be achieved without any further manual working, but from the information punched once-and-for-all in the various labour cards.

Thus, on the labour side of costs too, we see that from the one initial recording of the information relating to each entry, the entry is then made mobile by the machines to produce a proliferation of accounting records and documents.

PRODUCTION CONTROL

Another important function, in a workshop where Punched Card Methods are gaining increasing recognition is Production Control. As the Chief Designer establishes the nature of the product and the Production Engineer establishes the method of manufacture, so the Production Controller ensures the completion of the product in the appropriate quantity and at the desired or scheduled time. With a properly planned and administered Production Control optimum use can be made of available capacities which is of tremendous advantage to an expanding organisation. In the case of non-expanding organisations, productivity at a reduced cost, by careful adjustment and reloading of capacities, can be achieved.

A Punched Card application to Production Control, or for that matter to any other aspect of work, could vary from factory to factory, but a general scheme of Production Control will be discussed here.

A final product is broken down into its various components, and a card is punched for each component giving the Product Code, the Component Code, Time Planned, Quantity etc. These requirements may be separated to requirements of Main Assemblies, Sub-Assemblies, Piece Parts and Raw Materials. These cards are all field in Product Order.

When an order for a certain product is received, the particular batch of cards comprising that Product is picked out from the file and the set is reproduced into as many sets of cards as the quantity of the product to be ordered.

These cards are then tabulated, and the material required for each stage is ascertained. This tabulation can go to the Stores Department as a Stores requisition.

The load on each machine is then ascertained by tabulating the cards and obtaining the total hours required for an operation on each of the machines involved. The existing load on the machines is considered and a new programme drawn up including the load for the new products to be ordered. In this manner it is thus possible to forecast not only deliveries of machines on order, but what the likely delivery period would be for new machines.

In this article, the application of some aspects of work in a Workshop has been described, but as punched cards, being extremely flexible by their very nature, can be designed to suit the characteristics of almost any organisation we have here only dealt with a general picture of the use of punched card methods in the setting of a Workshop organisation.

It should however be manifest that the punched card approach affords a speedier and less arduous outturn of accounting records, an assured and high standard of accuracy, and the opening of new vistas of information to the Workshop Cost Accountant and Storekeeper.

Canadian-British Aluminium Co.

A new Company—Phillips C. B. A. Conductors—has been formed jointly by Phillips Electrical and Canadian-British Aluminium ; it is planned to erect a plant at Brockville, Ont., which will be managed by Phillips. The plant will produce aluminium rod, wire and cable.

DRAFT GEARS

By D. S. Campbell

Chief Engineer, Cardwell Westinghouse Co., Chicago, Illinois, U.S.A.

THE subject, "Draft Gears," has been an important one for many years, the first draft gears being small springs, which were satisfactory until the use of air brakes was resorted to by necessity of controlling longer and heavier trains. As the weights of rolling stocks and length and speed of trains were increased, spring draft gears were found inadequate, and the use of friction was necessary to eliminate damaging stresses to cars and shocks to ladings.

It was found impractical to increase the capacity of the spring draft gear so as to have sufficient closing capacity, as this would result in entirely too much recoil. A spring will kick back or recoil with practically the same force as applied to it.

In order to have a device which would offer a high capacity in closing together with a kick-back or recoil which would be low enough so as to allow smooth air brake applications, the friction draft gear was developed. The specifications for friction draft gears were at one time quite indefinite which led to inconsistency in draft gear performance, so the Association of American Railroads Draft Gear Committee set out to develop a draft gear specification. Considerable time and expense have been put into our present-day specifications.

The friction draft gear of today is a highly developed mechanism. The best draft gears today have extensive laboratory development as far as possible, then are watched in service performance for years for actual results, with designs changed for betterment, taking advantage of all technological improvements in material.

The purpose of a draft gear is to cushion, absorb, and distribute the force between colliding cars or equalize the speed of moving cars in coupled or uncoupled conditions. The draft gear travel multiplied by its average resistance is the capacity of the gear which is rated in foot pounds. The foot pounds capacity can also be measured by a drop hammer. The capacity determines the volume of a shock which can be imposed at the coupling without going into oversolid blows. The resistance offered by the draft gear at the coupling is the force applied to the car at the coupling. If sufficient shock is applied and the capacity of the draft gear is exceeded, the travel is then limited to the spring of the underframe with a rapid rise in resistance or sill pressure, which of course will cause failure if carried beyond the strength of the attachments or underframe.

There are three ways of cushioning and absorbing the energy of shocks in the operation of freight cars. First, the draft gears; second, the car structure, and third, the lading and car structure working together. There is no doubt that the draft gear itself is the economical way to do it, and if you are going to depend on the draft gear and not on the car structure or its lading, you are faced with the necessity of using modern draft gears and draft gear attachments in fairly good condition. It is considerably more economical to have the draft gears in good condition than it is to make unnecessary repairs to the car structure and to pay damage claims. Draft gear manufacturers have continually improved the materials used in their construction so as to reduce draft gear maintenance costs. There are many thousands of friction draft gears in extensive service today which have required no maintenance costs and will offer maximum car protection for many more years.

If forces high enough to cause failure in the underframe or car structure are reached by impacts above the draft gear's capacity, damage claims will follow. These forces are obtained and cannot be eliminated in ordinary operations and switching speeds if low capacity draft gears are used. At the same time, extremely low switching and operating speeds are not practical and of course result in higher operating costs.

Instructions as to maximum switching speeds can be

issued, but satisfactory results are not always forthcoming. Cars with a modern draft gear in good condition can be handled up to approximately 5 miles per hour impact without damage to car or lading, while cars with low capacity, worn and obsolete draft gears, would develop more damage when handled at an impact speed of 2 miles per hour.

Tests made show that high shocks are developed in rough brake application operations incidental to running out and in slack as well as those developed in switching. Slack in train lines is at a minimum when draft gear and attachments are in good condition, the only slack in the train line is in the couplers. Forces developed by the aid of this slack can be taken care of with safety by the draft gears.

Brake equipment on a car is used to develop resistance and absorb energy of a moving car, that is, to check the speed, or stop a car, it is necessary to maintain brake equipment to promote safety and prevent damage to cars, lading, and property. The work required to stop a car from 5 miles per hour is the same whether it is done by a draft gear or by the brake shoes. If the car is stopped by the brake shoes, many feet are required. If stopped by the draft gears, a few inches travel of the draft gears must handle the same amount of work.

No brake action can be had without imposing work on the draft gears, while work may be imposed on the draft gears without using the brakes, such as starting of trains, equalizing speeds of cars, switching, etc. It is then very reasonable to assume that a large saving can be made by the use of a high-capacity draft gear, and that the draft gear has a difficult function to perform. Modern friction draft gears show a low rate of wear in the draft gear itself which is no longer a major problem.

The above remarks are confined to railway cars equipped with automatic coupling, however in countries where hook and link coupling is used, friction buffers on the corners of the cars and friction draft gear designed for use with the screw or hook type coupling are available and offer the same type of protection to the equipment and the lading as does the friction draft gear applied with automatic coupling.

Some means of absorbing and dissipating the energy created by the force of colliding cars and to equalize the speed of moving cars is a necessity on all railway equipment, and a device employing friction will do that economically and will do it well.

World Steel Output Reaches 322 Million Tons

World steel production during 1957 was a record 322 million net tons, a 11 million ton increase over the prior record (311 million net tons) set in 1956, according to an average of estimates by two business magazines in the U.S.

Together, the free world countries increased their steel output by 7.3 million net tons to a total of nearly 243 million tons. During the same period, the communist countries increased their production by 3.4 million tons to a total of 79.2 million net tons.

The United States, largest steelmaking nation in the world since 1890, retained its leadership and produced about 35 per cent of the world's total. In the order of tonnage produced, the next largest steelmaking countries during 1957 were: Russia (nearly 56.3 million net tons); West Germany (26.8 million net tons); United Kingdom (nearly 24.3 million net tons); France (nearly 15.4 million net tons); and Japan (14.8 million net tons)

The seven steel producers in the European Coal and Steel Community together had a total output of 65.5 million tons, compared with 62.8 million tons during 1956.

* * *

GOVT. PLANTS TO PRODUCE IRON BY 1959

An optimistic picture about the production and supply of steel and pig iron in the country was given to the Lok Sabha by India's Minister for Steel, Mines and Fuel, Mr. Swaran Singh.

The Minister told the House that 1959 would see production along with construction. "In fact, considerable quantities of pig iron will be produced and we shall be exporting some."

A.E.I. Equipment for first 3000 volt D.C. Railway Electrification in India

By R. Subramanian, B. Sc. (Hons.) D. I. I. Sc.
Associated Electrical Industries (India) Private Ltd.

THE electrification of the Howrah-Burdwan Main Line of the Eastern Railway has the distinction of being the first 3000 volt D. C. Electrification on the Indian Railways. Associated Electrical Industries (India) Private Ltd. are proud of their contribution to this important suburban electrification, which is calculated to bring much-needed facilities to Calcutta's travelling public after a century of steam locomotion. Their role in this scheme includes the supply and erection of substation and track cabin equipment, electric traction equipment for the multiple unit stock and electric signalling equipment. All the equipments incorporate the accumulated experience, aggregating over a century, of the A. E. I. Group of Companies in the design and manufacture of all classes of electrical plant for use all over the world.

The 66-mile Howrah-Burdwan Main Line is equipped with 6 rectifier substations and 3 track cabins, the entire equipment for which, with the exception of the outdoor 33000 volt A. C. Switchgear, has been supplied by A. E. I. This large installation uses pumpless steel tank air-cooled rectifiers which have now become well-established for traction service.

The installed capacities and other basic details of these stations are as follows :—

Station	*Installed Capacity*	*No. of Outgoing Feeders*
Belur Substation	3–2500 KW units	10
Sheoraphuli ,,	3–2500 KW units	7
Bandel ,,	2–3000 KW units	6
Pundooah ,,	1–3000 KW unit	4
Memari ,,	1–3000 KW unit	4
Gangpur ,,	2–2500 KW units	8
Howrah Track Cabin	—	11
Konnagar ,,	—	6
Burdwan ,,	—	4

The Substations receive power from the Damodar Valley Corporation system, over the Eastern Railway's transmission lines, at 33000 volts, 3 phase, 50 cycles A.C. It is then transformed and rectified to 3000 volt D. C. by the transformers and rectifiers in the substations. The outgoing D. C. supply to the overhead equipment on the tracks is controlled by 3000 volt D. C. high speed circuit breakers. At the track cabins, similar high speed circuit breakers are provided to sectionalise and parallel the overhead equipments of the various tracks.

The rectifier transformer is of the outdoor, oil-immersed naturally-cooled type and weighs approximately 34 tons. The 33000 volt primary is connected in star, while the 3000 volt secondary is a 12-phase quadruple zig-zag winding. The transformer tank also houses a tertiary winding to provide a 400-volt 3-phase A. C. supply for the rectifier auxiliaries, a no-load voltage rise suppression unit and special current transformers for protection of the rectifier against back-fire.

Each rectifier unit consists of two pumpless, steel tank, air-cooled, six-anode mercury arc rectifiers. The tanks are mounted on withdrawable trucks on wheels, and are housed in steel cubicles. Underneath each tank, and forming part of the truck, is mounted a motor-driven fan to cool the tank. The rectifier cubicle also houses the ignition and excitation unit, grid control apparatus and other auxiliaries for the rectifier. The complete rectifier unit occupies a floor space of only 8 ft. × 5 ft. 6 ins., which has been possible due to the use of a most compact design of rectifier tank so far developed for Railway service.

The rectifier tanks are provided with grids, which are used for arc suppression in the event of a back-fire. Voltage control on the rectifiers is by means of off-load tap-changing switches on the rectifier transformers.

Adjacent to the rectifier cubicles, and forming a continuous panel with them, are the two cubicles which house the control and protective gear for the rectifier and its associated oil circuit breaker. In these cubicles are contained various instruments to measure the voltage, current and power being supplied by the rectifier, switches to start and stop the rectifier, indicating lamps and protective relays.

All the 3000 volt D. C. circuit breakers are of the high speed type, working on the " rate of rise of current " principle, which enables discrimination between overloads and short-circuits. The breakers are mounted on trucks on wheels, which are housed in concrete cells. Shutter mechanisms, with padlocking arrangements, are provided which ensure perfect safety for personnel working inside the cells with the breakers racked out. The rectifier breakers are rated at 1600 amps. and are set to trip on a reverse current of 500 amps. The feeder breakers are rated at 1000 amps. and can be set to trip on forward currents in the range of 1500 to 2500 amps.

The operation of the entire equipment is automatic, and can be controlled either from the control board in the substation or from the supervisory remote control board in Howrah. Operation of one switch will in succession, close the 33000 volt A. C. oil circuit breaker, start the rectifier fans, put on the ignition and excitation circuits in the rectifiers and close the 3000 volt D. C. rectifiers high speed circuit breaker. Protective devices ensure that the set is shut down and re-started (for a pre-determined number of time) in the event of any type of fault or incomplete sequence.

A noteworthy feature in the equipment is the comprehensive scheme of interlocking provided. Before access to the rectifier equipment could be obtained, a series of operations in a definite sequence have to be done; this is aimed at isolating the A. C. and D. C. sides of the equipment and earthing all live parts; conversely, these operations in the reverse sequence must be performed before the equipment could be energised.

Other items of equipment inside the substation are an L. T. A. C./D. C. board, which provides power at 400 volt 3-phase A. C., 110 volt single phase A. C. and 110 volt D. C. for the control circuits and auxiliary services, a negative recording cubicle to record the current drawn from the substation and to provide protection against an excessive rise in voltage of the rails above earth, a lead-acid station battery and a charging equipment.

The entire equipment, with the exception of the batteries and charging equipments which have been supplied by two well-known battery makers, has been designed and manufactured by the British Thomson-Houston Co. Ltd. of England, a member of the A. E. I. Group of Companies. A portion of the 3000 volt D. C. switchgear has also been manufactured in India by Associated Electrical Industries Manufacturing Co. Ltd., to BTH designs.

Associated Electrical Industries (India) Private Ltd. have also on order the complete traction equipments for 36 motor coaches and 68 trailer coaches to operate on the Howrah-Burdwan Main Line. These equipments, which will be installed on coaches built by Jessop & Co. Ltd., are being designed and manufactured by Metropolitan-Vickers electrical Co. Ltd. of England, another member of the A. E. I. Group of Companies. The design of the equipment will be generally similar to the 450 sets of 3000 volt D. C. motor coach equipments successfully manufactured by Metropolitan-Vickers for railways in South Africa, Brazil and Poland.

Each 3-car train will comprise one motor coach and two driving trailer coaches, the motor coach being in the middle. The train will be powered by 4—210 H. P. traction motors, mounted in the motor coach. The motors will be of self-ventilated, axle-hung, nose-suspended type, driving the wheels through solid gear-wheels. Current at 3000 volts D. C. will be collected from the overhead line by either of two light-weight pantographs and fed to the motors through the standard form of resistance control. The motors will be connected permanently in series—pairs, and the control gear will be of the modern electro-pneumatic unit contactor type. A motor-generator set, mounted on the underframe and driven off the 3000 volt D.C. supply, will provide low tension power at 110 volt D. C. for train lighting and ventilation, operation of the control circuits and of the brakes.

The equipments are designed to permit a maximum speed of 65 m.p.h. on level track with a fully loaded train, and a starting acceleration of 1.2 m.p.h. per second upto 25 m.p.h. Upto three 3-car trains can be coupled together and operated by one driver in the leading cab, which facility will be required during peak hours. Provision is also made to cut out half the motor power and run the train at reduced speed, in the event of a fault in any one motor.

Worthy of particular note is the fact that approximately 15% of the traction equipment is being manufactured in India. The manufacture is being carried out by Associated Electrical Industries Manufacturing Co. Ltd., to the designs of Metropolitan-Vickers. This is the first time when manufacture of traction equipment is being carried out in India, and represents a substantial and welcome saving in foreign exchange.

The electrification of the Howrah-Burdwan Main Line also involves provision of automatic signalling between Howrah and Serampore, and manually controlled colour-light signalling beyond. Well over 350 colour-light signals of the multiunit type, 50 electric point machines, and considerable numbers of junction direction indicators, A. C. and D. C. relays, and other signalling equipment have been supplied by Associated Electrical Industries (India) Private Ltd. These equipments have been designed and manufactured by Metropolitan-Vickers-GRS. Ltd. of England, also a member of the A.E.I. Group of Companies.

British Steel Works Engineer for Durgapur

Mr. P. W. B. Wanklyn, assistant chief mechanical engineer at the Ebbw Vale Foundry in Wales, has been appointed chief engineer of the Indian Steelworks Construction Co. Ltd., at Durgapur, for a period of three years.

Mr. Wanklyn has previous experience in India, where he joined the Indian Standard Wagon Co. at Burnpur near Asansol in 1929. Later he went on to an engineering firm in Calcutta, and returned to the United Kingdom in 1933.

Mr. Wanklyn, it is reported, says of his new assignment that he is interested to return to India and to be associated with an Indian venture which is a co-operative effort, with a consortium of British manufactures being responsible for the construction of the huge new iron and steel works.

* * *

AUTOMATIC BARRIERS AT RAILWAY CROSSINGS

The Railway Testing and Research Centre, Lucknow, has designed a mechanical device which, it is reported, will make it possible for gates at railway crossings to be automatically operated.

At present, the gates at the crossings are opened and closed by keepers appointed for the purpose. With a view to meet the growing need that it is only through automatically worked gates that the duration of detention and consequent inconvenience to road users could be minimised, designs of a barrier which is electrically operated by a train when it is at some distance from the gate, have been completed at the Lucknow Institute. Before being employed extensively, this device, is being further tested for performance.

* * *

BENTONITE CLAY IN INDIA

Occurrences of bentonite clay, so far, have been traced in India at Uttar Beini in Jammu, Hathi-ki-dhani in the Sheo Parganas of Jodhpur, Rajasthan and Tinpahar in the Santal Parganas of Bihar. Minor occurrences are also known at Dargama in Karauli and near Gajner in Bikaner, Rajasthan.

Bentonite is used in metal foundries as an ingredient of moulding sands, in oil drilling for thickening the drilling mud, in Engineering works for stopping leakage and percolation of water, in laundries and in ceramic industry. It is also used in refining of vegetable oils, for clarifying turbid waters and purifying sewage, as an admixture in concrete, in consmetics and pharmaceuticals.