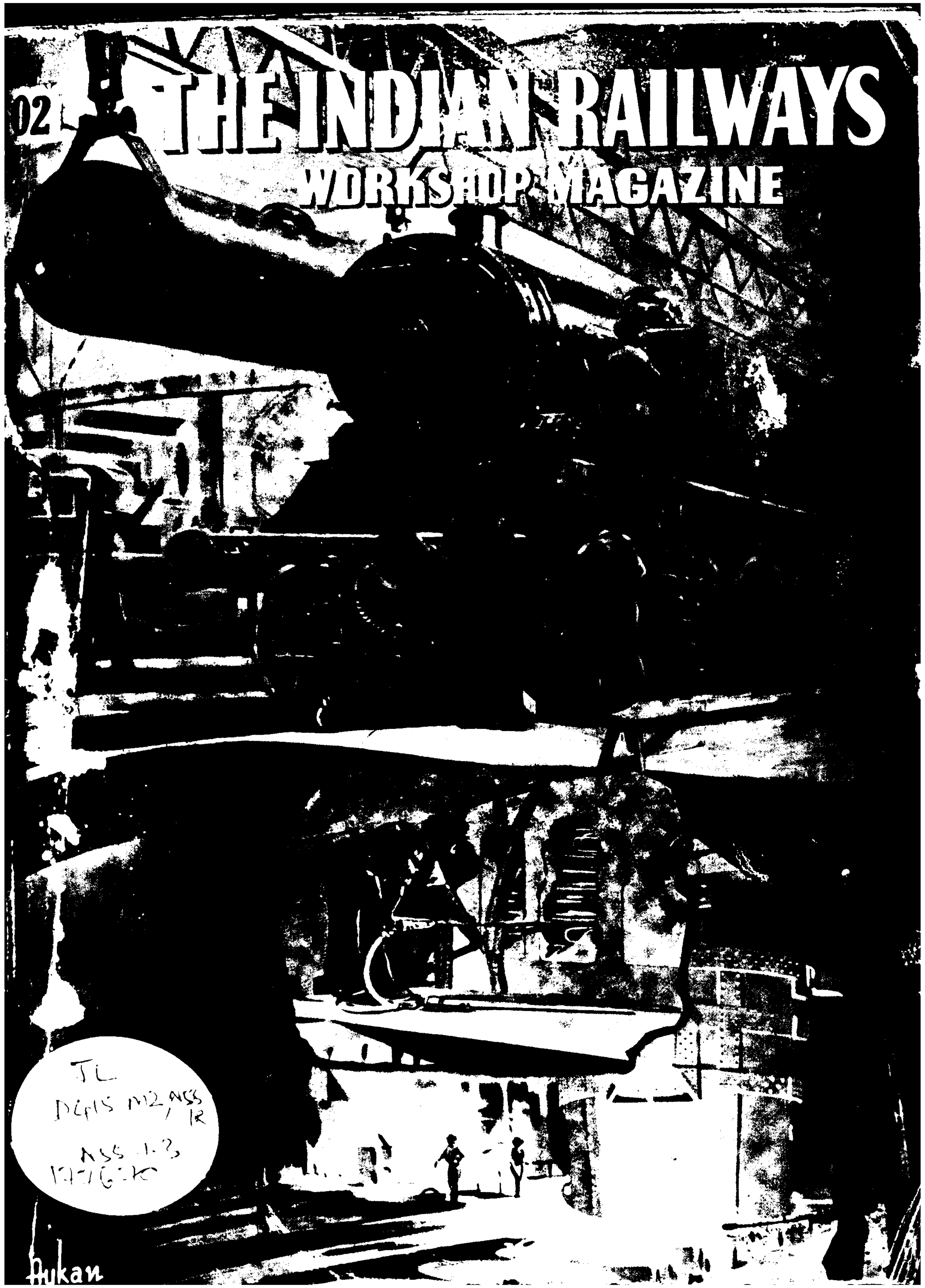
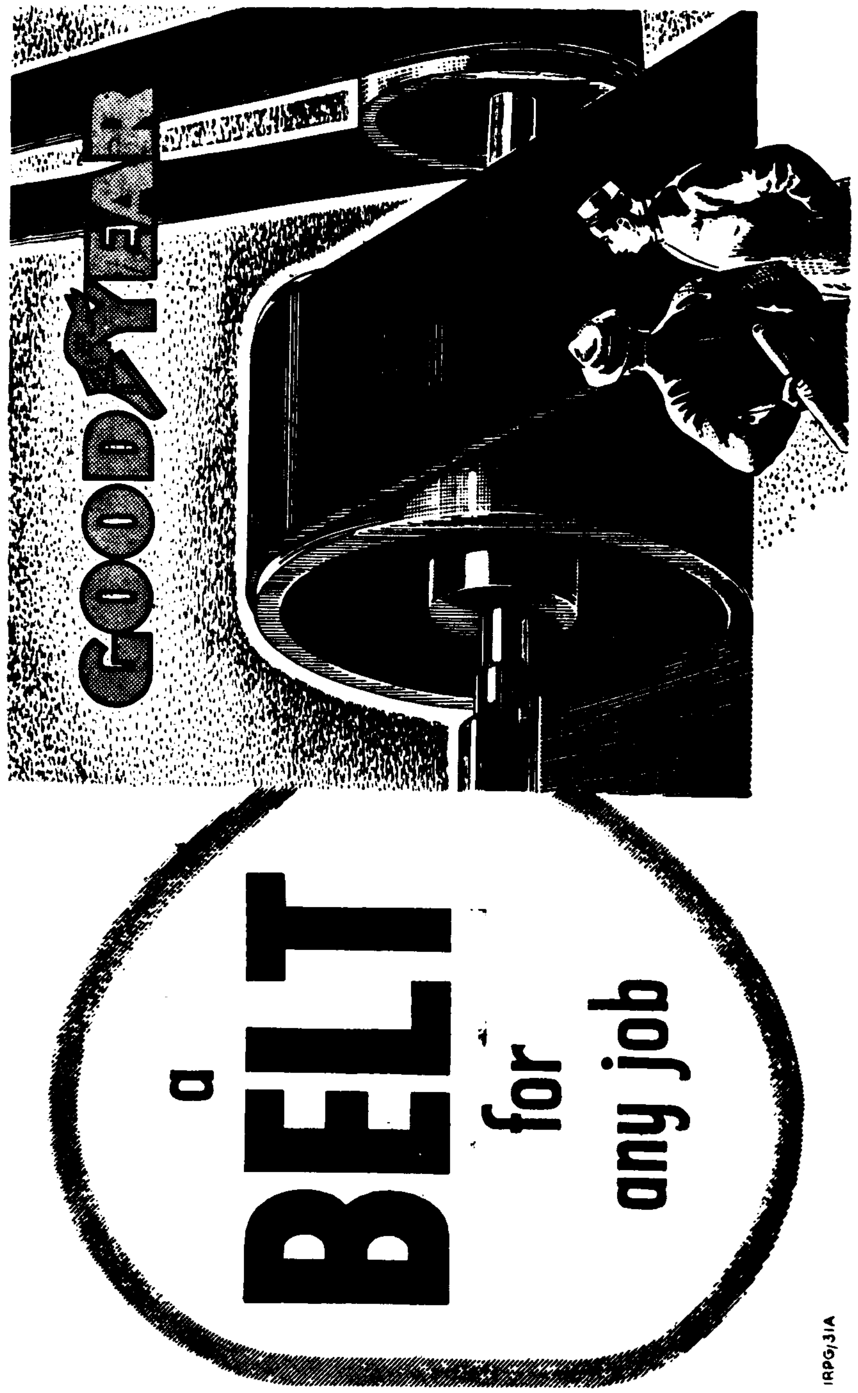
02

THE INDIAN RAILWAYS WORKSHOP MAGAZINE



TL
DG15 M2 ASS
/ IR
ASS 1.3
1976-K



CONTENTS

PAGE

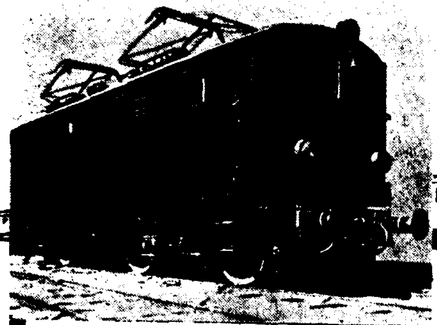
177670

Sweden stands for electrification

Sweden is a country of long distances which necessitates effective communications and in lack of natural resources of coal and oil but abundant in water power, the Swedish railway net work has been electrified up to an extent of 85%, the very highest percentage in the world. The Asea concern is the main supplier of the electric equipment and ASJ together with Kockums are the leading manufacturers of rolling stock not only for the Swedish State Railway but also for several Railway Companies in Europe.

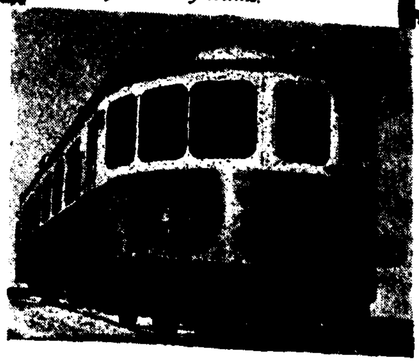
This restaurant car, built by Kockums, is divided into two dining compartments and is further provided with a cashier's desk and a kitchen department. The ceiling and walls are in polished veneer and flourescent dome ramps provide an agreeable illumination throughout the car. The comfortable furniture in harmonizing colours contributes to a pleasant journey.

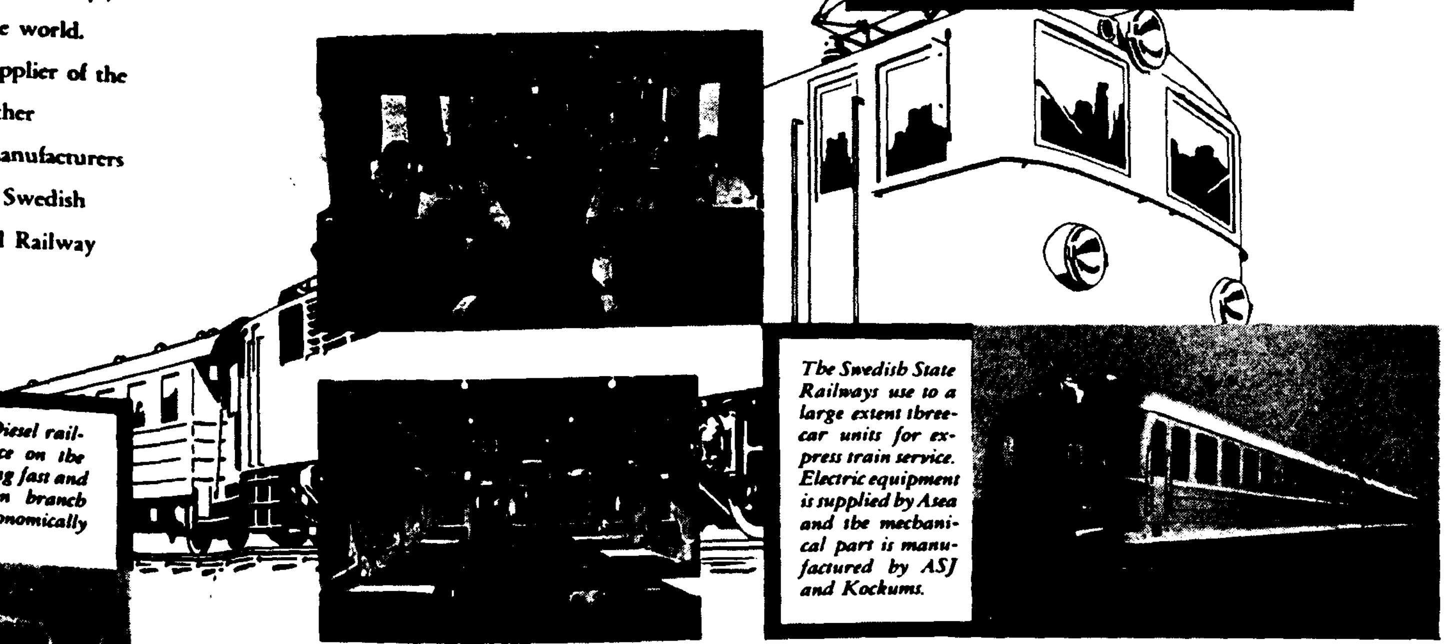
This subway car is manufactured by Asea and ASJ for the Stockholm Underground. 240 in service and 160 to be delivered.



Electric Locomotive Bo Bo, built for Poland by ASJ in eight units. The motor output is 2500 HP at a maximum speed of 62 m. p. h. Contact line voltage 3000 – 3600 DC.

Numerous Electric and Diesel railcars are placed in service on the Swedish Railways providing fast and dense communications on branch lines which cannot be economically run by ordinary trains.





The Swedish State Railways use to a large extent three-car units for express train service. Electric equipment is supplied by Asea and the mechanical part is manufactured by ASJ and Kockums.

ASEA Västerås
AB SVENSKA JÄRNVÄGSVERKSTÄDERNA (ASJ) Linköping
KOCKUMS MEKANISKA VERKSTADS AB Malmö
SWEDEN

Vol 4. No 5
D415m2 ... 51R

INTRODUCING Mr. CAREY OF GOODYEAR

WE have pleasure in welcoming the appointment of Mr. R. E. O. Carey as Managing Director of Goodyear-India which was recently announced by Mr.F.T.Magennis, Vice-President and General Manager of the Company in Akron, Ohio, U.S.A.

Mr. Carey joined the company as early as 1930 as Office Manager of Goodyear, Bombay and became District Manager at Lahore within six years of his joining the Goodyear organisation.

During World War II he served as a Wing Commander in the British Royal Air Force. While in the service he was mentioned in Despatches in 1944 and made an Officer of the Order of the British Empire 1945. On demobilisation in England in November 1945, he proceeded to Akron where he received special training in Pliofilm, Chemical Products and Aviation.

He rejoined the Goodyear-India organisation in Calcutta in August 1946 as Manager of the Pliofilm, Aviation and Allied Products Department. He was designated as Assistant to Sales Manager in May 1948 and later he became the Assistant Sales Manager. In August 1952 Mr. Carey was appointed as Managing Director of the new subsidiary started by Goodyear in Pakistan. In September 1953 he flew to the States from there he was appointed to the staff of the Australasian & Eastern Division, to handle special assignments. He continued in that post till he was appointed as Managing Director of Goodyear-India organisation.

Tall, handsome Carey is a keen sportsman and his interest and knowledge of photography is pretty near on a par with a professional, his speciality being 35 mm colour photography. Mr. Carey is married and has two sons, Stewart John, who is with the Imperial Tobacco Company of India and Richard Keith who is attending Cheltenham College in Gloucester, England. Mr. Carey is well known throughout the transport industry, and allied trades and has travelled extensively throughout India and the Far East.

We wish Mr. Carey all success in his new appointment and fervently hope that he will keep up the traditions of Goodyear organisation in this country.

Woodhead-Monroe Fluid Cushion Shock Absorbers for Railway Rolling Stock

CONSTRUCTION

THE basic, tubular, direct acting design of Woodhead-Monroe shock absorbers is the same for all applications, be it motor cycle, small car, large car, goods vehicle or railway stock. The only difference is the size or more appropriately capacity of the various types used.

For railway work the Woodhead-Monroe "Railway Version" 2" bore shock absorber is recommended. This basically robust unit of liberal proportions has been specially strengthened in the detail of the end mountings, so providing the necessary capacity to withstand the continuous hard work and hammering which are met on all railway tracks. Every part has been designed in such a way as to keep stresses within safe limits, and a special feature is the design of the oil seal, which has proved to be reliable under all climatic conditions. Alternative types (loop or stem) end fittings can be provided, in either case, specially developed rubber cushions being used which give long life, and need only occasional replacement during normal service.

Referring to Fig. 1 it will be noticed that the top attachment is connected to a piston rod. This is protected by a dirt shield, and a piston is situated at the lower end of the rod. The piston reciprocates in a honed pressure tube. Both the pressure tube and the reserve tube are attached to the mounting, and are sealed at the top by the rod guide. A sturdy compression valve is situated at the lower end of the pressure tube, and a rebound valve is incorporated in the piston. The pressure tube is always full of oil, while the reserve tube contains only sufficient oil to keep the compression valve constantly immersed.

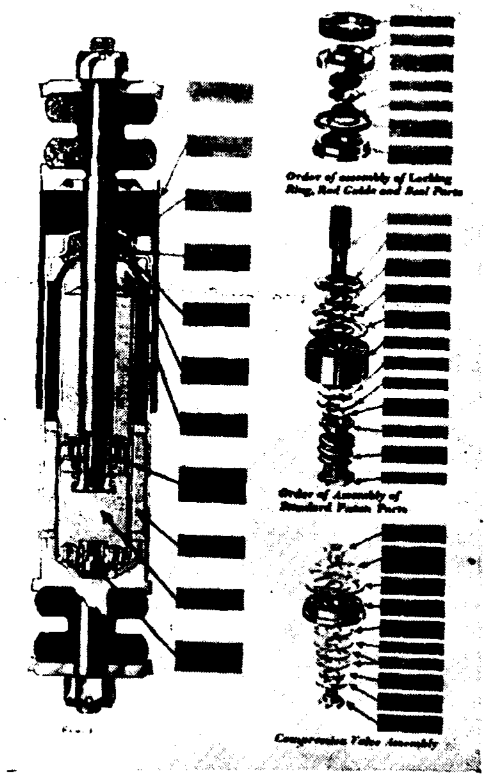


Fig. 1.

THE OIL SEAL

The rod is lubricated in the rod guide by oil from the pressure tube, which is at a pressure above atmospheric when the shock absorber is operating. Excess lubricant tends to escape from the shock absorber, but is prevented from so doing by the synthetic rubber oil seal. This seal has four wiping lips to clean the rod as it is withdrawn from the shock absorber. There is cavity a beneath the seal, connected by ports to the reserve tube, and excess lubricant finds its way into this cavity, is relieved of its pressure, and drains back into the reserve tube which is at atmospheric pressure. It will be appreciated therefore that the oil seal is never subjected to oil pressure, its duty being simply to wipe the rod dry. The rod is ground to a smooth surface finish, after which it is given a coating of hard chromium and buffed. This procedure not only produces a mirror-like surface, but prevents corrosion.

Owing to the precision finish of the piston rod, wear on the oil seal is negligible, but it will be noticed that a spring constantly presses against the oil seal retainer, holding the seal tightly against the rod and automatically taking up wear. It is the design of this seal and the surface quality of the piston rod which are chiefly responsible for the long life of the unit.

COMPRESSION STROKE FIG. 2

As the shock absorber is compressed, the piston rod is introduced into the pressure tube, which is full of oil. A quantity of oil, equal to the volume of the piston rod, is, therefore, displaced through the compression

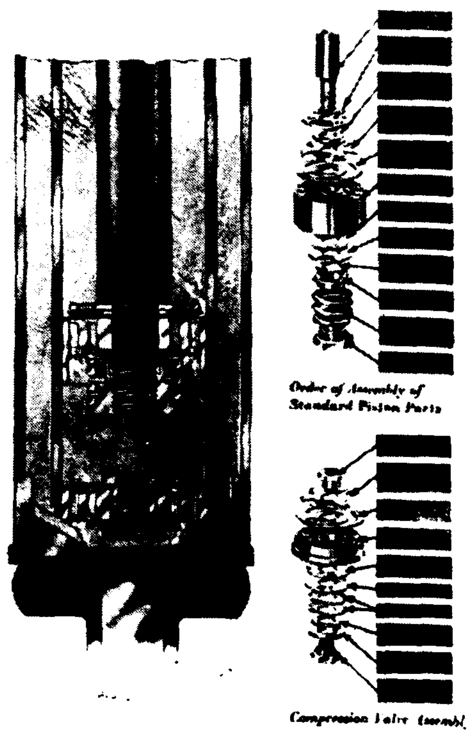


Fig. 2.

valve, into the reserve tube. The compression valve resists the passage of oil, thus offering a resistance to the downward movement of the shock absorber on the compression stroke. As the piston descends on this stroke it is necessary to allow oil to pass into the space above the piston, and for this purpose a light 'one-way' valve is situated at the top of the piston, which will open only while the piston is descending.

On the compression stroke it will be noticed that the outer ring of holes in the compression valve is closed to the downward passage of oil by the intake valve. Therefore, all the oil passing downwards through the compression valve follows the course, of the arrows, passing down the inner ring of holes into the annular groove beneath them, which is normally sealed by the metering spacer and spring disc. If only a very small quantity of oil is to pass it will be able to leak out of the groove by way of the bleed notches in the metering spacer, but when the flow of oil increases (i.e. when the speed of movement rises), pressure is built up in the groove and the metering spacer and a spring disc, hitherto pressed firmly against the base of the valve by the uniflex discs, are deflected downward, so that the oil can escape. The oil pressure at which the discs deflect is controlled by the strength and number of uniflex discs used. In certain circumstances it is an advantage to have a build up in resistance at the higher speeds of operation and in this case 'orifice control' (which is velocity conscious) is introduced by restricting the size and number of holes in the compression valve through which the oil must pass. If necessary the outer ring of holes in the piston can be similarly restricted, and it will be appreciated that any pressure of oil caused by this means will act, not only on the cross section area of the piston rod, but upon the whole area of the piston, so that big resistances can be obtained for high operating speeds without an undue increase in oil pressure.

In order to replenish with oil the part of the pressure tube above the piston, the piston incorporates an outer ring of holes through which recuperating oil can only pass as shown by the arrows. It must lift the piston intake valve as it goes, as this valve is normally closed, allowing oil to pass only upwards through these holes.

REBOUND STROKE FIG. 3

When the shock absorber is extended, the piston rises in the pressure tube, and as the pressure tube is sealed at the top end by the rod guide, oil must flow downwards through the piston. In the piston is the

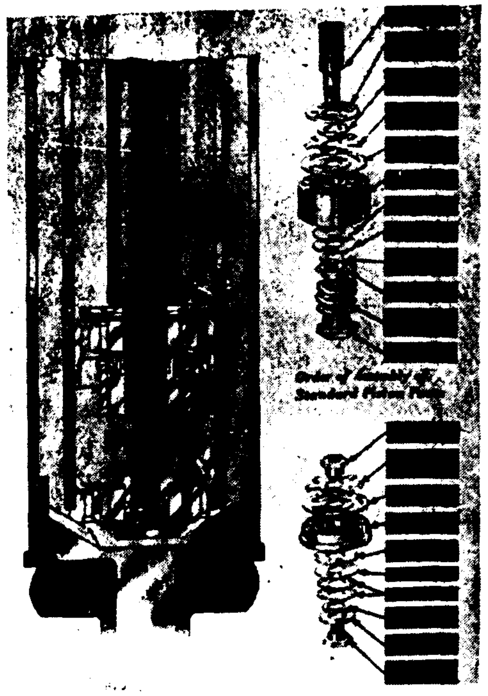


Fig. 3.

rebound valve, offering a resistance to this flow of oil, and thus causing and controlling the resistance of the shock absorber on the rebound stroke. As the piston rod is being withdrawn from the pressure tube on this stroke, it is necessary to replenish with oil from the reserve tube, and to enable this recuperation to take place a light 'one-way' valve is situated on the top face of the compression valve.

The intake valve in the piston is closed on this stroke by the pressure of oil above it, and the oil is forced down the inner ring of holes in the piston into the groove beneath them. This groove is normally sealed by the metering spacer and spring disc. Small quantities of oil can escape through the notches in the metering spacer, but when the speed of the piston increases, causing more oil to pass through the valve, a pressure is built up in the groove, which at a pre-determined amount is sufficient to cause the metering spacer and spring disc to deflect against the coil spring. Oil is therefore allowed to flow as shown by the arrows. As in the case of the compression valve 'bleed' and 'blow-off' characteristics are independent of one another, the former being controlled by the number of notches in the metering spacer and the latter by the strength of the coil spring. As on the compression stroke, velocity conscious orifice control can be introduced when necessary to cause a rapid build-up in resistance at the higher speeds of operation. This is done by restricting the size and number of the holes in the piston through which the oil must pass, although the degree of restriction is critical and must be carefully chosen.

On this stroke, oil is drawn into the pressure tube up the outer ring of holes in the compression valve. The intake valve ensures that oil can only pass upwards through these holes and is normally closed.

VALVING AND SPECIAL PISTONS

The use of metering spacers, blow-off discs and coil springs or uniflex discs to to control blow-off, is a basic advantage, because only small deflections are necessary to allow the flow of oil, which means that initially the shock absorber is allowed to move quite freely, but resistance is quickly built up, resulting in a genuine cushioning effect. Up to a point the blow-off effect is velocity conscious, as the resistance tends to increase with increase of operating speed. To supplement this, 'orifice' control is used.

The different applications of these shock absorbers have resulted in the development of three different piston assemblies.

"A" *Rebound Disc Type*

"B" *Compression Disc Type*

"C" *Cross Drilled Disc Type*

"A" REBOUND DISC TYPE

This arrangement is similar to the conventional rebound valve, except that 'blow-off' is controlled by uniflex discs as in the case of the compression valve.

"B" COMPRESSION DISC TYPE

It will be noticed that the piston and its various parts are similar to 'A', but 'upside down'. This arrangement gives a very high resistance on the compression stroke and negligible resistance on rebound. It will be appreciated that the oil pressure beneath the piston in this case operates on the whole area of the piston, enabling very high resistances with comparatively low pressures.

"C" CROSS DRILLED PISTON

Some applications, particularly when horizontal control is required, demand an equal amount of resistance on each stroke. It can be said that this piston has a conventional rebound valve on each side of it, so that movement is resisted in both directions.

By carefully selecting 'bleed' and 'blow-off' controls on the piston and the compression valve, equal resistance is obtained in both directions, or, alternatively, the unit can be made to have more control on the compression stroke than on the rebound stroke, a characteristic required by certain applications.

APPLICATIONS

The use of shock absorbers on railway rolling stock is comparatively new. A basic design providing a reasonable level of comfort by using leaf and coil springs in a system of axle box and bolster springing has been established over the years. Build-up of oscillation has been prevented by arranging for dissimilar

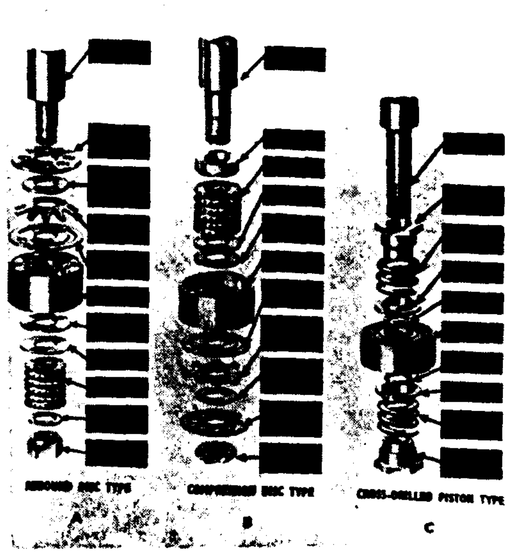


Fig. 4.

periodicity of the bolster, and axle box suspensions, as compared with the likely frequency of the track joints at any speed of travel over the track. In addition the use of laminated springs by virtue of internal friction has tended to damp excessive oscillation.

But with modern progress—reasonable comfort is not sufficient. Rolling stock engineers are faced with increasing speeds, at times over worse tracks, and a general clamour from travellers for increased comfort and safety. This has resulted in coil springs being used increasingly with greater static deflections and shock absorbers to control them. The principle is that increased flexibility and more movement of the unsprung portions of the bogies are necessary to give greater comfort, but equally necessary is the need of preventing

(Continued on page 9)

Ward Staybolt and Fusible Plug Lathes

WHILST Messrs. H. W. Ward & Co. Ltd., Birmingham manufacture a wide range of standard Capstan and Turret Lathes for general use in locomotive workshops, they have also developed a number of special machines for the production of Firebox and Roofing Staybolts and Fusible and Washout Plugs.

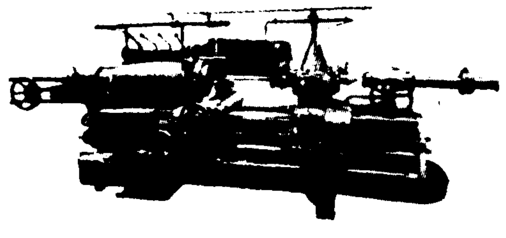


Fig. 1. No. 7 Staybolt Turret Lathe equipped for producing roof staybolts from bar.

The machine shown in Fig. 1 is a No. 7 Staybolt Turret Lathe specially designed and equipped for producing roof or crown staybolts from steel bar or forgings and it will handle staybolts up to 1.3/8" diameter by 34" long.

When required for making staybolts from bar, the machine is fitted with a hand or air operated bar chuck with a far feeding arrangement that will accommodate bars up to 12' 0" long. It is recommended that all bars, which can be black or bright drawn are reeled before they are used.

The undercut portion between the two threads machined with a special double throw roller steady turning toolholder that

(Continued from page 8)

excessive movement and oscillations for the sake of safety and stability.

For axle box springing, generally speaking shock absorbers of the compression resistance type are recommended. Under all circumstances the tendency is to prevent any built-up of oscillations, and at the same time to increase wheel adhesion. The action is such that all upward movement of the wheels away from the track is checked but the springs are allowed to push the wheels back on the track without any opposition.

Bolster springing is normally controlled by double acting shock absorbers, the choice of coil spring or uniflex discs in the piston assembly being made according to the prevailing conditions of operation. The aim is to give maximum comfort inside the coach. By having a controlled bolster suspension, there is a tendency to stabilise the axle box springing, although of course this is only a small proportion of the direct acting effect if shock absorbers are fitted there.

In certain applications there is a need for lateral control, in particular Diesel Rail Cars, Diesel and electric locomotives, electric trains (of the British Railways Southern Region kind.) Excessive side sway can build up, especially on the leading and trailing bogies. Lateral shock absorbers, with a specially fitted air dome which permits the units to work in a horizontal position, can be installed to control the swing movement of the bolster links. The full controlling effect can only be appreciated after a practical test.

From a comfort point of view, shock absorbers fitted to control the bolster suspension will be most readily appreciated. But when fitted to control the axle box springs, shock absorbers probably do the most work. Results cannot be appreciated immediately, because any additional comfort experienced is small compared to bolster control but the saving in wear and tear over a period of time is really worth while.

has eccentrically operated slides for quickly setting the rollers and cutting tool. Before this toolholder is used another special roller toolholder produces an undercut wide enough to allow the rollers and tool of the turning toolholder to be set at the required reduced diameter.

The threads are cut simultaneously with two self opening dieheads. One is mounted on the turret face opposite to the cut away in the turret for the second diehead that is

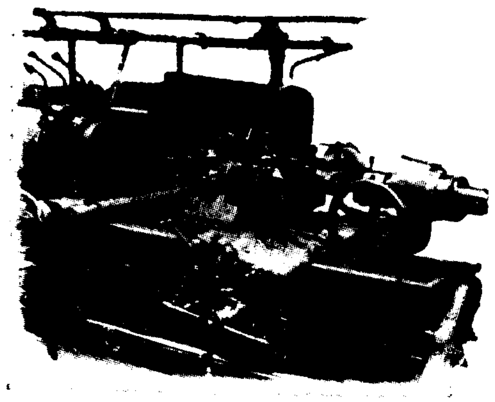


Fig. 2. View of Turret Toolholders and Duplex Diehead Bracket on No. 7 Staybolt Lathe.

mounted on an extension barrel that can be set to cover varying lengths of staybolts, there is also a graduated dial for setting the two dieheads in pitch. To ensure that the dieheads cut accurate threads, the turret saddle has leader screw control. The lever that engages the nut with the leader screw can be seen on the left hand side of the turret, shown in Fig. 2.

When one end of the staybolt has a taper thread, a diehead with a taper threading attachment is used for producing the thread.

Production times for four types of roofing staybolts are given in Fig. 3, these include staybolts made from bar and forgings. The times cover for the use of Tungsten Carbide tools for all turning operations and high

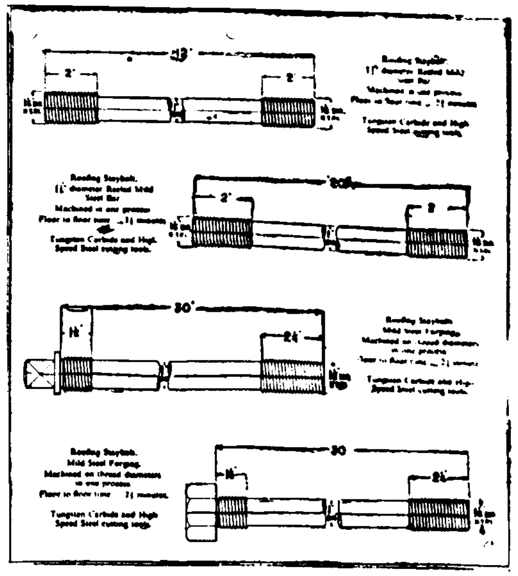


Fig. 3. Group of Roof Staybolts with production times.

speed steel cutters for the forming, screwing and parting off operations.

The No. 3A Staybolt Capstan Lathe shown in Fig. 4 is equipped for manufacturing fire-box staybolts. This lathe will deal with staybolts up to 1.3/8" diameter × 10.1/2" long

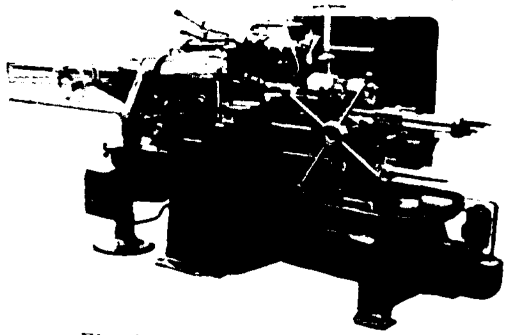


Fig. 4. No. 3A Staybolt Capstan Lathe with tooling equipment for machining Firebox Staybolts.

when made from either copper, steel or monel metal bar.

The machine is fitted with an automatic bar chuck which can be of the hand or air operated type and the bar feed arrangement will handle bars up to 13' 6" long.

A special roller steady turning toolholder is used for turning the reduced diameter between the threads. This holder has a lever operated tool slide and carries rollers that are in advance of the cutting tool and steady on the outside diameter of the bar.

A close up view of the tooling equipment can be seen in Fig. 5 and on the turret face

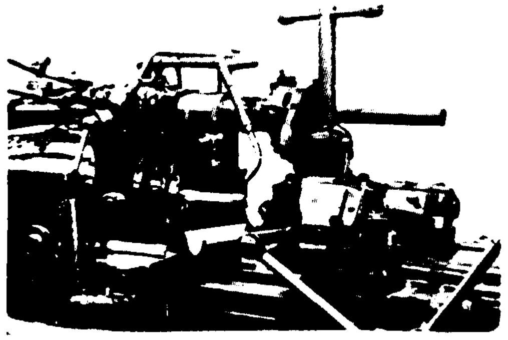


Fig. 5. View of air bar chuck with overhead leader screw and tooling equipment.

carrying the adjustable stop can also be seen a special cone that is used for spinning the end of the copper bar true before machining commences. Underneath this is a "catcher" for collecting the finished staybolt when it is parted off.

To ensure that the threads are in continuous pitch the self opening diehead is controlled by an overhead leader screw, the nut for engaging with this is carried in a bracket on the top of the hexagon turret. The leader screw cannot be seen in the photograph as it is covered by telescopic guards; it is conveniently driven by gearing from the lathe spindle. When different pitch staybolts have to be machined, the leader screw and nut can be quickly changed.

The lathe has a specially designed large capacity swarf pan and it is possible to remove all swarf from the rear of the machine without interferring with the Operator and affecting production.

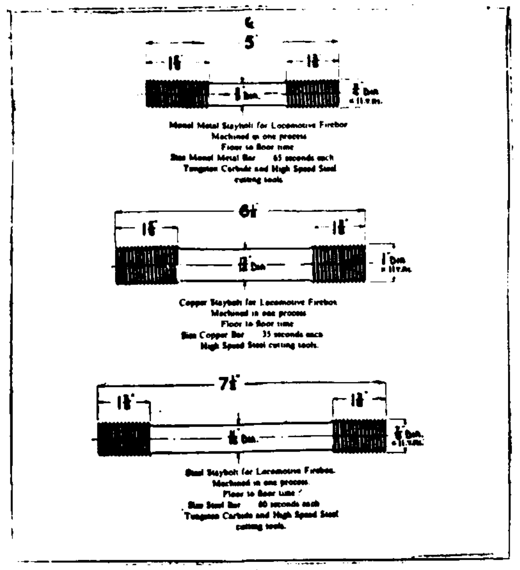


Fig. 6. Production times for Firebox Staybolts on No. 3A Staybolt Capstan Lathe.

Fig. 6 gives floor to floor times for three sizes of fire box staybolts when made from monel metal, copper and steel bar.

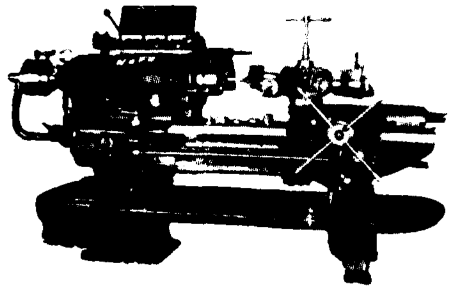


Fig. 7. No. 7 Fusible Plug Capstan Lathe fitted with air operated two jaw chuck.

The machine shown in Fig. 7 is a No. 7 Capstan Lathe specially arranged and equipped for the production of fusible and washout plugs.

A hand or air operated two jaw chuck with vee shaped jaws is used for gripping the gun metal castings on the squared head.

All the machining operations are effected by toolholders mounted on the turret of the capstan slide and it will be noted from the photograph, Fig. 7 that the machine is not fitted with an intermediate saddle.

When the machine is set up for producing fusible plugs, the first operation is to start drill and cone the end, this is followed by a combined drilling, ending and step turning

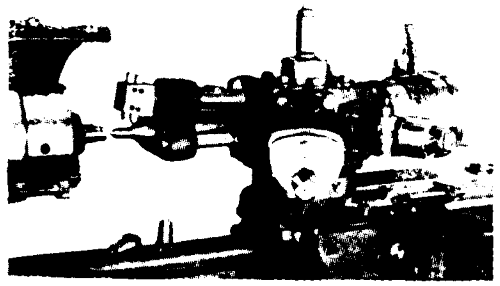


Fig. 8. View of some of the special toolholders for producing Fusible Plugs.

operation. A special taper turning toolholder that can be clearly seen in Fig. 8 turns the taper thread diameter and also the small taper step at the front of the plug.

The undercut at the back of the thread is produced by an automatic recessing toolholder that has a cam actuated toolholder whereby the cutting tool passes through an angle of approximately 90° to produce the required depth of undercut.

A ground thread tap held in a releasing tapholder is used for tapping the internal thread and this is mounted on the fifth turret face.

The last operation consists of cutting the taper thread and this is done in one cut with a 2" self opening diehead that has a taper threading attachment. To enable this diehead to rotate over the top of the capstan slide, the machine has an increased height of centre.

The sequence of operations to produce taper washout plugs is similar to those above,

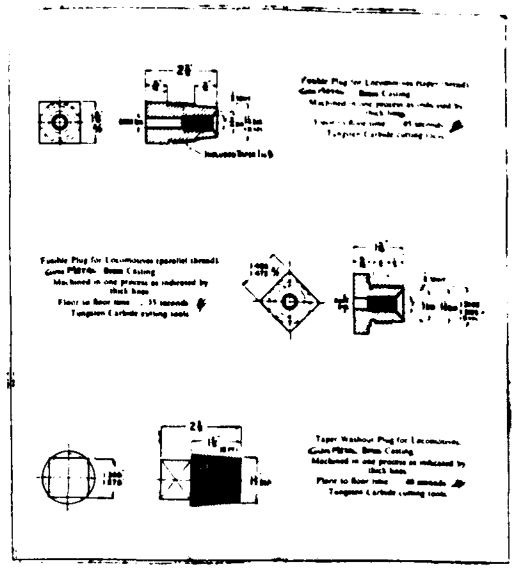


Fig. 9. Three types of Locomotive Plugs with machining times.

but instead of the drilling, coning and tapping operations, the plug is only centre drilled. This centre hole forms the location and abutment face for the revolving centres in the taper turning and undercutting toolholders.

Floor to floor times for three sizes of plugs are given in Fig. 9 and include for using Tungsten Carbide tools for the turning operations.

AUTOMATIC FLASH BUTT WELDING MACHINES

AUTOMATIC Flash Butt Welding is undoubtedly the process of "Perfect Welding" in that the parts are truly forged in a manner comparable with the power hammer, of blacksmith's weld. The principle of this method is shown in Fig. 1. The two parts are clamped in the jaws or vices of the machine, which in turn are connected to the transformer, the one jaw being fixed and the other movable, mounted on a slide, through which the forging or upsetting pressure is applied.

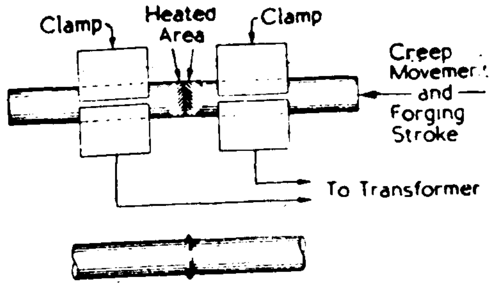


Fig. 1. The principle of Flash Butt Welding.

Simultaneously with the current application a very light pressure is applied to the moving jaw, causing an arc between the contact faces of the metal. The heat generated from this arc is so intense that it burns away the end faces uniformly on both sides, so that if the arc is maintained by a "creep" action of the moving jaw, a high temperature is rapidly obtained, the current is them switched off and the creep movement transformed instantly into a sharp blow, this action forging the plastic, or weldable metal and giving a homogeneous joint.

Automatically controlled machines operate on mass production lines and are capable of giving a high rate of output.

An automatic general-purpose flash-butt welder is shown on Figure No. 2. This machine uses compressed air at a pressure of 80 to 100 lb. per sq. in. and has a patented automatic control which can be set to give any desired welding conditions for the work in hand so that it is possible to pre-set the flash distance, upset distance, flashing time and upsetting pressure to suit any particular assembly within the capacity of the machine without the interchange of any parts in the control system, a simple adjustment of the indexing system being all that is necessary to give the correct welding conditions.

The machine is suitable for the high speed flash-butt welding of medium-light assemblies not only for quantity production but also for those conditions where a variety of assembly operations are required in the production programme.

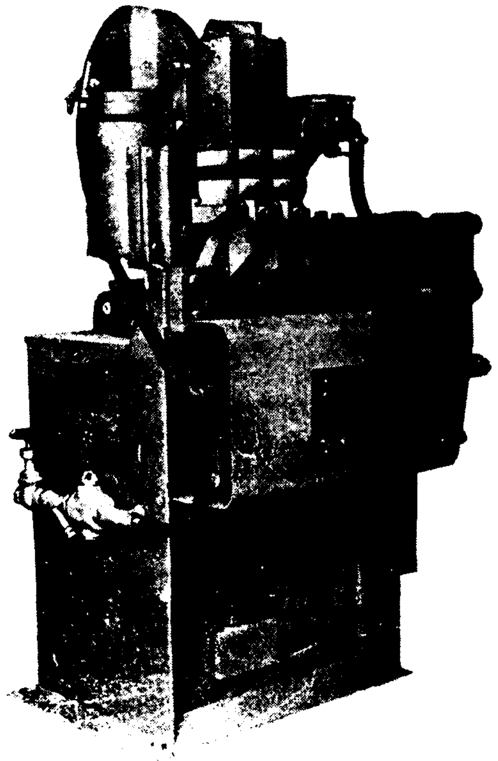


Fig. 2. A. F. /1 Automatic Flash Butt Welder.

An example of an automatic flash-butt welder specially designed for the welding of light alloy cycle rims is illustrated on Figure No. 3. In the past, the flash-butt welding of light alloys presented many problems, but these have now been successfully overcome and the machine shown has been designed to give high-class quality welding results coupled with a high rate of production. A patented system of control incorporating Ignitron Contactor Switchgear is fitted, as very accurate timing of the weld cycle is essential, the actual weld time being so short that it is measured in cycles.

Similar machines of this type have been supplied to handle other light alloy welding applications, such as the flash-butt welding of light alloy window frame sections, etc. As the welding times are so short, the output depends almost entirely upon the rate of loading and unloading.

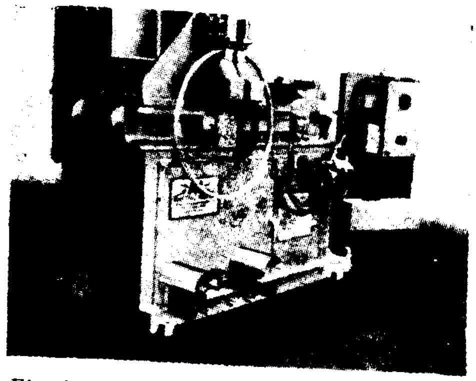


Fig. 3. A-1 Automatic Flash-Butt Welder for Light Alloy Cycle Rims.

To meet the demands of industry for the increased production of automobile wheels, tractor rims and the like, the automatic flashbutt welder shown on Figure No. 4 has been developed. This machine is capable of giving an output of 750 KVA and is able to handle rims up to 14 in. wide by .187 in. thick, and from 14 in. to 36 in. diameter, and therefore should be of particular interest to all firms engaged in the manufacture of wheels and where basic costs of quantity production are a prime consideration. Air-oil intensification has been incorporated in the clamping and forging units, giving exceptionally rapid action in clamping and inclamping. A fully automatic cycle is given from the commencement of the clamping operation until the rim is ejected from the electrode dies at the termination of the weld cycle. The actual welding time is 2 seconds, whilst the automatic features involving the progressive clamping, welding, unclamping and ejection of the rim result, in a total floor to floor time of 6 seconds when welding average-sized rims.

Ignitron contactor equipment has been incorporated, thereby eliminating the problem of maintenance which is so serious on high-speed machanical contactor switchgear.

The welding of steel rails is becoming increasingly important. The system has long passed the experimental stage and there appears to be no doubt that the system will be increasingly used throughout the world. The advantages of greater safety combined with smoother running as well as less wear and tear upon the roolling stock can only be achieved by having accurately aligned rails which are perfectly welded and afterwards

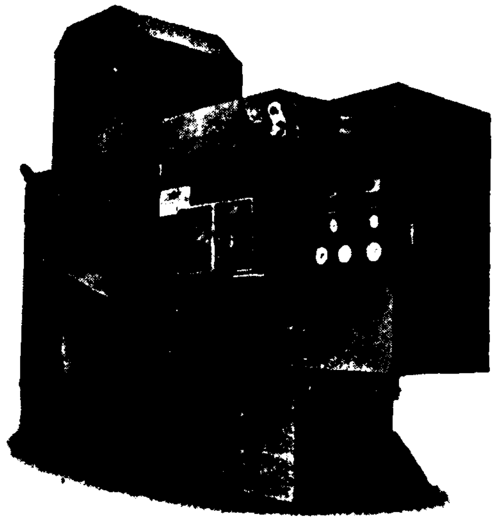


Fig. 4. 750 KVA High Speed Automatic Flash Butt Welder for Steel Rims.

normalised to ensure that the crystal structure and physical properties of the fininshed rails are consistant throughout their length, for we must never lose sight of the fact that every inch of rail is subjected to load and stress conditions, a state of affairs which is not usual with welded components.

The illustration given on Figure No. 5 shows an automatic rail welder capable of welding main line rail sections up to 131 lb. per yard. Such rail welding machines have been installed in many parts of the world. Horizontal and vertical adjustment is provided so that the rail surfaces are perfectly aligned even when under full clamping

Fig. 5. A. I. Patent Automatic Rail Welder. (Machine in Operation at Netherlands State Railways Utrecht Depot)

pressure. Central loading gives equivalent distribution of the upset pressure over the entire rail section. The clamping arrangements for such large sections must necessarily be substantial and on these machines duel clamping is employed, a heavy horizontal clamp action being applied to the rail web whilst the current application is given by compensating clamps of the certical type, requiring only the pressure necessary to maintain efficient current contact.

Automatic control governs the pre-heating, flashing and final forging of the rail sections, the special feature of this control system being that the pre-heating application is compensatory for the contact surface conditions of the rails, a factor of importance in rail welding technique.

" A. 1. " Post Heating Equipment for normalising the flash-welded rail joints is built in two models, stationary and portable. The rails are normally fed from the Rail Welding Machine into the Post Heater where the rail joint is automatically normalised by raising the temperature to 850° c., the temperature being automatically controlled by means of an optical pyrometer unit.

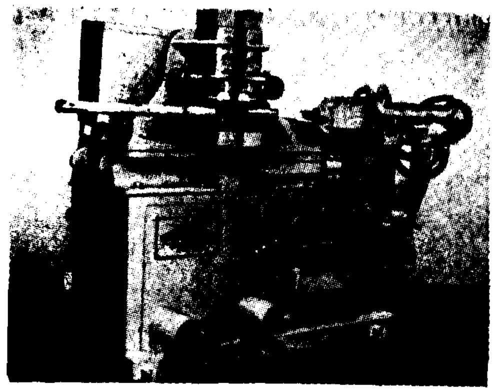


Fig. 6. A-1 Automatic Flash-Butt Welder With Tube Stripper.

The clamp equipment is of the air-oil intensifier type which secures high efficiency in current contact conditions.

Another extremely interesting automatic Flash-Butt Welder is the machine shown on Figure No. 6 which is specially designed for re-ending the tubes from locomotive boilers. As is well known when tubes are withdrawn from a locomotive boiler the ends are not suitable for further service. These re-ending machines enable the old ends to be removed and new ends to be flash-butt welded in a matter of seconds. The clamping and upsetting machanism is air-operated whilst a stripper unit is provided to remove the inside weld extrusion from the tube. The welder is rated at 100 k VA and is suitable for tubes up to $2\frac{1}{4}$ in. diameter.

(Continued on page 16)

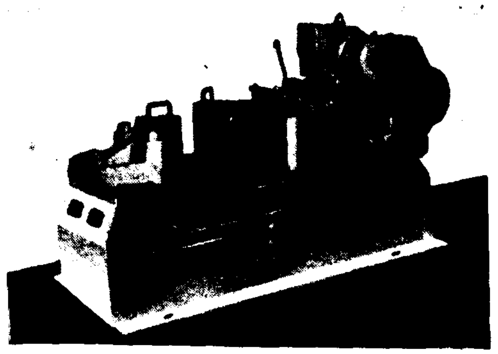
FINLAY HYDRAULIC PRESSES

FOUNDED in 1923 by two Scottish brothers, J.B. and R.P. Finlay, Finlay Engineering Ltd., of Newport, Mon., England originally built mining machinery for a variety of installations in South Wales. Among their first machines was a press used mainly for straightening distorted pit props and arches. This press had of necessity to be compact and robust for use in confined spaces and it was of an essentially simple design. It could be powered by hand, compressed air, or, for work underground, by a flame-proof 3 H.P. electric motor.

Close-up of the Finlay RG 100 Press forming a ring out of 8" by 3" bar steel.

Finlay's RG 100 machine was specially designed to take 24" by 7½" rolling steel joists.

When Industry came to realise the value of such a press for other purposes two new models, the R100 and the R70, of respectively 100 and 70 tons ram pressure were introduced. These presses have several special features which make them valuable for a wide range of engineering work. They will bend any main-line railway section and can be employed to make ring flanges, cleats and structural components, or to bend steel plate.



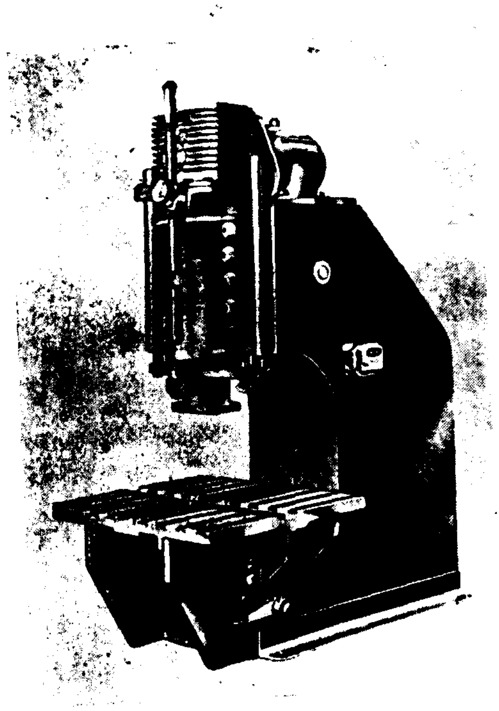
RG 100 Machine is shown here adapted for ring forming.

Basically the construction of the Finlay machine is very simple; it consists of a press unit comprising a horizontal ram and cylinder pump assembly and power drive, and a bed-plate or other mounting. The ram cylinder

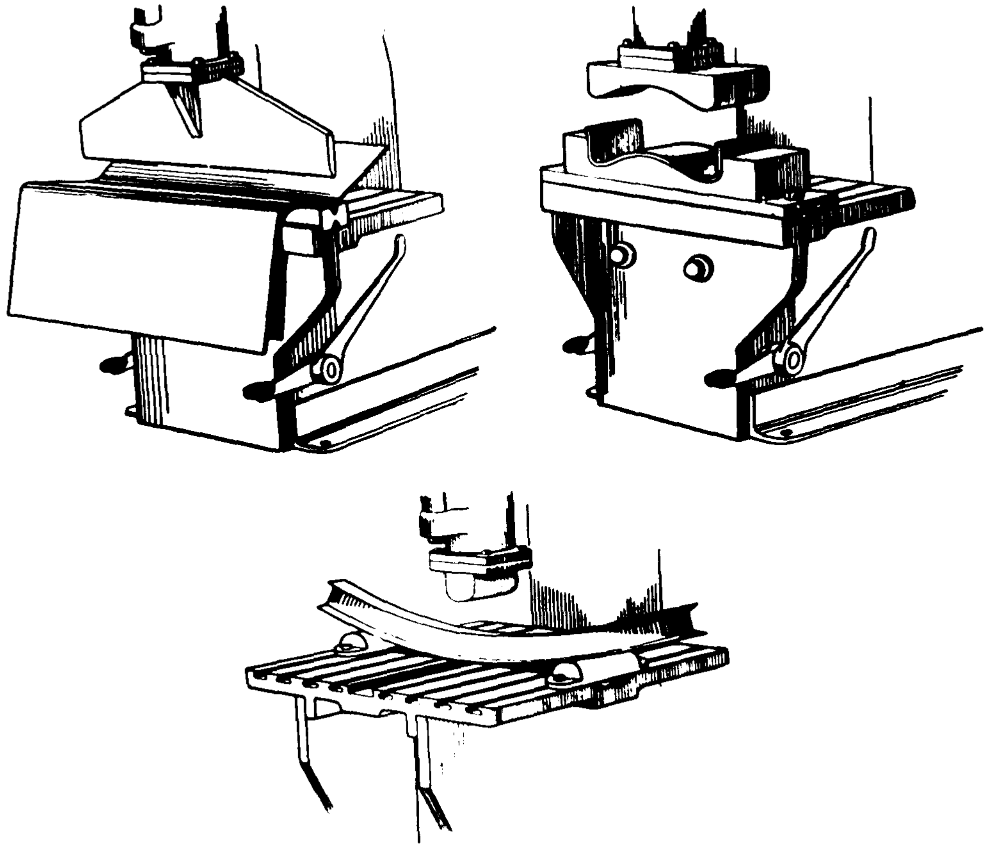
(Continued from page 15)

A larger model of similar general construction is manufactured for superheated flue tubes up to 5½ in. diameter.

The various patented Automatic Flash-butt Welding Machines described in this article are manufactured by A. I. Electric Welding Machines Ltd., London.



Left: Finlay's latest Vertical Press for plate bending and component fabrication.

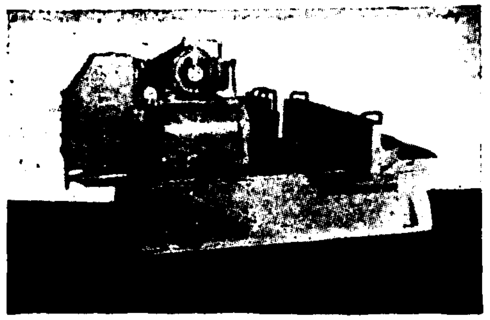


Bottom: Diagrams show how various ram heads may be fitted to the V120 press for a variety of plate bending and forming operations.

is cast in high tensile, close grained iron, and is machined to take the ram, control valve, safety valve and pump assembly. A cast steel ramhead is fitted to the polished steel ram on standard models, but special cross-heads for ring and flange forming or plate bending, together with appropriate anvil blocks may be fitted in a matter of minutes.

The ram movement is controlled by a hand operated lever, and there is a safety valve fitted which may be adjusted to allow for any pressure between 40 and 100 tons. Two plunger pump units are operated by a cam shaft through tappet levers, and all wearing surfaces of the equipment are of hardened steel.

Of the same basic specification as the R100, but specially modified to meet the requirements of structural engineering firms in



R 70 Finlay Industrial Press.

Canada, the RG100, a new press, can accommodate joists 24" deep in addition to performing all the operations of the R100. The latest addition to the Finlay range of presses is a new vertical machine, the V120 which while retaining all the best features of Finlay horizontal presses occupies much less floor space. Again, it is of simple robust design and consists of a fabricated gap frame with

(Continued on page 19)

THE OXY-CHLORIDE FLOORING PRODUCTS LTD.

Stonette Building, Arthur Bunder,

Colaba, Bombay-5.

Manufacturers of :

ELEPHANT STONETTE & WAGONLITHE BRANDS FLOORING COMPOSITIONS

Being used by Indian Railways as per approved standard since 1930 Flooring in Passenger Coaching, Goods and Animals as vanning stocks

Selling Agents :

Messrs. HEATLY & GRESHAM LIMITED

BOMBAY • CALCUTTA • MADRAS

MAIN-LINE LOCOMOTIVES FOR DENMARK

Detailed description of American-type European-built series with 18-ton axle load and a high standard of design

FOUR 1,500 h. p. six-axle locomotives now going into traffic on the Nyborg-Fredericia-Aarhus-Frederikshavn main line of the Danish State Railways (Danske Statsbaner, or DSB) are of exceptional interest in being the first Electro-Motive type main-line locomotive to be seen in normal revenue-earning service in Europe, and also the first of the type to be built in Europe. They have been constructed at the Trollhattan works (Sweden) of Nydqvist & Holm A.B. (Nohab) under licence from the Electro-Motive Division of General Motors Corporation, but the engine-generator equipments were supplied from La Grange to Nohab.

Preliminary studies showed that one of these locomotives would haul a 14-car passenger train of 500 tons trailing (and allowing 3.5 kW auxiliary load for each car) between Nyborg and Frederikshavn, 270 miles, in 5½ hr. with 17 intermediate Stops; and a 1000-ton freight train over the same route in 9½ hr. with 16 intermediate stops.

Though nominally styled as of 1,500 h.p., this is actually the traction input to the main generator, and the engine output is nominally about 1,665 b.h.p. as a maximum, though for test-bed conditions of 16°C. and 29.92 in. of mercury the engine throttle is set to give a maximum of 1,720 b.h.p. Nevertheless, only four force-ventilated traction motors are needed to take up the main generator output, and the wheel arrangement thus is A1A-A1A.

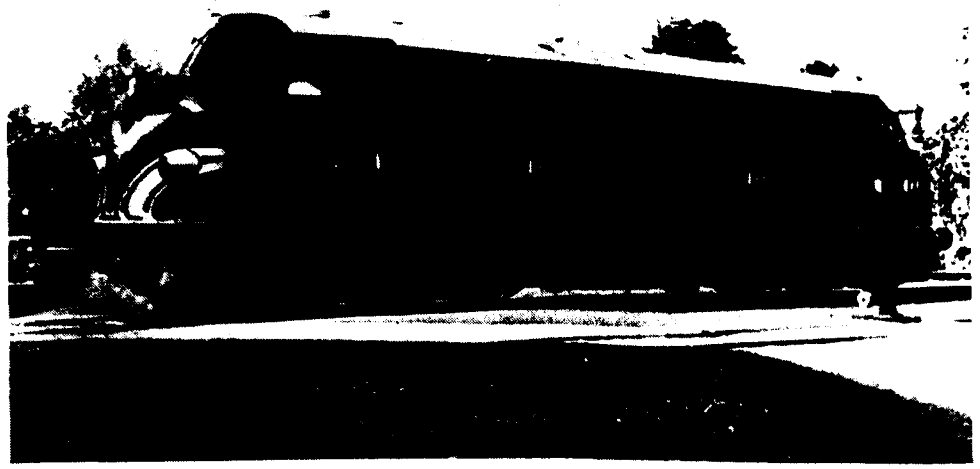
To suit Danish conditions the locomotive was built to a maximum axle load of 18 tons. This is the weight on all drivers, giving an adhesion weight of 72 tons; but the weight on the centre carrying wheels is less, being only 13.3 tons. The total weight with all on is 98½ tons. In this are included 750 gal. of fuel oil and 1,000 gal. of train-heating water.

Tractive effort rating is 31,700 lb. continuous at 14½ m.p.h. equivalent to 20 per cent of the adhesion weight at 17½ per cent of the top designed speed of 83 m.p.h. Starting tractive effort at 25 per cent adhesion is 40,000 lb. Capacity of the electrical transmission is such that short-time ratings equal to 24 per cent adhesion, or 38,000 lb., are possible at a speed of 12 m.p.h. Traction motor groupings are: (1) series-parallel; (2) series-parallel with 44 per cent shunted

(Continued from page 18)

48" square table, ram and cylinder assembly with spring return, 3-plunger pump unit and direct coupled driving motor. A feature of the press table is that it is made with a detachable front section to allow clearance immediately in front of the plate die for work with reverse bends.

The ram, which is capable of a maximum pressure of 120 tons, is controlled by a foot treadle or hand lever and has a stroke of 15". There is a spring type safety valve, and a pressure gauge is included in the hydraulic system. Power is supplied by a push-button controlled 10 H.P. electric motor. The press is capable of cold-bending steel plate of up to ½" thickness and 48" width and will curve and form a wide range of steel sections. It can also be used for fabricating steel components. These machines with their cold-bending techniques, and others from the same organisation are making ever-increasing contributions to productivity in mines and engineering shops all over the world.



1600 HP Diesel-electric Locomotive for the Norwegian State Railways.

field; (3) parallel; (4) parellel with 44 per cent shunted field.

MECHANICAL PORTION

Underframe, locomotive body, and bogie frames are of all-welded designs, and in order to reduce weight built-up profiles have been used in many places in place of rolled sections. Compared with the standard EMD design as used in America, the underframe had to be re-designed to suit the DSB buffing and draw-gear, and consists of two longitudinal beams connected by heavy cross members of welded plate construction. About the middle of the underframe of the locomotive the cross members, together with the longitudinal beams, form an especially rigid frame, which carries the diesel engine and generator. The cross members above the truck centres are designed as box girders with welded stiffening plates, and the ends of these cross members are designed to facilitate lifting of the locomotive either by applying jacks directly to pads, which are welded on, or by special lifting devices inserted into the ends.

The buffer beams are designed as open box girders, the two longitudinal beams of the underframe being directly connected to the buffer beam behind respective buffers. The buffing load, and also, in particular, the pulling forces, are transmitted to the cross member above the truck centres through U-shaped beams connected to the buffer beams. All-welded centre bearings are bolted to the cross member above the truck and are provided with wearing plates of hardened spring steel on the bearing surfaces. Necessary arrangements are made in the underframe to carry the fuel and water reservoirs, battery housings, cooling air ducts for the traction motors, steam generator, equipment rack, compressor, etc.

Ring-spring friction-type buffers and the draw gear are of standard type used by the DSB. Necessary couplings for air brake and steam heating and for multiple drive are provided. The couplings for steam heating are of two kinds, the DSB and the international (UIC) standard designs. Both ends are provided with rail guards consisting of a reinforced and bent one-piece steel plate.

The locomotive-body frame is designed as a bridge construction and forms together with the underframe the complete structure, but the external plates serve only as cover plates. Gusset plates connect the framework to the cross members of the underframe. To take the strain caused by the buffer and draw gear, which are located at a lower level than the underframe, part of the framework extends past the cross members above the truck to a transverse beam at the buffer beam. The underframe and car-body are calculated to stand a buffing load on each buffer of 100 tons or a load of 75 tons on each buffer diagonally.

The longitudinal lower part of the roof is welded to the upper part of the framework to make an integral part of the structure. Due to the shape of the clearance diagram the arch of the roof is higher than usual in Europe. The roof is provided with one big and one small hatch for the installation and removal of the diesel engine and generator. There are, besides, two small hatches for installation and removal of the steam generator and the water reservoir. Mounted in the big hatch are four coolers and four electrically driven cooling fans for the cooling of the engine. The hatches, which are of 1½ mm. steel plate, are built on an angle iron construction and bolted to the roof.

The sides and end-pieces of the locomotive body are covered externally by steel plates, 1½ mm. thick at the sides and 2 mm. at the ends. To give a greater stiffness to the sides, there are three longitudinal corrugations in the side plates. All plates are welded to the locomotive-body frame. The side plates are welded in a special manner so as to obtain a certain flexibility with the body.

DRIVING CABS

A driver's cab is provided at each end of the body. This cab is moved somewhat backwards, thus affording better protection to the crew in case of collision. As the driver's cab is located high above the rail the visibility is good, and the irritating effect that the sleepers have on the driver's vision is reduced to a minimum. The outside walls and the roof are insulated. The interior of the side walls consists of masonite board, whereas the roof and the front are covered with aluminium plate. The roof plates are perforated to improve sound insulation. The cab floor is of wood covered with linoleum. There is one driver's chair in each cab, fastened to the floor and provided with upholstered back and elbow rests. The chair is adjustable horizontally and vertically and can be rotated.

At each end of the locomotive, there is a swing door and gangway for the crew for possible use in multiple-unit driving. The gangway is turned inwards when not in use. The air brake apparatus is placed in special racks at the nose ends of the locomotive, where the auxiliary air receivers of the HIKS brake are located. This power brake equipment was supplied by the Knorr-Bremse A. G., of Munich.

Both driver's cabs are heated by means of the engine cooling water passing through radiators at suitable locations, and there is also a special foot-warmer for the driver. To prevent freezing, a small heating unit is placed in each nose end of the locomotive near the racks for the air brake apparatus.

The end windows are fixed in rubber strips and provided with laminated safety glass of 10 mm. thickness. The side windows and the windows of the side doors are of the drop type and provided with safety glass of 7 mm.

thickness. The engine room windows are round and of safety glass of 7 mm. thickness fixed in rubber strips. Two of these windows, one on each side, are on hinges and can be swung inwards.

Controllers with handles for engine throttle and for reverser are lacated in front of and somewhat to the side of the driver's seat. The governor which is actuated by the throttle through electric contacts, regulates the speed of the diesel engine. The reverser handle controls the current for the magnet valve of the reverse, which is placed in the electric cabinet and is operated by compressed air. The throttle is designed so when in the "idle" position it is possible to remove the reverser handle to lock the controller. An illuminated dial indicates the positions of the throttle. A dead-man pedal and a push button are provided and operate to bring the engine to idling speed and bring the air brake into action after a certain interval.

Alarm bell and signal lights warn against overheating of the engine or low oil pressure and a fall of alternator voltage below a predetermined figure. Grouped on the instruments panel, conveniently in front of the driver, are the brake pressure gauges, speedometer, lighting, and various other switches. For the steam generator there is a main switch, signal lamps, steam pressure gauge, and push button for the separator blow-down.

FUELLING AND BATTERIES

Amongst the other installations on the locomotive are the fuel tanks with their pipes arranged to permit quick filling from either side of the locomotive. Tests made show that complete filling of the tanks can be performed in 6 min. at a fuel oil pressure of 57 lb. per sq. in. Filling of water for the heating system is arranged by means of a so-called non-spill device.

The lead batteries are of 64 volts 426 amp.-hr. capacity and are placed in boxes, at each side of the locomotive. They are accessible from outside. At each end of the locomotive there is a 250-watt headlight and two buffer lights each of 100 watts. All lights can be dimmed and the buffer lights can be switched on and off separately. Furthermore, there are two lights in each driver's cab, six in the engine compartment, one in each nose and two wall sockets for the inspection lights. On each side of the locomotive, underneath the underframe at each driver's cab, are placed two marker lights. Window shield wipers of DSB standard type are provided at each end window, and electric heating devices of DSB standard design for hot drinks are provided in each cab. Fire extinguishers of CO_2 and foam type are provided.

TRUCKS

When considering what type of three-axle truck should be used the choice was between the types used on electric locomotives in Europe or the new type made by EMD, designated as the Flexi-Coil type. Extensive tests by EMD with the Flexi-Coil type had shown very good riding qualities at high speeds; further, earliar comparative tests made by EMD had shown advantage regarding setting up stresses in the track, as well as in the locomotive, with the trucks spaced far apart and with freedom in all the different movements; finally, estimates showed that the Flexi-Coil type could be built somewhat lighter than the European type.

In the Flexi-Coil truck all springs are coil springs. The springs which carry the bolster serve also as pendulums. Friction dampers are fitted between the frame of the truck and the bolster and neutralise the horizontal as well as the vertical oscillations. Actual flexibilities are:

(*a*) Lateral flexibility in the axleboxes 9.5 mm.

(*b*) Vertical springing between the axlebox and the truck frame 30 mm.

(*c*) Vertical flexibility between the truck frame and the locomotive body 32 mm.

(*d*) Lateral flexibility between the truck frame and the body 38 mm.

Based on Nohab's long experience of all-welded construction it was decided to design and execute the truck frame fabricated and all-welded. The longitudinal as well as the transverse beams of the frame are designed as box girders. The bolster, which is all-welded, is carried by coil springs at four points in the truck frame, and the locomotive body is carried by a centre bearing in the bolster. The truck frame in its turn is carried by coil springs above each journal box.

The spring system thus consists of four double coil springs at the bolster and 12 double journal box coil springs on each truck. All springs are made of round sections, centreless ground before winding. As the spring rigging lacks equalising beams, the weight distribution within the truck is carried out by means of shims. The necessary restoring force is obtained by the oblique displacement of the coil springs. In the longitudinal direction of the locomotive the bolster is guided by brackets on the truck frame. The pulling and braking forces are transmitted through these brackets. The bolster and the brackets are provided with wear plates of hardened spring steel, and the lubricated centre bearing is also fitted with a wear plate of steel on its bearing surface. The clearance between the locomotive body and the truck permits an oblique displacement of the truck frame of at least 2° upwards and downwards when running through curves of 90 m. radius.

Wheels of the first locomotive were supplied by a Swedish firm. The wheel centre is made of rolled and heat treated material and machined on all sides before and after the heat treatment. The wheel centres are shrunk on the axle and can be taken off by oil pressure according to the SKF patented method. The wheels for the second, third and fourth locomotives were made in England and are of conventional type. The diameters of the wheels on the same axle must not differ more than 0.5 mm. The wheel centres and tyres of the same pair of wheels as far as possible have the same weight, with a tolerance of not more than 2 per cent. The finished pair of wheels are carefully balanced.

The traction motors are axle-hung with plain bearings, and supported by coil springs in the truck frame. This method of supporting the traction motors in the truck frame eliminates all bolted connections and facilitates the dismantling of a wheel pair together with its traction motor. Cooling air is supplied to the traction motors through rubber bellows and air ducts from the fans located in the car body. Each bellow has at the lower part a comparatively heavy steel frame, which with its own weight tightens against the corresponding air intake on the traction motor. As there are no bolted connections, the simple way of removing the trucks from the locomotive may be easily seen.

The axleboxes are located on the outside of the wheels. On the electric locomotives Europeon practice tends towards the use of single spherical roller bearings, which do not allow for lateral movement of the axle in the boxes. However as EMD experience had shown the benefits of freedom it was decided to use the type of roller bearings generally used on EMD diesel locomotives. The journal size is 6 in. by 11 in. and a lateral flexibility in the axlebox of 9.5 mm. on each side is permitted. The journal boxes are oil lubricated.

The lateral thrusts are taken by a rubber-spring arrangement via the shaft end directly by the axlebox. The truck frame is provided with guides for the axleboxes with wear plates of hardened spring steel. The axleboxes are fitted with the speedometer drive and brake switch for the HIKS brake. Furthermore, there is a centrifugal contact for disconnecting the dead-man pedal when the locomotive speed is below 12 m.p.h.

BRAKES AND SANDING

The locomotive is fitted with Knorr automatic air brake of the HIKS system for braking the locomotive and the train. There is, furthermore, a direct acting brake for the locomotive only. The braking percentage at speeds exceeding 34 m.p.h. is 143 per cent and below 34 m.p.h. it is 70 per cent. The brakes act on all locomotive wheels. Brake shoes of DSB standard type are applied on both sides of the wheels. There is a hand wheel in each cab for the hand brake, which acts on two pairs of wheels on the nearest truck. Each truck is equipped with four brake cylinders and four slack adjusters. The compressed air system, which was designed in collaboration with the DSB and Knorr, is arranged to supply air to the brake of one truck in case of burst air hoses to the other truck.

The locomotive is equipped with electro-pneumatic sanding, operated from the driver's place. Eight sandboxes are carried in the locomotive body, four for each truck, connected to the trucks by reinforced rubber hoses. Sanding is made ahead of the first pair of wheels of each truck in both running directions. The sandboxes are filled from the outside through lids in the side plates of the body.

MAIN ENGINE

The diesel engine is the model 16-567B, with a displacement of 9.3 litres per cylinder of 8½ in. bore by 10 in. stroke. The cylinders are in two banks in the form of a 45 deg. V. This two-stroke engine provides 1,500 h.p. at 800 r.p.m. to the main generator for traction, plus additional power for the air compressor, auxiliary generator, and fans for engine cooling radiators, traction motor blowers and generator. This top output is delivered to the generator at 8th throttle position regardless of the train speed and load, or temperature or altitude that will be encountered in Denmark.

Use of the narrow 45-deg. angle of the V allows good aisles on both sides of engine and helps ease of removal of the power groups. Placing the blowers high at the rear end allows close coupling of the generator and use of the rear end bearing of the engine as one support for the generator. The narrow thin-disc coupling provides flexibility and aids close coupling of engine and generator. Accessories for water, oil and fuel are all at the front end of the engine, with short connections to a compact equipment rack containing oil cooler and filters, water tank and motor-driven fuel lift pump.

Air is supplied for uniform scavenging by Roots-type three-lobe helical blowers. Inlet ports in the cylinder are opened at the bottom of the stroke, and burned gases are exhausted through four exhaust valves in each cylinder head. Discharge pressure of the blower is about 4 lb. per sq.in.

The four exhaust valves are operated by two rocker acting on two T-shaped bridges directly from the camshaft. Hydraulic lash adjusters are installed in the bridges. The camshaft also operates the individual injectors located in the centre of each cylinder head. The camshaft assembly has induction-hardened journals and cams, and is supported by a pair of bearing blocks at each cylinder. Precision steel-backed copper-lead bearing inserts are used, with alignment of bearing blocks maintained by close tolerances and keying to the crankcase.

The unit injector is a combination of a spray tip and a pressure pump with a metering plunger. The quantity of fuel injected per stroke is controlled by helical grooving on the plunger, which is positioned by movement of the injector rack. Proper atomisation of the fuel is provided by the six 0.011 in. (0.28 mm.) holes in the spray tip. At rated load each injector sprays about 0.38 litres per

min. of fuel with peak injection pressure of about 2,000 lb. per sq.in,

High strength cast-iron is used for the cylinder head, the cylinder liner, and the piston. The cylinder liner is cast with integral water jacket, with water cooling in the inlet port area as well as below. Silicone rubber is used for seals at the bottom of the liner jacket as well as at the drilled holes at the top. Water flows into the head, around the exhaust valve seats and to the centre of the head before flowing to the outlet at the top part of the head. The cylinder is bolted to the head with a 0.015-in. thick copper-clad steel shim acting as combustion seal.

The novel piston design allows free floating of the piston around the malleable iron piston pin carrier. This eliminates pin boss distortion in the skirt and allows symmetrical piston design and close fitting of the piston to liner (0.009 in. to 0.013 in. diametral clearance). The piston is full floating and the steel-backed plated silver bearing at the top of the forged steel connecting rod also floats. The piston and carrier assembly is held together by a steel snap ring, which carries no load during normal operation of the engine. The crown and ring belt section of the piston is designed to minimise heat flow to the three compression rings and allow major heat removal from the crown by means of a piston cooling oil jet. The compression rings have a grooved face with ferrox filling the grooves. Two double hook scraper oil rings control oil consumption.

The fork-and-blade connecting rods have a unique crankpin bearing arrangement to allow use of a large crankpin diameter and still allow removal of connecting rods through the top of the cylinder. The steel-backed, copper-lead-tin precision bearings are retained by a hinged strap bolted to the sides of the fork rod. The blade rod has a hardened slipper surface that runs against a copper-lead-tin bearing on the top side of the upper half bearing.

The main bearings are also steel-backed copper-lead-tin precision bearings, and have a lead-tin overlay for break-in, as do the rod bearings. Main bearing pressure lubrication is provided by a crank-case manifold through a groove in the unloaded upper half bearings. Pressure feed to the rod crankpin bearings is provided by drilled holes from main to pin.

Crankshaft Journals and crankpins are induction hardened. The low alloy carbon steel crankshaft is drop forged and twisted. Two sections, bolted at centre flanges, are used. The crankshaft is counter-weighted and dynamically balanced. Operating torsionals are kept to a minimum by use of a spring pack type of harmonic balancer assembled on the front end of the crankshaft. The primary rocking couple is also balanced by use of counterweights at both ends of the camshafts.

The crankshaft is retained by serrated caps bolted to the A-frame forging of the crankcase. Bearing alignment is obtained by line boring of the crankcase with the caps bolted in place. The crankcase is a welded fabrication of steel plates and forgings. It retains the cylinder liners and cylinder heads, using crabs and crab studs to transfer the combustion load to the crankcase stress plates and main bearings. The crankcase is supported on the fabricated oil pan which provides a sump for lubrication and piston cooling oil, as well as acting as the engine base.

A gear train at the rear end of the engine drives the blowers and camshafts, while the pumps and governor are gear driven at the front end of the engine. A spring pack type flexible gear on the crankshaft minimises any torsional effects on the various pump gears. Two centrifugal water pumps supply engine cooling water. Pressure oil lubrication and piston cooling oil are provided by a dual gear pump assembly. A gear-type scavenge oil pump is provided to draw oil from the sump and force it through filters and an oil cooler.

GOVERNING

The electro-hydraulic governor controls the position of the injector racks through mechanical linkage, thus controlling the fuel rate. The speed setting is established by four solenoids, singly or in combination, that are controlled by the position of the driver's throttle. For each speed setting this governor establishes a constant power output for the engine, through a load control pilot valve that regulates the generator battery field. This governor also provides shut down protection for the engine when oil pressure is low, or oil pump suction is high. Engine overspeed protection is provided by a spring loaded flyweight on the front end of the right bank camshaft. At 900 r.p.m. this weight trips a pawl shaft that raises the injector rocker arm roller followers off the cams.

A power-plant accessory rack contains most of the auxiliary equipment for engine operation. Included are the engine cooling water tank, lube oil cooler, lube oil filter, load regulator, fuel pump and fuel filters. Oil and water connections to the engine are through flexible metallic containers. The cooling water tank contains a sight gauge showing both running and stopped conditions. There is room for expansion above top level and the tank is vented to atmosphere. Filling pipes from outside the locomotive body lead into the top of the tank. An overflow valve provides an indication of full water level for filling purposes. Total cooling water capacity is approximately 165 gal. Provision for complete drainage of the system is provided.

LUBRICATION SYSTEM

The lubricating oil cooler is an oil tank in which is immersed a radiator core through which the water passes. Water is supplied by return flow of coolant from radiators. Filters for the lube oil are four cartridge-type elements contained in a fabricated tank. Relief valves ensure correct pressure through the filters at all times.

Lubricating oil under pressure is forced through the engine by the combustion pump for lubrication and piston cooling. That oil which falls to the bottom of the engine oil pan is picked up by the scavenging pump and forced through the filters and cooler to the oil strainer housing on the engine. The strainer housing is a reservoir from which the lube oil pump is supplied. Excess oil returned to the strainer housing overflows to the oil pan and re-circulates. Lube oil is added through the cover of the strainer housing and must pass through a mesh screen before it can be picked up by the pump.

FUEL SYSTEM

Two 375-gal. fuel tanks are supported beneath the underframe. They can be filled from either side and a gauge is provided at each side to indicate fuel level. Tanks are interconnected and fill at the same time from either side. Both vent to atmosphere.

Fuel is drawn from these tanks through the suction side of the dual filter to the motor-driven pump. Both of these latter items are on the accessory rack. From the pump, fuel is forced consecutively through the pressure side of the dual filter and the twin-element sintered bronze filter mounted on the right front of the engine. It then flows to the injectors where it is metered to the cylinders by the injectors. As the pump is a constant-speed device, there is an over-supply at all times, which aids in injector cooling and also creates a constant flushing action which prevents air binding in the lines. The over-flow then passes through a restricting orifice and sight glass located on the bronze filter and returns to the main storage tank. The return flow line is purposely located close to the fuel suction pipe to derive the maximum benefit possible from the warmed excess return oil in cooler weather. As much as 30° F. increase in fuel temperature has on occasion been realised by this practice.

A relief valve is installed on the pressure side of the dual filter which will permit by-pass to the bronze filter should the dual filter become clogged. Elements for the dual filter may be replaced by hand with no tools required. There is also a relief valve provided for the bronze filter which can open to by-pass fuel around the engine to the fuel return line in case the filter elements are dirty or the manifold lines are clogged. A sight glass in this by-pass line indicates this condition.

WATER SYSTEM

Water flows from the oil cooler and engine water supply tank on the accessory rack to the two engine-driven centrifugal water pumps. The water is pumped to the bottom of each cylinder liner and from there, up through the cored passages of the cylinder and head, to the outlet manifold. It then flows through two banks of radiator cores, each bank containing five sections, located in a roof-mounted hatch. After passing through the cooling cores, it returns to the oil cooler and supply tank and then to the suction side of the pumps.

Radiator cooling air is drawn through the two louvred air intakes in the sides of the locomotive body by four a.c. driven cooling fans. The air passes through the cores and then the fans, from which it is discharged to the outside of the locomotive. Admission of air through the intakes is controlled by thermostatically-actuated air piston operated shutters. Operation of the cooling fans is also thermostatically controlled so that an increase in engine coolant temperature initiates the sequence of fan and shutter operations required to restore normal running temperature. The shutters are not of the modulating type but are either fully opened or closed at all times.

A hot-engine alarm is provided which causes a light to flash and a bell to ring in the operating cab should the coolant temperature become excessive. While the cooling system is adequate for use with permanent types of anti-freezi solutions, the general practice in American usage is to use water and keep the engine running. As these radiators automatically drain dry on engine shut-down, a relatively small amount of additional heating equipment for standby protection or provisions for utilisation of an outside heating source are required if the customer requires engine shut-down. Water treatment must be used in the cooling system at all times. This also applies to the steam-generating system on these units.

MAIN GENERATOR

The main generator is an 1,120-kW machine with a rating of 2,200 amp. at 1,500 input h.p. at 800 r.p.m. when ventilated with 6,000 cub. ft. per min. of air. Maximum voltage rating of this generator is 930 volts.

Six field windings are used in the generator. The shunt field provides the bulk of the excitation. It and an external resistor are connected directly across the generator terminals. The series differential field is used to provide a drooping voltage characteristic which more nearly approaches constant h.p. curve than that of a simple shunt machine. It also helps to stabilise the generator under transient conditions. The battery field is externally excited. It supplies the balance of excitation required beyond that supplied by the shunt field, and is varied to keep the load constant. The interpole winding and pole face compensating winding are needed for good commutation. The starting winding is connected to the battery in series with the differential winding when using the main generator as a motor to start the engine. The insulation system used in the generator eliminates organic material wherever performance and life is affected. Inorganic materials and silicone resins are the main insulation constituents.

THE ALTERNATOR

The alternator is a 100-kVA, 0.8 p. f., 149-volt Y-connected, 388 amp. rating, three-phase, $106\frac{2}{3}$ cycles, 800 r.p.m. machine. It is an integral part of the generator-alternator assembly. Its inclusion permits use of induction motors on all traction motor cooling and radiator blowers, thus eliminating the miscellaneous clutches, belts, and gearboxes often accepted as locomotive equipment. The insulation scheme used on the alternator also uses inorganic materials and silicone resins. The main generator-alternator group is a single-bearing machine directly coupled to engine flywheel through a flexible coupling.

TRACTION MOTORS

Each traction motor has a rating of 825 amp. at 284 kW when supplied with 2,400 cub. ft. per min. of air. The armature coil design incorporates features that contribute to a relatively easy winding assembly, long life, heat resistance and top performance. High dielectric and heat-resisting materials, such as glass-backed mica and silicone resins, are used in a hot and cold pressing insulation procedure. The coil support insulation also contains long life, heat resistant, inorganic materials having low compressibility. A film of tetrafluoroethylene (Teflon), having high anti-frictional qualities, is located on the coil support directly under each layer of armature coils. This provides anti-frictional surfaces for the thermo-contraction and expansion movements of the copper. All mica, which has a tendency to powder and disappear under thermo movement of the coils, has been elimnated from these locations. The commutator neck width has been increased by 14 per cent over previous EMD designs. New production procedures include improved soldering techniques using pure tin for tinning leads, silver plating on commutator bar necks and tin-antimony solder.

The carbon bushes are of the split type having tamped (cemented) flexible shunts. The stator coil insulation system uses the high-dielectric heat-resistant materials such as glass-backed mica and silicone resins. Improved pressure-type connections are used in the field-circuits, replacing the former brazed connections.

The armature bearings are lubricated by a recently-developed non-oxidizing grease which needs no running maintenance. The lubricant is replenished only during the periodical motor overhaul, which in the U.S.A. varies generally from 200,000 to 400,000 miles. These features permit a sealed bearing.

AUXILIARY GENERATOR AND MOTORS

The auxiliary generator and related equipment provide 74-volt d. c. for charging the battery and to operate the low-voltage control circuits, lights, and battery field circuit while the engine is running. It is self-excited and is driven by a direct connection through a flexible coupling to the engine gear train. Since the speed of the engine varies during normal operation, a voltage regulator is used to maintain a constant 74-volt output. One other duty of the auxiliary generator is to provide excitation for the alternator. When the engine is shut down, the reverse current relay de-energises the battery charging contactor, opening the charging circuit, thus isolating the battery circuit from the auxiliary generator.

AUXILIARY MOTORS

The radiator cooling fan motor is a 9 h.p. 1,550 r.p.m. a. c. motor energised by the alternator. This motor can be termed as an " inside out motor " because the rotating component is on the outside and includes the fan blade construction. Four of these motors are installed in the locomotive and are connected to the alternator circuit so that the number of fan motors energised depends upon the demand for cooling as determined by four thermostatic switches located in the engine cooling system. This self-contained motor and cooling fan unit offers many advantages. The locomotive builder can locate it in the most desirable location and connect it in the a. c. circuit. In previous designs the location was dictated by the mechanical driving mechanism which at times became complicated. The railway benefits in that the cooling fan motor is inherently a low maintenance item, can be easily replaced as a unit, and is a convenient warehouse item.

TRACTION MOTOR BLOWERS

The traction motor blower is a 5 h.p. 3,150 r.p.m. a.c. motor energised by the alternator. Each traction motor has its individual blower motor. These blowers operate continuously as long as the engine is running, and the alternator is producing power. As the current of the alternator is dependent upon the engine r.p.m., the speed of the blower is automatically regulated by the work requirement of the traction motor. When the load demand is great and the engine is producing its maximum h.p. the blower motor is delivering maximum air to the motor. When power is not needed, and the engine is idling, the air supply to the motor is considerably reduced.

CONTROL DEVICES

The transmission control system may be conveniently divided into two functions, load control and transition control. The load regulator and the engine governor comprise the load regulation system. The load regulator is a hydraulic-vane type motor connected to a commutator-type rheostat which is in series with the main generator battery field. The commutator and resistances are mounted on the same framework to form a compact unit with a minimum of commutator to resistance wiring.

The engine governor of electro-hydraulic type controls the engine speed and meters fuel to the engine in accordance with throttle position. It contains a pilot valve, the position of which is a measure of the fuel rate to the engine. If the engine should overspeed due to underloading the governor will reduce the fuel rate. This in turn moves the pilot valve, which admits oil to the vane motor in a manner to increase the battery field excitation and, thereby, increase the load on the engine. If the engine slows down due to overload, the same sequence occurs, but now to decrease excitation and load.

All devices have coils with high-temperature insulation and main contacts with magnetic arc blow-outs and/or special alloy contact material. All auxiliary contacts, interlocks, and relay contacts use silver or alloy contacts. Interlocks and relay contacts are enclosed against dust and dirt. Relays and contactors, where rating permits, use electro-magnetic actuators (coils) rather than air, for simplicity, and contacts are carried directly with solenoid plungers, in straight line motion, without links or levers.

Relays are designed for repeat accuracy of 1 per cent; circuit breakers have special temperature compensation features to enable them to function properly in the variable locomotive ambient temperatures. Cable is for the most part made up of heat-resistant rubber insulation with neoprene jacket, the combination being considered the best available for locomotive installations where excessive moisture and relatively high temperatures are encountered.

CONTROL OPERATION

Transition on the locomotives is completely automatic. The four traction motors are arranged in series-parallel at the start. As speed increases the motor fields are shunted, then the motors are switched to full parallel connection and back to full field strength at the same time, and finally the fields are again shunted. All of this is to keep the generator within its operating range.

All transitions occurring with increasing speed are actuated by relays sensing generator voltage. The power circuits are not opened when shunting the fields as the equipment can handle the transients which occur. In the transition from series-parallel to parallel, generator excitation is removed when the relay picks up and generator voltage is allowed to decay. Switching starts after the voltage has fallen to the relay drop out value. When all circuits are re-established, the generator fields are again energised.

Transition with decreasing speed is made on a relay sensing generator current. The sequence is similar to that above. The generator is de-energised and allowed to decay. The current relay drops out, switching occurs and power is re-applied. The motor field shunting contacter is opened at a predetermined relay drop-out value, and no power reduction is necessary.

Wheel slip is detected by two methods depending on the motor connections. In series-parallel a bridge circuit is used with two motors in one led, balanced resistors in the other, and a relay in the bridge. When slip occurs the slipping motor takes the voltage, unbalances the bridge and picks up the relay. In parallel connection, leads from two motors are passed through a C-clamp type relay with opposite direction of current flow, so that a current balance is obtained. No current goes through the relay as long as the motors run at the same speed, but if one should slip, it will drop current in that motor lead and the current through the relay will be the difference between the two leads. The relay will pick up at a predetermined value.

STEAM GENERATING EQUIPMENT

The steam generator is located over the bolster at cab No. 1. Exhaust and inlet stacks extend through the roof of the locomotive body. A 1,000 gal. water tank is mounted in a corresponding position over the bolster at cab No. 2. These locations are ideal for weight distribution should no steam generator be required for a similar model. The steam generator has a maximum rated evaporative capacity of 2,750 lb. per hr. Operation is completely automatic after the steam generator is started, and full operating steam pressure is reached within a few minutes.

The steam generating part of the unit consists of three sets of coiled water tubing, nested and connected in series to form a single tube several hundred feet long. Feed water, after passing through the heat exchanger, goes through the economiser coil and from there to the main coils of the steam generator. As the water progresses through the coils it is converted into steam. Heat is furnished by the combustion of diesel fuel oil, which is sprayed by compressed air through the atomising nozzle in the fuel spray head into the firepot above the coils. Here the fine oil spray mixes with the air supplied by the blower and is ignited by a continuous electric spark. The hot gases flow first downward then up and outward through the nest of coils, finally flowing out the stack. The supply of fuel is regulated to evaporate 90 to 95 per cent of the water pumped through the coils. The excess water flushes scale and sludge from the coils and is carried over with the steam into the steam separator where the water and sludge are removed before the steam flows into the train-line.

Excess water collects in the bottom of the steam separator. Water above the level of the return outlet flows out through a steam trap and through the heat exchanger where it gives up its heat to the incoming feed water. From the heat exchanger the return water flows through the return water flow indicator back to the water supply tank.

A motor drives the blower, water pump, and fuel pump at a constant speed. The water by-pass regulator automatically controls

(*Continued on page 31*)

COAL FREIGHT ACCOUNTS BY PUNCHED CARDS

By A. A. Foren

Head of the Mineral Accounts Section of the Chief Accountant's Office, British Railways (Western Region), Barry Docks.

THE application of punched card methods to the work of compiling Railway Coal Freight Accounts is well out of its infancy; in fact the Mineral Accounts Office responsible for safe-guarding and collecting the revenue arising from the conveyance of coal and coke originating on the Western Region of the British Railways, has been using and developing the system for more than twenty years. It will be appreciated, therefore, that the idea has long passed from the experimental stages to that of established practice.

A short outline of the procedure adopted to meet the rather unusual features of the work in connection with Railway Coal Freight Accounts may interest other users and potential users and, in some way, assist in solving some of the problems connected with the fitting of mechanical accounting to circumstances which, at first, seem unpromising.

DECLARATION BY CONSIGNOR

The charging of "Coal Class" traffic is primarily based on a declaration, variously known as a Consignment Note or Colliery Permit. This is required to be handed to the local Railway Agent when traffic is tendered for conveyance and includes, inter alia, all the information required to enable the charges to be assessed, viz.—

(*a*) The point from which the traffic is to be taken.

(*b*) The point at which the traffic is to be delivered.

(*c*) Net weight contained in each wagon, totalled if more than one wagon.

(*d*) Date.

(*e*) Name of party liable for conveyance charges.

INVOICING

From the information shown on the Consignment Note, the Forwarding station Agent prepares a document known as a "Weight Invoice"; this is sent to the Agent at the station to which the traffic is consigned and the arrival of the wagons is thereby checked.

The forwarding station Agent summarises daily the details shown on the "Weight Invoices" issued, and sends this summary, together with the relative consignment notes, to the Mineral Accounts Office.

(*Continued from page 30*)

steam generator output by regulating the amount of water fed to the coils. Before entering the coils, the water passes through servo-fuel control which admits fuel to the spray nozzle in direct proportion to the amount of water entering the coils. The servo-fuel control also adjusts the damper to admit the proper amount of air for efficient combustion of the fuel. Train-line steam pressure is regulated by adjusting the setting of water by-pass regulator. The length of train and weather conditions determine setting.

Remote control panels are located in the cabs. Mounted on each panel is a push button switch to operate the separator blow-down valve. A train-line steam pressure gauge is mounted adjacent to the remote control panel.

CHARGING AND PREPARATION OF ACCOUNTS—Mineral Accounts Office

(a) Daily Record of Tonnages

The total tonnage of each summary received from the forwarding station is recorded daily and a Regional total obtained.

(b) Pre-punched Cards—White

Much of the information required for the preparation of accounts recurs day by day and a file of white cards is maintained pre-punched for the forwarding point, the receiving point, the rate per ton, and, in some cases, a code number signifying the account to be debited. Experience has shown that these cards cover approximately 70 per cent of all consignments.

(c) Unpunched Cards—Green

A supply of unpunched cards is available for the 30 per cent residue; these cards are green.

(d) Preliminary Operations for Completion of Cards

The station summaries and consignment notes, referred to under " Invoicing " above, are passed each day to female operators who refer to the file of " white " cards and extract cards for each consignment for which an appropriate pre-punched card is available; a " green " unpunched card is interpolated for the residue not covered by the pre-punched file.

The items covered by the green cards are then subjected to further examination and the cards are punched with the destination details.

The code number of the freighter (i. e. party paying carriage) is in some cases already provided for on the white cards; for the remainder, the information is, at this stage inserted on the respective consignment notes.

The consignment notes and cards, each assembled in the same order, are then passed to punch operators who punch—

(*a*) Code number of account to be debited (if not already pre-punched)

(*b*) Date

(*c*) Weight

and additionally in the green cards only—

(*d*) Farwarding station (in code) and the Colliery.

The cards are then tabulated in the same order with the tabulators set to provide—

(*a*) Sub-totals, representing forwardings of each station

(*b*) Grand total of the day's forwardings.

These tabulations are scrutinised by clerks, who compare them with the consignment notes and satisfy themselves that the tabulated information is correct in all details, or amend as necessary; in this process the sub-totals are compared with those shown on the Agent's daily summary which accompanied the consignment notes.

The corrections indicated by the checkers are then carried out on the cards and a further check imposed to ensure accuracy.

(e) Balance Control Book Totals

A reliable grand total of the tonnage forwardings for the day is now available and is recorded in a " Balance Control Book " designed to ensure the maintenance of tonnage and charges balances through all the stages of the work; the inclusion of charges in the book is covered by succeeding operations as detailed below.

It is claimed that the control exercised by the medium of the " Balance Control Book " is so effective that once a consignment has come under notice it cannot by inadvertence be overlooked through the loss of the consignment note or the Powers-Samas card on which it is recorded.

The well laid-out battery of Automatic Key Punches at the Mineral Accounts Section, Barry Docks.

(f) Separation of White and Green Cards for Further Operations

The reader will gather from the foregoing that the cards at this stage contain all the information required except—

(*a*) White cards require evaluation

(*b*) Green cards require rating and evaluation.

The cards are therefore passed through the automatic sorter to separate them into these two categories.

(g) Evaluation of White Cards

The cards are machine sorted into gradations of rate and weight and ready reckoners specially complied with separate pages for each rise of 1d. rate, showing, for each 1d. rate, the evaluation at each 1 cwt. stage, are available for assessing the charges; with ready reckoner and cards in sympathetic order, the work of writing the cash values on the cards is carried out with surprising speed.

These written amounts are then punched into the cards, which are again tabulated, this time setting the tabulator to produce sub-totals of tonnage and cash at each variation of rate.

A check is made to determine that the sub-totals thus produced are correct in calculation, and if so, it is assumed that the individual cards comprised are correct.

After carrying out the correction of those cards found to be inaccurate and suitably amending the grand total, the grand totals of tonnage and cash are recorded in the "Balance Control Book," and the cards are set aside until required at the month's end for freighters' accounts.

(h) Rating and Evaluation of Green Cards

The cards are tabulated and clerks, working from rate books, of which there are several hundred, insert the chargeable rates on the tabulation and return it to punchers to carry the information to the cards.

Accumulating several days, as convenient, the cards are sorted in an order which corresponds with the rate books and tabulated again for rate checking, after which they follow the same procedure as the white cards.

(i) Production of Monthly Accounts

At the month end all the cards are assembled and sorting is commenced for the production of the monthly accounts.

The accounts vary widely in size, from a single item to thousands, but all are sorted into alphabetical order to assist the freighters to check the accounts and to enable them, and the Mineral Accounts Office staff, to quickly locate any particular consignment.

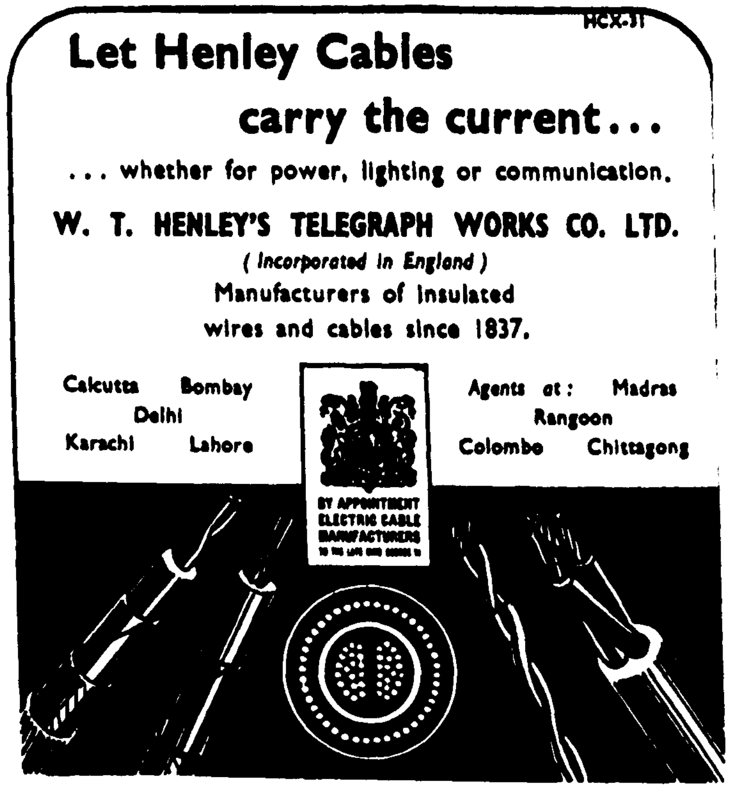
The sorting is broken down to comparatively small batches of groups of freighters for convenience of handling and also to allow the tabulation of some of the accounts to go forward whilst the remainder are still in the sorting stages.

As the Accounts are tabulated they are passed to a punch operator who punches a Ledger Posting card to record—

(*a*) Freighter (Code number)
(*b*) Grand Total, tonnage and cash,

and the grand total, tonnage and cash, of these cards, when ultimately tabulated, should agree in total with the figures already ascertained and entered in the " Balance Control Book ".

(Continued on page 35)



Forty Years of Sulzer Diesel Traction

FORTY years ago, in September of 1912, the world's first Diesel locomotive ran its trials on the Winterthur-Romanshorn line in Switzerland.

This first Diesel locomotive was equipped with a single-acting reversible four-cylinder Sulzer engine of the two-stroke type which developed a maximum output of 1,600 H.P. at 304 revs. per min. and transmitted its power direct to the driving axles. The nominal rating of the locomotive was approx. 1,000 B.H.P. It had two four-wheel carrying bogies and two driving axles supported in the frame. Its length was 16.6 metres (54 ft. 6 in.) over the buffers and its weight in working order about 95 tons.

In March 1913 the locomotive travelled by way of Basle, Strasburg, Worms and Nordhausen to Berlin, where it was taken over by its purchasers, the Prussian State Railways.

Forty years after this event, it is interesting to look back over the developments which have since taken place and to consider the present situation of Diesel traction.

HISTORICAL SURVEY

The idea of employing the Diesel engine for rail traction is as old as the engine itself. As early as 1897, when the first practical Diesel engine was completed, its use in rail vehicles was seriously considered, in accordance with the plan which Diesel himself had natured from the outset. More than ten years were to pass, however, before this idea was to take on material form. The creation of Diesel engine suitable for the purpose envisaged was in fact one of the most difficult designing tasks which could have been set before the engineer of those days. Foremost among the numerous difficulties were the problems of weight and space requirements. Whereas in marine propulsion, for instance, fairly wide scope is left for the choice of these two factors, the limits imposed by the requirements of rail vehicles are so narrow that no satisfactory solution to the problem

(Continued from page 34)

The accounts then pass to clerks for finalising by the addition, by hand, of supplementary debits which arise in respect of earlier months' accounts from diversions of consignments, amendments of declarations, and other causes. Cards are punched to represent these debits, and together with the Ledger Posting cards referred to in the previous paragraph, are used to produce the Ledger Posting Sheets, from which, as the name implies, the debits are posted to the Ledger Accounts.

(j) Check with Receiving Station Returns

After the freighters' accounts have been completed and balance achieved, the whole of the cards are re-sorted by machine into receiving station order and a separate tabulation producing for each Railway Region for the purpose of checking with the receiving station's returns of invoices received, so completing the chain of checks necessary to ensure that the correct charges are collected on all traffic that passes.

INSTALLATION

The installation consists of 3 Powers-Samas Tabulators, 8 Automatic Key Punches, 3 Sorters, 1 Reproduces, and deals with 65/70,000 consignments per month.

was feasible until the Diesel engine itself had made considerable progress. Other difficulties which confronted the designer were those of starting, manoeuvring and governing, which are for obvious reasons all much more complicated in the traction field than in any other Diesel application.

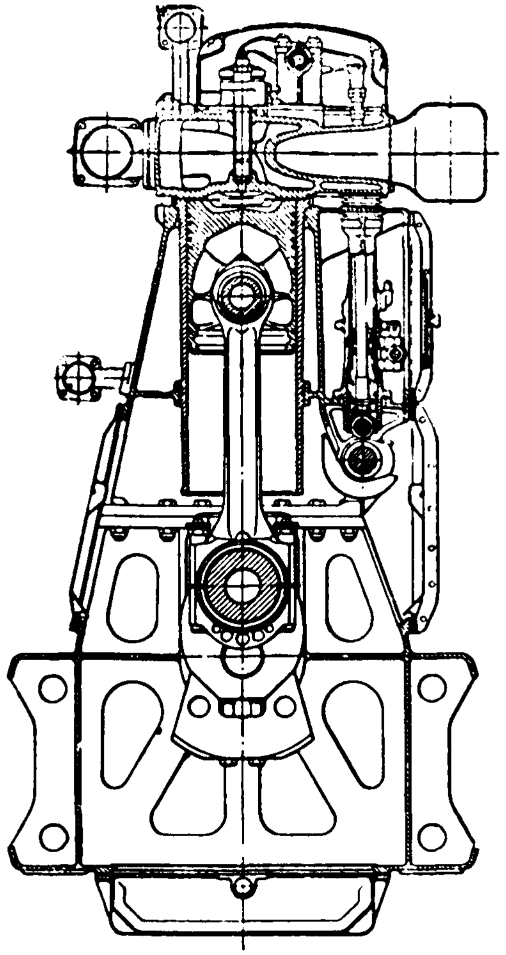
Sulzer Brothers of Winterthur tackled these problems at a very early stage and made an outstanding contribution to their solution. In colloboration with Rudolf Diesel and A. Klose of Berlin they founded in 1906 a Society for Thermolocomotives, and enterprise which was to occupy itself with the study and design of large Diesel locomotives. In the following years the engine for the world's first Diesel locomotive was constructed to Sulzer plans in the shops at Winterthur, undergoing its first trials on the test-bed there in April 1912. The planning and building of the mechanical part of the locomotive had been entrusted to Messrs. Borsig of Berlin. The main responsibility for the success of the undertaking, however, lay with Sulzer Brothers, who not only

The world's first Diesel locomotive, which was equipped with a Sulzer four-cylinder two-stroke engine of 1,000 H. P. transmitting power direct to the driving wheels.

designed and constructed the engine but also installed it in the locomotive with all the necessary auxiliaries and apparatus.

Thus the first Sulzer Diesel locomotive came into existence.

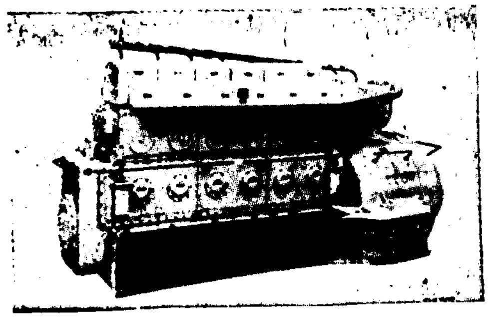
The building of this locomotive was a first practical attempt to use the Diesel engine for propelling a rail vehicle. Although this prototype, with its direct power transmission to the driving wheels, did not give full satisfaction, it at least enabled valuable experience to be acquired and turned to account later in the further development of the Diesel locomotive. The next important advance was the adoption of electric transmission between the Diesel engine and the driving wheels. The output of the Diesel engine is here



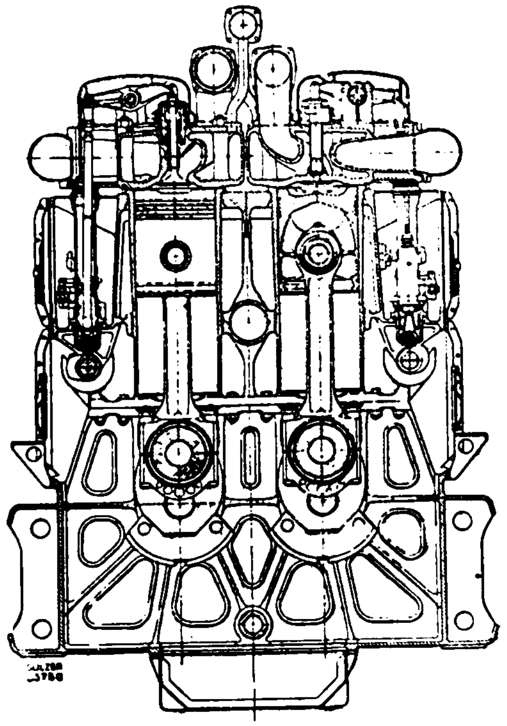
Cross-section through a modern Sulzer single-row traction Diesel engine of welded design.

absorbed by a generator which in turn feeds the traction motors. A few railcars equipped with 200 H.P. Sulzer Diesel engines and with electric power transmission were supplied to German railway companies even before the outbreak of the first World War.

From this point onwards the evolution of the Diesel locomotive and the railcar went forward without intermission. Sulzer Brothers from the first took a special interest in the development of high-powered units, assuming that this would be a particularly promising application of the Diesel locomotive. Their studies in this direction revealed that it was possible to build Diesel locomotives of over 4,000 B.H.P. with weights not much in excess of those of steam locomotives of the same power. The Diesel locomotive was thus able to enter the lists on an equal footing with steam and electric locomotives. Its employment now depended solely on considerations of economy and rail traffic requirements. Diesel traction has special advantages to offer in regions where water is scarce or on lines on which fuel must be carried over long distances. Its low water and fuel consumption and the much easier transport of its oil fuel as compared with coal make the Diesel engine highly suitable for working conditions of this kind. These and allied considerations have in recent years led many railway companies to introduce Diesel traction on some of their lines.



Six-cylinder single-row Sulzer Diesel engine of 735 H. P. at 850 revs. per min., with exhaust-gas turbo-charger. Welded dust-tight design. The frame carrying the main and auxiliary generators forms part of the crankcase.



Cross-section through a double-row Sulzer traction Diesel engine of welded design, 1952 model.

CONSTRUCTION OF THE SULZER TRACTION DIESEL ENGINE

The characteristics of the single-row traction Diesel engine as built today by Sulzer Brothers appear from the cross-section, general view and the cross-section of the double-row engine employed for higher outputs, shown in above illustrations. The crankcase is carried up well above the centre line of the shaft and is therefore very rigid. The U-shaped transverse walls support the crankshaft bearings. The upper halves of these bearings are supported by keys on the projections of the tie bands which form the inner limit of the transverse wall. The tie band transmits the reaction forces of combustion from the cylinder block along the shortest path to the crankshaft bearing saddles, so that the flux of force takes the simplest possible form. The crankcase also incorporates the members which support the whole engine-generator group on the underframe. On the generator side the bars are extended and

Diesel-electric railcar, rated at 270 H.P., of the Ferrocarril Provincial de Buenos Aires. Four of these narrow-gauge railcars have covered about 1,600,000 km. or 1,000,000 miles each in 16 years (supplied in 1936).

curved outwards to take the generator, which is direct coupled to the Diesel engine. The crankcase was originally made of cast iron and later of cast steel, the bars supporting the Diesel-generator group being designed as a sub-frame. Today the sub-frame and the crankcase are welded to form a single whole, which naturally increases the strength of this structure. The transverse walls are of cast steel in the large engines while in the smaller units they are of steel plate like all other parts of the crankcase. This combined design permits the wall thicknesses to be more accurately adapted to the strength calculations than would be possible with an exclusively cast-iron or cast-steel design, and fullest utilisation of the material is thereby attained.

The vibration-free running of the Diesel engine depends partly on the effective balancing of the reciprocating and rotating parts and partly on another important consideration: the question of whether the crankcase is rigid enough to take the stresses due to the internal moments of the masses without any deformation of practical significance. The design of the Sulzer traction Diesel engine adequately fulfils this latter requirement also, a point in which it is superior to light-metal designs, which tend to plastic deformation and are not entirely satisfactory in their resistance to vibration.

The cylinder block is constructed on the same designing principles, the transverse walls—which are of steel plate in the smaller and cast steel in the larger engines—being welded to the steel-plate longitudinal walls to form a solid block. The water-cooled and interchangeable cylinder liners are inserted in the cylinder block in the usual way.

Each cylinder has its own cylinder cover with one admission and one exhaust valve. The light-metal piston can be readily removed from above after taking off the cylinder cover and unscrewing the connecting-rod bolts.

The fuel pumps are fitted with delivery plungers which are rotated to regulate the quantity of fuel injected and are so arranged that all the supply pipes running to the injection valves in the cylinder covers are of equal length. This permits uniform distribution of the output over the individual cylinders at all loads. The plungers are provided with oblique control edges both for the beginning and for the end of injection. As a definite torque and thus a definite delivery quantity of the fuel pumps is allocated to every engine speed, the preliminary injection can be adapted to the speed in a very simple way.

All moving parts of the Diesel engine are connected to the automatic forced-lubrication system, so that there is no obstacle to an enclosed dust-tight design.

Vibration dampers of the Sarazin type have given excellent service in the control of critical vibrations of the crankshaft. A description of these dampers was given in Sulzer Technical Review No. 1, 1945, page 115.

CONTROL SYSTEM

The present-day Sulzer control system for Diesel-electric vehicles is no doubt the most consistent embodiment so far achieved of the principle of running the Diesel engine at the most favourable speed for the required traction performance at all times, while setting the load by regulation of the generator excitation in such a way that due account is taken of variations in the loading capacity resulting from the thermal conditions of the engine. The Sulzer control system fulfils these requirements in the simplest possible way by taking its control impulse from the governor of the Diesel engine. The allocation of a definite torque to each engine speed, a feature introduced by Sulzer Brothers, has made it possible to fix the beginning of delivery by a second oblique control edge on the pump plunger. This is beyond doubt a great simplification. On the other hand, it was only the use of a pressure-charging safety device in conjunction with a spring member fitted between the governor and fuel pumps which enabled the advantages of this output control system to be secured in the pressure-charged Diesel engine. The Sulzer control system thus exercises the following functions:

The field regulator keeps the output of the engine constant on every controller notch within a given range in spite of changes in the resistance to motion (e.g. gradient of line) the temperature of the electric machines or the load on the auxiliary generator.

The load on the engine is reduced, while the engine speed is kept constant, if the pressure-charging safety device comes into action or the output of the engine falls off temporarily for any exceptional reason, as for instance a leakage in one of the fuel pipes.

The pressure-charging safety device takes effect when the charging pressure is too low for the fuel quantity injected, as far instance during acceleration of the Diesel engine or the pressure-charging group, or when the resistance in the suction-air filter is excessive as a result of fouling.

Long years of experience have shown that the Sulzer control system is able to fulfil all the requirements imposed by normal traction service. Supplementary protective equipment has been developed and patented for lines running at great altitudes or with widely varying temperature conditions.

SERVICE RESULTS

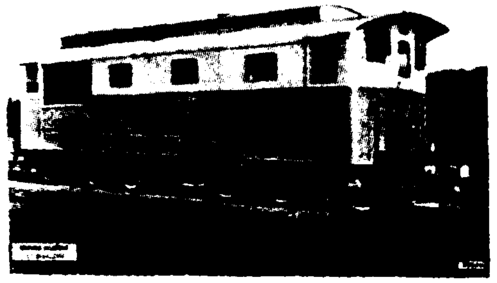
One of the earliest Sulzer Diesel railcars, which first took up service in Germany in 1914, and later, after conversion, came into the possession of a Swiss private railway, is still running today. Throughout this periods no major repairs have been necessary to the Diesel engine, nor have any important component been replaced.

Two travelling power houses of 1,200 H.P. each have been running on the suburban lines of the former Ferrocarril Sud de Buenos Aires since 1930. Each unit is powered by two Diesel engines of a type employing pre-combustion chambers and developing 600 H.P. at 700 revs. per min. The vehicles weigh 87 metric tons each and have a maximum speed of 75 km. (47 miles) per hr. In addition to the motors in the power-station vehicle itself, the generators feed traction motors fitted in five of the carriages. This arrangement permits of the high acceleration needed for suburban service. When required, the two power stations can be combined with their carriages to form a 730-ton train seating 1,100 passengers.

Sulzer Diesel-electric shunting locomotive of 735 H. P. owned by the Societe Nationale des Chemins de Fer Francais (supplied in 1938). Their experience with these locomotives led the S. N. C. F. to order numbers of other shunting locomotives with Sulzer Diesel engines.

These vehicles have covered 60,000 and 65,000 km. (37,500 and 40,500 miles) per year respectively at the low average speed typical of suburban service. About the middle of 1933, the same railway company commissioned three further more powerful travelling power houses, each equipped with two engines of 850 H.P. These units weigh 132 tons and are normally used with eight carriages fitted with two traction motors each. The weight of the train is then 570 tons, the accommodation comprises 800 seats and the maximum speed is 112 km. (70 miles) per hr. The higher output per ton of train weight and the higher maximum speed permit a noticeably better utilisation of these vehicles, each of which has now covered about 2 million km. (1,250,000 miles). These mobile power stations are submitted to a general overhaul after each 300,000 km.

Very detailed data are available on the service of four railcars which Sulzer Brothers supplied in 1936 to the Ferrocarril Provincial de Buenos Aires. These railcars, each fitted with a six-cylinder engine having a one-hour rating of 270 H.P. at 1,100 revs. per min., weigh 37 tons and are able to seat 62 passengers. Their maximum speed is 80 km.



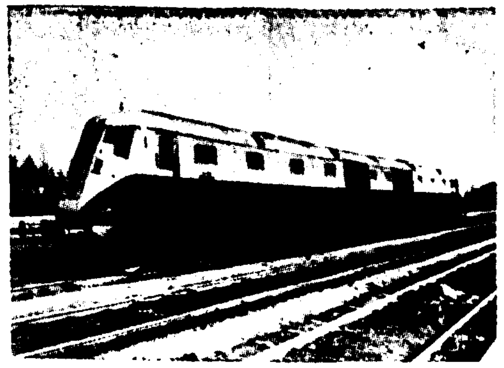
Diesel-electric freight locomotive of 735 H. P. owned by the Compagnie des Phosphates de Constantine.

(50 miles) per hr. In their sixteen years of service up to and including 1951, they had averaged 1,600,000 km. (1 million miles) each.

During the whole service period of these Diesel engines, they have given no trouble of a serious nature. In particular no connecting rods, cylinder covers, liners or fuel pumps have been replaced, although the engines are of a comparatively fast-running type.

Up to the present the railway company has not considered it necessary to undertake capital overhauls.

Locomotives equipped with Sulzer Diesel engines have been adopted on an unusually wide scale in France and the French Colonies. Some of these units were put into service in 1933 by the Compagnie des Chemins de Fer Paris-Lyon-Mediterranee, as it was then



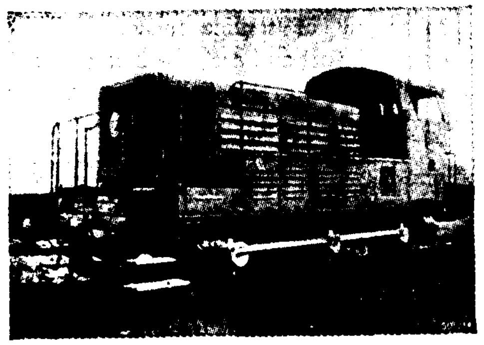
Diesel-electric locomotive rated at 4,400 H. P. and employed by the Societe Nationale des Chemins de Fer Francais for hauling 600-ton trains at 80 km. (50 miles) per hr. on gradients up to 8 per mille (1 in 125), or at 130 km. (81 miles per hr. on the level (supplied in 1938).

designated, and by its Algerian lines, as well as by the Syndicat des Chemins de Fer Ceinture de Paris. Mention should also be made of a series of shunting locomotives, each equipped with a six-cylinder engine developing 735 H.P. at 850 revs. per min. This engine is a standard type of which 117 units have so far been supplied. The locomotives in question were purchased by the Societe Nationale des Chemins de Fer Francais. They weigh 71 tons each and have a maximum speed of 50 km. (31 miles) per hr.

The same engine type is fitted in the locomotives of the Cie. des Phosphates de Constantine, which have a weight of 67 tons and the same maximum speed of 50 km. per hr. These narrow-gauge locomotives were used for the first three years for pulling heavy train-loads of minerals, on which duty they covered a total of 150,000 and 200,000 km. (94,000 and 125,000 miles) respectively. Since 1941 they have been employed on the lines of the Chemins de Fer Algeriens and the Chemins de Fer Tunisiens. The outstanding results obtained with these locomotives under the most unfavourable climatic conditions, including high air temperatures, sandstorms and the like, greatly contributed to the decision taken by other railways in tropical and sub-tropical countries to purchase Diesel locomotives with the same Sulzer engines. The Cie. des Phosphates et du Chemin de Fer de Gafsa, for instance, has so far ordered 17 of these locomotives, the Chemins de Fer Tunisiens 33, the C.F. Dakar Niger 24, the C.F. Madagascar 14 and the C.F. Cameroun 6.

The 4,400 H.P. locomotive of the Societe Nationale des Chemins de Fer Francais is of particular interest. It has a length of 33.05 metres (108 ft. 5 in.) over the buffers and a weight in working order of 228 tons, while its maximum speed is 130 km. (81 miles) per hr. This locomotive took up service in the summer of 1938, covered 222,700 km. (139,200 miles) before the outbreak of war and was then taken out of service till the middle of 1945. From this date till the summer of 1952 it again covered 1,300,000 km. (810,000 miles). The maximum wear on the piston ring grooves after a total of 966,478 km. (approx. 600,000 miles) was 1.5 mm.

Owing to the events of the war, very little information has been received on the service results of the 4,400-H.P. express locomotive of the Rumanian State Railways, which is 29.3 m. (96 ft. 4 in.) long, weighs 230 tons in working order and has a maximum speed of 100 km. (62 miles) per hr. The locomotive



Diesel-electric shunting locomotive of the S.N.C.F., equipped with a six-cylinder Sulzer Diesel engine of 570 H.P.

was employed on a difficult mountain line where it acquitted itself excellently. When put into service, it was the most powerful Diesel locomotive in the world. It attracted a great deal of attention not only in Rumania but in the Balkans as a whole on account of the simplicity of its controls and servicing, its low working costs and its great reliability. It is fairly certain that this successful new design would have resulted in numbers of repeat orders if the war had not intervened. The locomotive escaped the severe bombardments of the Rumanian railways. As it was less dependent on depots than steam locomotives, it was always in very active service, while its stays at the points most exposed to the danger of air attack were kept to a minimum. After the end of the war the locomotive was used for a considerable period as a mobile power station supplying current during the reconstruction of railway workshops.

The 1,200-H.P. locomotives owned by the Swiss Federal Railways, with a service weight of 65 tons and a maximum speed of 110 km. (69 miles) per hr., are each fitted with an eight-cylinder engine running at 750 revs. per min. These locomotives were to be the prototypes of the vehicles which the Swiss Federal Railways wished to employ on lines with little traffic for hauling light express trains. They were put into service at the outbreak of war, but shortly afterwards had to be taken out of service on account of the shortage of fuel and are now being employed for local traffic on the few lines not yet electrified, where they had covered approx. 600,000 and 700,000 km. (375,000 and 450,000 miles) respectively by the end of 1951.

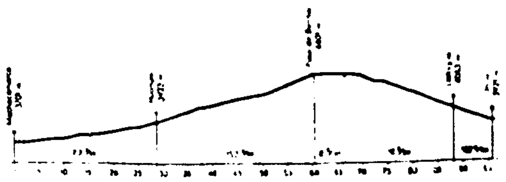
NEW UNITS

In conclusion a few examples may be quoted of units which have been put into service in the last few years.

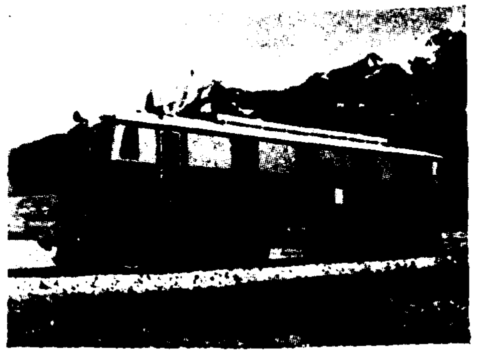
Prompted by the excellent results obtained with their other Diesel-electric locomotives, the S.N.C.F. decided in 1945 to order 48 Diesel-electric shunting locomotives, each to be equipped with a six-cylinder Sulzer Diesel engine of 570 H.P. The first of these units took up operation in July 1950. They were intended not only for the usual shunting duties on stations but also for handling heavy trains at comparatively low speeds and for hauling trains of all kinds on branch lines at speeds up to a maximum of 60 km. (37 miles) per hr. They are used either alone or in pairs, according to the job in hand. Remarkable results were obtained even during the first trial runs. On the particularly difficult line from St. Etienne to Roanne, which has gradients up to 18 per mille (1 in 55), two units coupled together were able to handle 600-ton trains without any trouble at an average speed of 50 km. (31 miles) per hr. During the shunting trials in the Lyon-Guillotiere station, trains of 600 and 850 tons were moved from rest by a single locomotive.

The above illustration shows a Sulzer Diesel-electric locomotive of 730 H.P. supplied to Bolivia a few years ago. The Patino Mines and Enterprise Consolidated (Incorp.) ordered this locomotive from Sulzer Brothers, Winterthur, with a view to improving the through passenger and goods services on their own winding narrow-guage line from Machacamarca to Uncia. Sulzer Brothers, who acted as general contractors for the locomotive, built the Diesel engine and its accessories in their own shops while entrusting the Maschinenfabrik Oerlikon of Zurich with the electrical equipment and the Ateliers Metallurgiques S. A. of Nivelle, Belgium, with the mechanical part. A detailed description of this locomotive was given in the Sulzer Technical Review No. 1, 1950, p. 16. The total length of the locomotive is 15.404 m. (50 ft. 8 in.), the maximum service weight 70.4 metric tons. It is driven by a Sulzer six-cylinder Diesel engine with a one-hour rating of 730 H.P. at 750 revs. per min. and 4,000 m. (13,000 ft.) above sea level, and a continuous rating of 650 H.P. at 700 revs. per min. at the same altitude. Extensive trials were run with this locomotive, with trailing weights up to 250 tons, on Swiss narrow-gauge lines.

Sulzer Diesel-electric locomotive of 730 H.P. for a Bolivian railway company.



Longitudinal profile of the Machacamarca-Uncia metre-gauge line in Bolivia.



Sulzer Diesel-electric locomotive of 960 H.P. owned by the Thai State Railways.

To supplement their fleet of Sulzer locomotives, the Thai State Railways have ordered from Sulzer Brothers three further Diesel-electric locomotives of 960 H.P. which are intended mainly for service on the 1,200-km. Bangkok-Penang line, the northern section of the run of the "Southern Express" from Bangkok to Singapore. These locomotives will also be used, however, on the mountainous northern line, 750 km. in length, from Bangkok to Chieng Mai. Once more acting as general contractors, Sulzer Brothers ordered the electrical equipment from the Maschinenfabrik Oerlikon of Zurich and the mechanical part from Messrs. Henschel & Sohn of Kassel. The locomotives are propelled by eight-cylinder Sulzer Diesel engines developing 960 H.P. at 850 revs. per min. A full description of these units was contained in Sulzer Technical Review No. 3, 1951-p. 15.

Diesel-electric luggage railcar of the Chemins de Fer Algeriens, equipped with two six-cylinder Sulzer Diesel engines of 735 H.P. each.

The above illustration shows a Diesel, electric luggage railcar of 1,470 H.P. for the Chemins de Fer Algeriens. This unit is fitted with two six-cylinder Sulzer Diesel engines of 735 H.P. each.

CONCLUSION

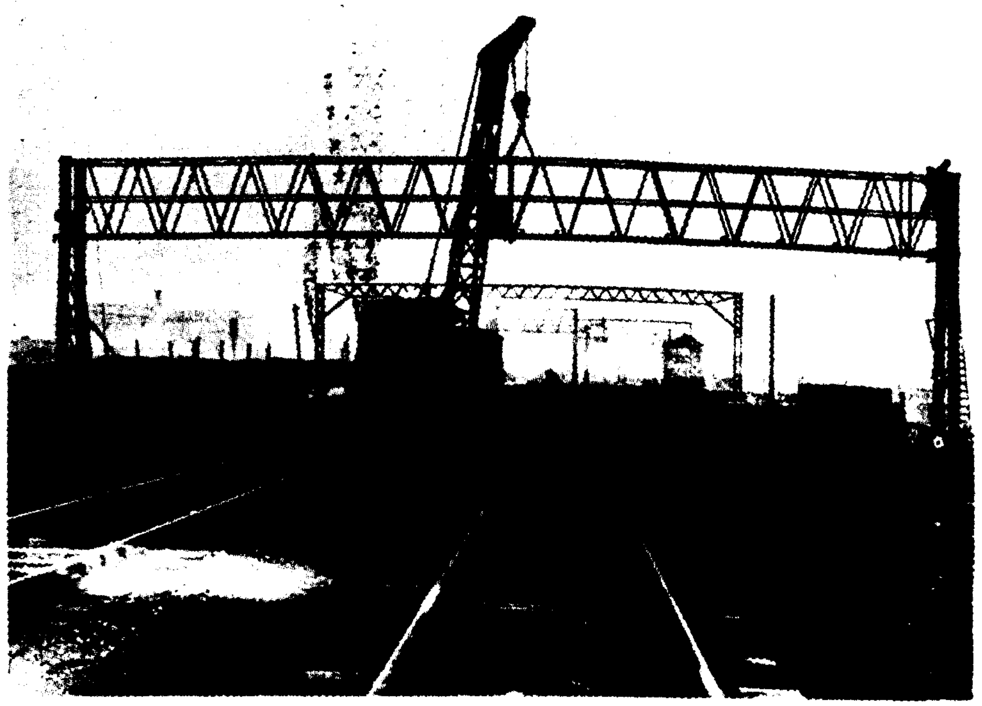
In the course of four decades the Diesel engine has earned a reputation as a traction power unit which assures it of an ever-widening field of application.

Engineers from three different branches—the locomotive builder, the Diesel-engine designer and the electrical supplier—all make their contribution to the construction of a Diesel-electric rail vehicle. Each of these branches of engineering has its own traditions, which are founded on many years of experience. The Diesel-electric vehicle can therefore only be a success when the general planning of all three parts is co-ordinated by being placed in the same hands. The successes achieved by Sulzer Brothers in the field of Diesel traction are largely to be attributed to the fact that an organisation created many years ago puts them in a position to act as general contractors for the construction of Diesel-electric vehicles.

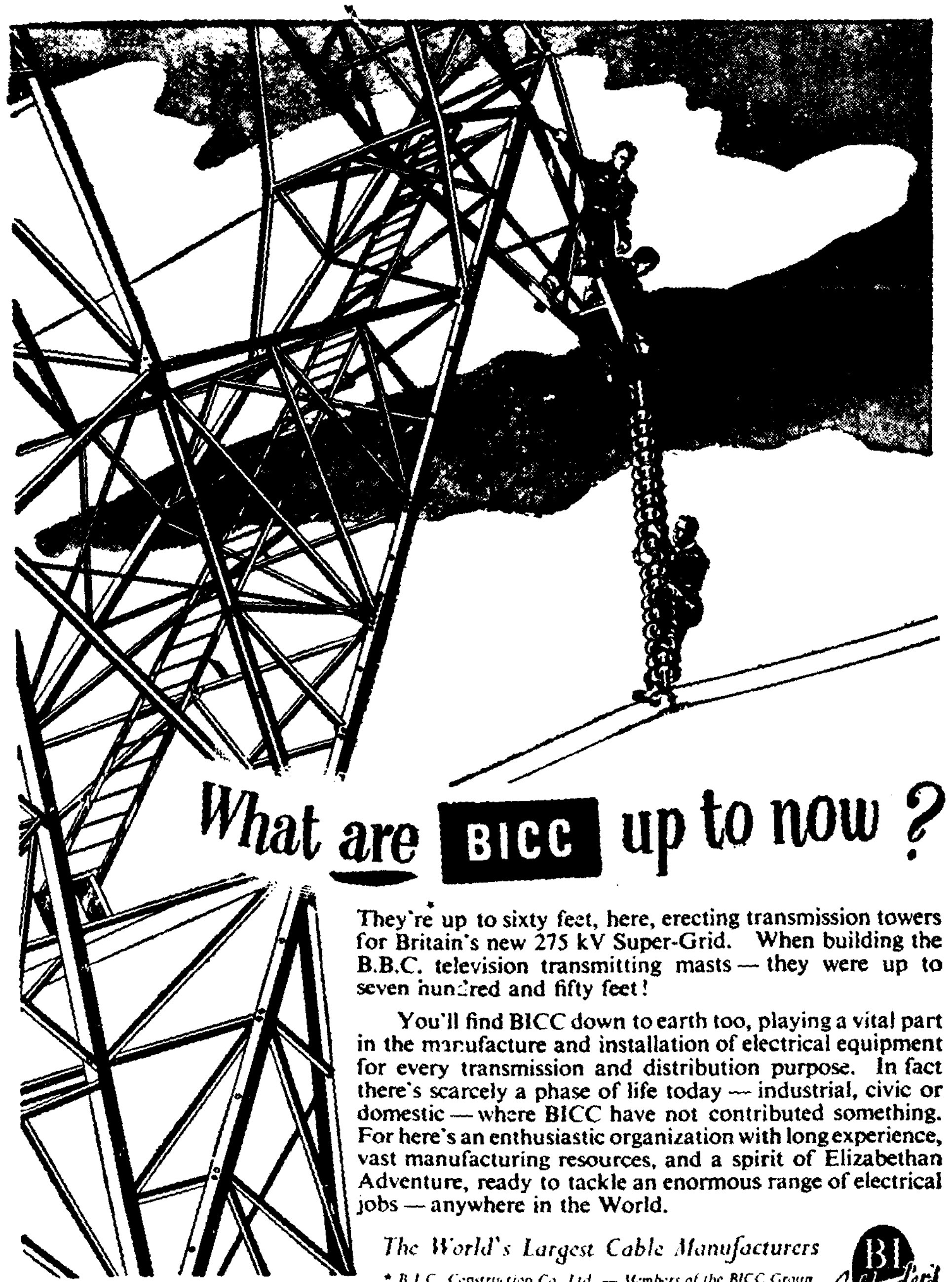
The Role of BICC in Railway Electrification

THE initials BICC, familiar in every continent of the world, are frequently to be seen in those countries where schemes for industrial development and modernisation are progressing most rapidly. It is not possible to compute the many thousands of miles of telephone and power cables that have been manufactured and installed since the first branches of the Group were formed in 1882 nor would any useful purpose be served in enumerating the many overhead transmission line and trolley bus schemes successfully carried out. It is, however, not without review the part played by this Organisation in the modernisation of railway transport systems which has now become an essential feature of our economic life.

British Insulated Callender's Cables Limited, together with its subsidiary British Insulated Callender's Construction Company Limited, has been associated with railway electrification for forty three years, since the commencement of the electrification of the Melbourne suburban lines of the Victoria State Railways in 1912. This scheme was authorised to enable the railway company to cope with the ever growing traffic resulting from the rapidly increasing population of Melbourne during the years immediately preceeding the first World War. Since those early days many further railway electrification schemes have been successfully undertaken and commissioned in countries with climates varying from the sub-trophical conditions of Brazil, South Africa and India, through the more temperate weathers of Australia and Britain to the continental extremes of Poland. The underlying reasons which prompted the several authorities to pursue such progressive schemes were, of course, not identical in each case, although many of the benefits which are inherently derived from electrification were common to all. It may perhaps be advanta-



Erecting the bridge of a multi-track anchor structure—London to Shenfield Electrification.



They're up to sixty feet, here, erecting transmission towers for Britain's new 275 kV Super-Grid. When building the B.B.C. television transmitting masts — they were up to seven hundred and fifty feet!

You'll find BICC down to earth too, playing a vital part in the manufacture and installation of electrical equipment for every transmission and distribution purpose. In fact there's scarcely a phase of life today — industrial, civic or domestic — where BICC have not contributed something. For here's an enthusiastic organization with long experience, vast manufacturing resources, and a spirit of Elizabethan Adventure, ready to tackle an enormous range of electrical jobs — anywhere in the World.

The World's Largest Cable Manufacturers

* B.I.C. Construction Co. Ltd. — Members of the BICC Group

BRITISH INSULATED CALLENDER'S CABLES LIMITED

Esplanade House, Waudby Road, Fort, P. O. Box No. 111, Bombay-1

Branches also at :

Ahmedabad, Ambala, Bangalore, Calcutta, Coimbatore, Kanpur, Madras, Nagpur, New Delhi, Secunderabad (Dn.) Trivandrum.

Four-track, broad flange beam portal structure. Showing a method of "registering" (i. e. locating) the contact wire and auxiliary catenary wire over each track. The wires are arranged in compound catenary form.—London to Shenfield Electrification.

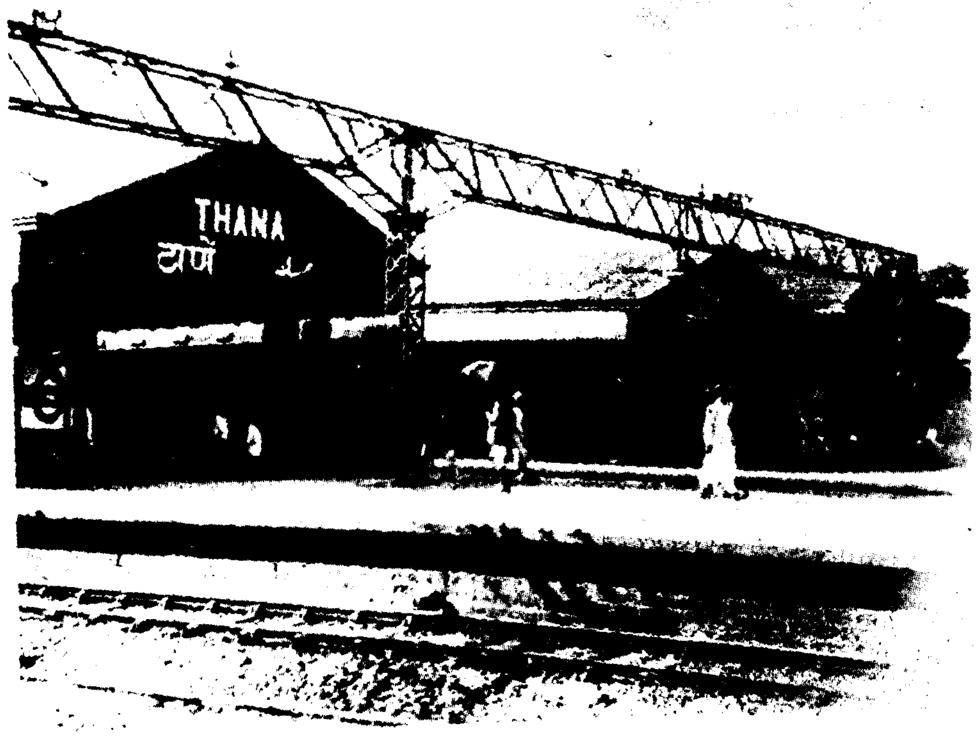
Two-track construction on the Central Railway (ex G. I. P. Railway, India).

geous to pause here and outline briefly why this should be so.

All countries for their transport systems require a prime source of power whether it be coal, oil or water and it is a fundamental measure of economy that where one or other of these sources of supply is non-existent or unduly expensive that emphasis should be placed on the full utilisation of the home produced or cheaper product. Certain countries, notably India, Central Africa, New Zealand and others in Europe and Scandinavia are fortunate in possessing huge latent reserves of water power and it is therefore proper that these peoples should seek to derive the maximum benefit from the natural resources within their boundaries. For such reasons hydro-electric power stations have been planned and built to generate electricity to supply the industrial areas while at the same time the adoption of electric traction is projected in many cases to make use this readily available power.

It is also without dispute that the energy to be derived from coal or other indigenous fuels can be extracted through the medium of thermal power stations and converted to electrical energy with far greater efficiency than can be obtained by burning these fuels in steam locomotives. In addition, lower grades of fuel are normally consumed at power stations in contrast to the high quality coal required for steam traction.

Thus it may be said that conversion to electric traffic effects a considerable saving in the annual amount of fuel consumed. The efficiency of transmission and utilisation at the



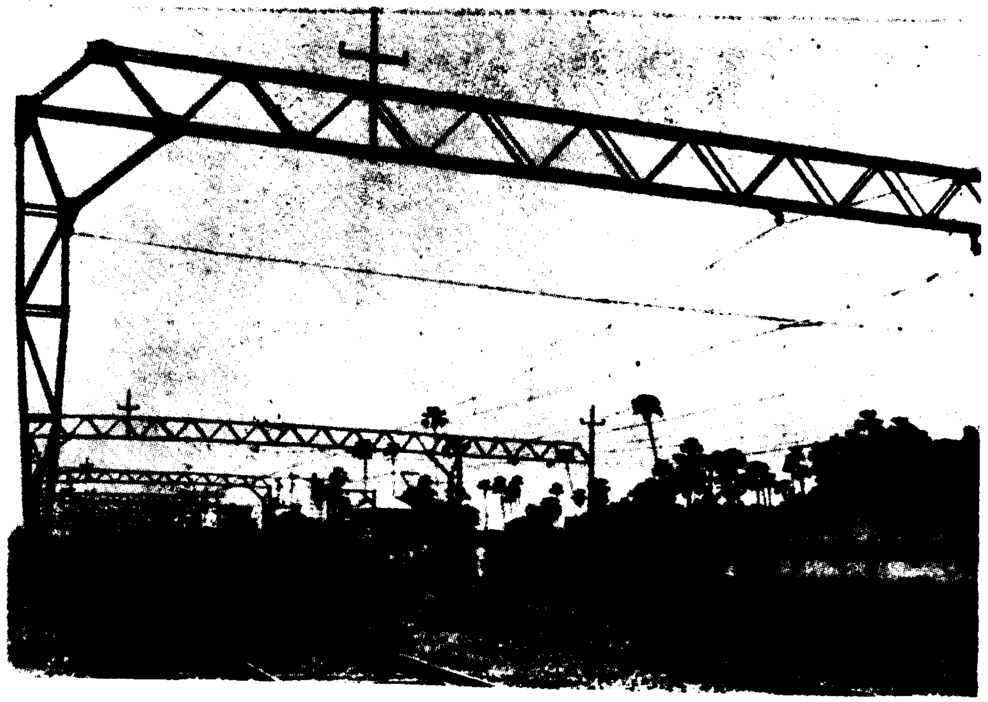
Lattice-type supporting structure at Thana, Central Railway, India. Note the bird guards over the insulators to prevent accidental earthing of the overhead equipment.

traction motors is extremely high, and the nature of the power demand at industrial off-peak hours enables the available generating plant to operate at a more uniform and therefore more economical loading.

From the operating viewpoint railway electrification provides advantages of similar magnitude. The availability of electric locomotives is very high because power is immediately on hand without the delays imposed by refuelling or refiring. Existing services may thus be operated with fewer locomotives, requiring a smaller maintenance staff together with the complete abolition of fuel storage facilities and turntables, leading to the simplification of sidings. Electrically propelled rolling stock has high rates of acceleration and deceleration permitting more punctual running and closer timings which enable (heavier and) more frequent trains to be handled over the existing tracks on faster schedules. Costly track duplication is thereby eliminated.

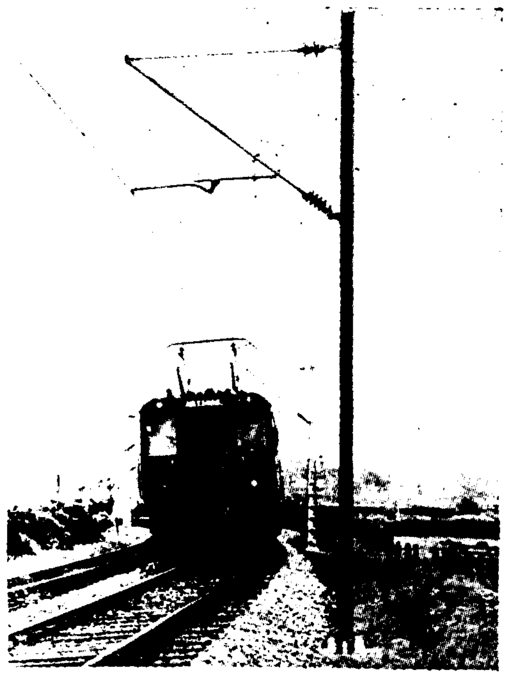
In the absence of smoke and soot associated with steam locomotives, the travelling public is presented with clean, fast and attractive rail transport which is unfailingly reflected in increased passenger traffic typified by two recent suburban schemes carried out by BICC in Britain. Today after 5 years of electric operation, the traffic on the London to Shenfield line is more than 100% higher than prior to electrification. On the Manchester–Glossop service after only 8 months, passenger traffic has increased by 142%.

Railway Electrification schemes are of necessity complex operations involving close co-operation between the several railway departments and contracting engineers to ensure the smooth flow of materials and an uninterrupted erection programme. It is at this stage that the wide manufacturing interests of the BICC Organisation and unrivalled skill of the construction staff offer to the railway the maximum advantage.



Long span lattice structures on the Western Railway (ex B. B. & C. I. Railway), India showing the structure extensions to carry transmission lines. The wires are arranged in simple catenary form.

A detailed track survey must first be made to determine the types of foundation to be employed and siting of structures, places of electrical feeding and sectioning to mention but a little of information that must be carefully compiled. It is sometimes necessary to supplement existing track plans by aerial photography of sections of the route. With this knowledge to hand the structures which are to support or anchor the overhead contact systems are carefully designed while a parallel examination is made of the relevant electrical data including the power to be supplied over each section of the route, permissible voltage drop and the provision of protective devices. Particular attention is required at tunnels, stations and at road crossings where adequate electrical clearances are generally more difficult to obtain.



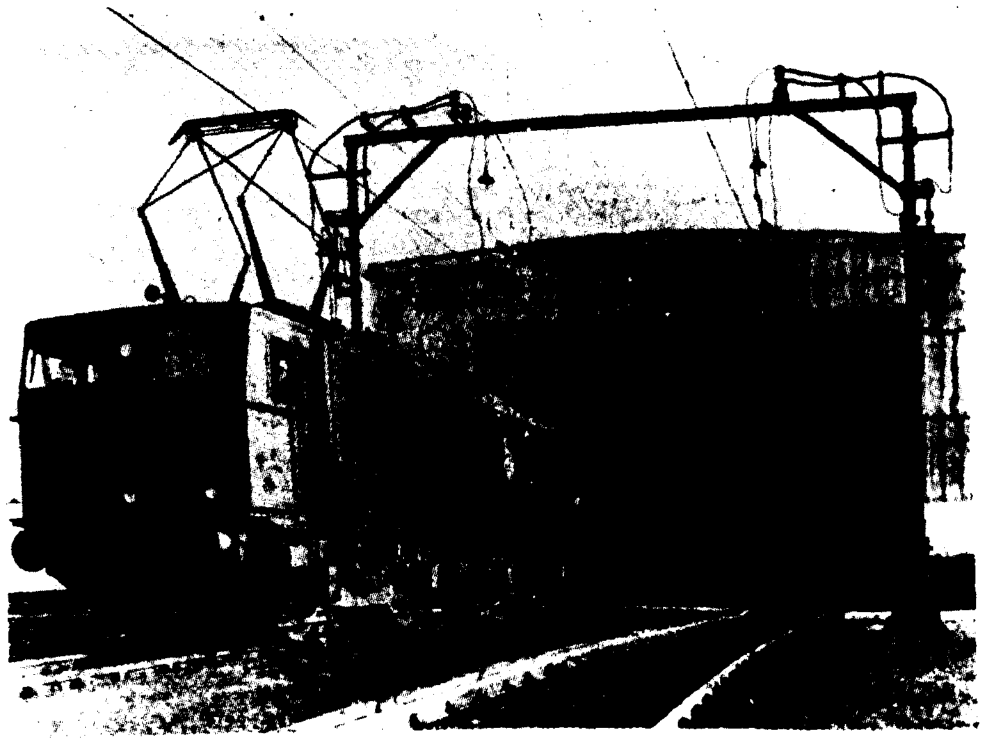
Single track cantilever construction with steel and pre-stressed concrete structures. 6600 Volt alternating current electrification.—Lancaster to Morecambe & Heysham Railway.

Operations on site begin with the selection of a suitable centre from which the field operations can be supervised and the necessary office and stores accommodation set up. From this depot foundation and steelwork trains convey the material to each track location at which experienced engineers control the excavation and placing of the foundations and the subsequent erection of the structures which are usually of steel in one of the many sections-channels, rods, broad flanged beams, rolled steel joists etc. When it is recalled that structures are sometimes required to span eight or more tracks it will be readily appreciated that any small errors in the placing of foundations may prove extremely costly during the steelwork erection. Here, too, close liaison with the railway operating department is vitally important to prevent delays to normal traffic; reference to some of the accompanying photographs will illustrate these remarks.

In due course, other construction trains, from which the overhead conductors are erected, begin operations under the surveillance of the wiring engineers. The conductors will usually be composed of one or two stranded wires per track which are suspended by insulators from the track structures in what is generally known as compound or simple catenary construction (See photographs). These wires form a flexible suspension system to carry the solid copper contact wire. Flexibility is essential to ensure sparkless current collection by the locomotive pantograph which must remain in sliding contact with the contact wire. For the same reason it is essential to avoid sharp changes of gradient of the contact wire during the planning stage and as these changes may also be self-introduced by seasonal changes in the conductor tensions it is sometimes desirable to arrange automatic tensioning devices (see photograph) whereby a constant mechanical tension may be maintained in the conductors throughout the complete temperature range.

Other site work includes the provision of feeder cables and switches by which the catenary system is energised from adjacent traction substations. These substations are frequently interconnected by overhead transmission lines are power cables and may be remotely controlled from a central supervisory centre for which purpose telecommunication cables are required. Special auxiliary power cables are also provided for the remote operation of signal and point motors. The joints between the ends of rails are usually electrically bonded to provide a conducting path for the return current and for safety reasons structure to rail bonds are fitted or else a continuous earthwire is used to connect all structures. These and numerous other essential features of a completed electrification scheme cannot be more than briefly described in an article of this length but it is hoped that the details mentioned will serve to enable the reader to appreciate more fully the overwhelming advantages of careful planning in design, manufacture, supply and erection which are made possible by many years of experience in this specialised field.

As recorded earlier the first complete railway electrification scheme pioneered by the BICC Group was in Australia where in addition to the conversion of 341 track miles to electric operation BICC also supplied 20,000 volts transmission mains linking the various traction substations to the Central Power House and telephone cables laid along the same route. In 1922 on behalf of South African Railways electrification of 300 track miles on the Natal Main Line between Pietermaritzburg and Glencoe was undertaken. This section was the most difficult to negotiate by steam traffic, as the route passes



Electrical sectioning point outside locomotive shed showing switches and feeder cables mounted on the structure.—Manchester to Sheffield & Wath Electrification.

through the mountainous parts of the South African Tableland. It is also the main artery between the Natal Coalfields and the coast at Durban where there is a constantly increasing demand for bunker coal. Since electrification the daily gross tonnage hauled in the Glencoe-Durban direction has increased from 13,000 tons to 34,000 tons and the average travelling time in the reverse direction for passenger traffic has improved from 14½ hours to 8 hours. On this scheme which was completed in thirtynine months some 1,000 miles of copper conductors and 7,000 tons of steel structures were used.

Electrification schemes in India commenced in 1923 with the Bombay Harbour Branch and local lines from Bombay to Thana comprising 160 track miles of equipment. This was followed by an extension from Thana to Kalyan and later extensions from Kalyan north eastwards to Igatpuri, and south eastwards to Poona with storage yards and goods sidings. Both these routes include a mountainous section and the equipments for the heavy gradients, tunnels and other special features demanded particular attention. In all 591 track miles of overhead equipment were erected together with 2.2 kV signal supply and 22 kV power supply lines. On the Kalyan to Poona section it was possible as a result of electrification to increase the gradient and remove the reversing station on the Bhore Ghat and so obtain through running. Smoke and fumes in tunnels which had been a source of great nuisance to the passengers were eliminated and considerable increases in train mileages and passenger traffic were obtained (e. g. the annual passenger traffic increased from 33 to 130 millions between 1929 and 1949).

Simultaneously the 52 track miles of the main line between Bombay and Borivli were

Adjusting the overhead equipment at the entrance to the New Woodhead Tunnel.—Manchester to Sheffield & Wath Electrification.

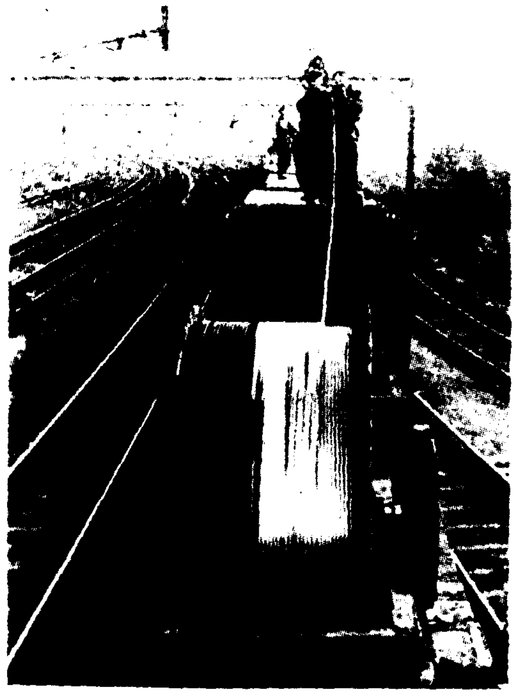
172670

electrified. The reasons for this electrification, which has since been extended to Vihar, was the necessity for providing a quick means of transport for the growing population; recent figures indicate that the number of suburban passengers rose from 42 million in 1938 to nearly 135 million in 1948.

In 1934, 163 track miles of the Warsaw suburban system, Polish State Railways, were electrified. This scheme was notable in view of the wide temperature range and ice loading conditions under which the overhead equipment had to operate. For this reason the catenary and contact wires were automatically tensioned using balance weights and supported on swinging canti-lever structures.

BICC has undertaken two major schemes in Brazil where a total of 380 track miles of the Estrada de Ferro Central and the Estrada de Ferro Santos a Jundiai were electrified. The former, officially opened in 1938, served the densely populated area of Rio de Janeiro where electrification was adopted to increase the carrying capacity of the line to deal with the rapidly increasing passenger traffic. The development of hydro-electric power in Brazil combined with the scarcity of local fuel supplies and the high cost of imported fuel naturally led to the conversion from steam to electricity as the motive power in the latter case. This scheme from Jundiai to Maua runs through the richest coffee growing area in the world and serves the heavy suburban traffic around Sao Paulo. A rather unusual problem was presented by a tramway crossing at Mooca. Here a system was devised to enable inter-running of both railway and tramway services on the overhead equipment at the crossing, whereby the contact wires were energised at 3,000 volts or 600 volts according to whether the crossing was open to trains or tram cars. A photograph of this equipment is included with the illustrations. As part of both railway projects high voltage power lines and low voltage signal feeder lines were also supplied and erected on extensions to the track structures.

In Britain there are many miles of electrified railway using the third rail conductor principle. This has many disadvantages including limitation of conductor voltage, faults in bad weather and obstruction to track maintenance. Three exhaustive reports in the past twenty years have concluded that the

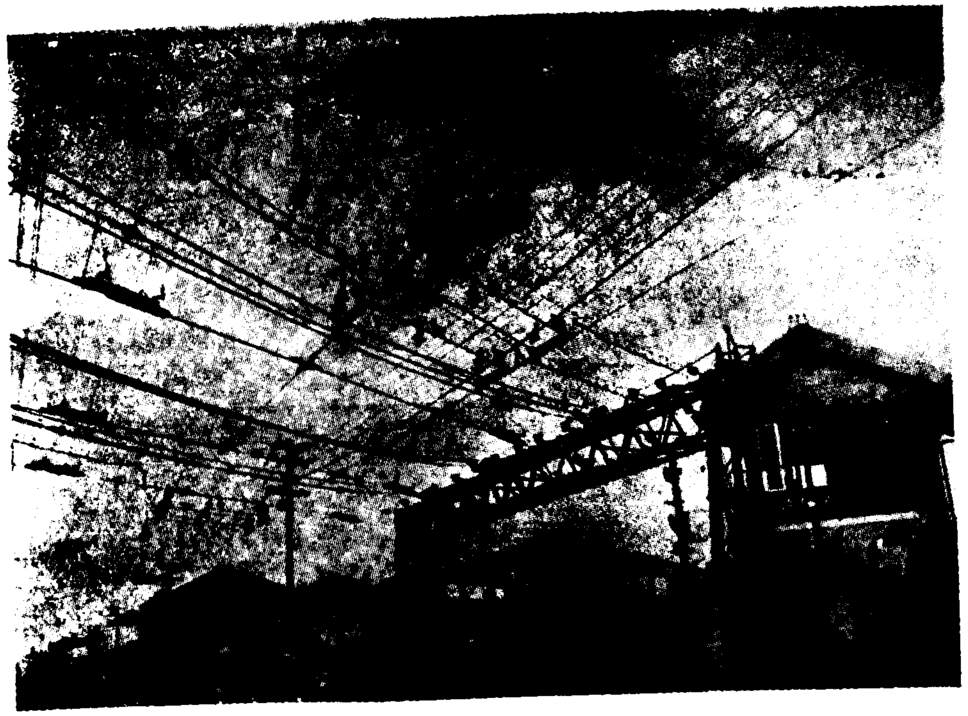


Erecting the contact wire using specially modified flat roofed coaches.—Manchester to Sheffield & Wath Electrification.

most suitable and economical method of electrification for this country is the overhead catenary system and this form of construction is to be adopted for all major schemes in the future.

Between 1929 and 1931 BICC converted the Manchester-Altrincham suburban line to electric operation. This line, which was the first in the country to be electrified using the 1500 volt overhead system, included a 1¾ mile section carried on a viaduct with curves and a gradient of 1 in 100.

In 1938 work commenced on the electrification of the London to Shenfield and the



The overhead equipment at Mooca level crossing showing the arrangement designed to permit tramcars to operate across the electrified tracks. The central section containing the actual points of crossing of the overhead wires is electrically separated from both tramway and railway equipments but may be energised at 600 volts or 3000 volts according to whether the crossing is open to tramcars or trains.—E.F.S.J. Railway Brazil.

Manchester to Sheffield and Wath Lines. Work was stopped during the war years but both routes are now operating electrically and the former scheme is being extended to Southend and Chelmsford. Reference to the great increases in passenger traffic resulting from these schemes has already been made but perhaps even more remarkable are the freight results achieved on the Manchester-Sheffield-Wath project where the haulage of heavy mineral traffic over the Pennine Mountains has been so speeded up that the running time in some cases has been more than halved. On the formidable 1 in 40 gradients of the Wath bank to electric locomotives now haul heavier loads at double the speed of the four steam locomotives previously used while locomotives on the downhill journey with empty stock return power to the line by regenerative braking. Work is now proceeding on the electrification of the main lines between Sydney and Lithgow in New South Wales, Australia. This project across the Blue Mountains, reaching a height of 3700 ft., comprises 240 track miles and the first section has recently been put into service.

We have seen how the cleanliness and speed of electric travel is appreciated by the general public and railway staff alike, while the overall saving and economy in fuel made possible are points of national importance. The Weir Report of 1931 gave the conclusion that in Britain alone the electrification of all main lines would result in a reduction in coal consumption by 72% and in the cost of locomotive maintenance by 57%. Such trends are not unique but have been the experience wherever existing lines have been electrified.

BICC, the largest single organisation in the world with facilities for the design, manufacture, supply and installation of material for

(Continued on page 54)

STEEL CASTINGS

Layout for Varied Production at Grimesthorpe Foundry

FOR the past 25 years continuous development and extensions have been taking place at the Grimesthorpe steel foundry, which is owned by English Steel Corporation, Ltd., and employs approximately 700 men. Much of the present programme is already finished, and when it is fully completed it is estimated that the foundry's current output of 1,000 tons a month may be doubled.

English Steel Corporation, Ltd., is one of largest steel founders in the British Commonwealth, as well as the biggest producer of special alloy steels and forgings in the Sheffield area, though its foundations go back for more than 100 years. The business was established in 1929 by the amalgamation of the steel interests of Vickers, Ltd., Sir W. G. Armstrong Whiteworth & Co., Ltd., and Cammell Laird & Co., Ltd. The Corporation has several works in Sheffield and Darlington, and it also owns the Darlington Forge, Ltd., and Taylor Bros., Ltd. From the River Don and Grimesthorpe Works at Sheffield (which covers 130 acres), and from the Darlington Forge, Ltd., have come some of the largest ships' and other castings ever made. There is also a steel foundry in Manchester which specializes in the manufacture of steel castings from ¼ oz. to 10 cwt. for printing, textile, dairy, electrical and agricultural requirements, and largely supplies firms in the North-West; but this operates on a far smaller scale than the other foundaries owned by the Corporation.

At Grimesthorpe it has been normal for many years to study American and Continental methods and to colloborate with foreign

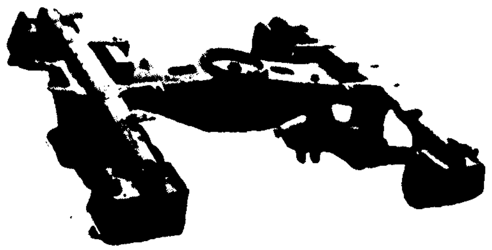


Fig. 1. One of the range of side frame and bolster castings for railway wagon bogies.

firms. It is therefore not surprising that plant and practice resemble closely those recommended in the report of the Anglo-American Productivity Team. The programme of re-equipment, which had been going on over many years, made Grimesthorpe the most highly mechanized steel foundry in this country at the outbreak of World War II. It could, therefore, immediately make a large contribution to the supply of armour-quality tank parts, at a time when the output of cast armour had not yet been augmented because the country's industry had not yet been extended in that direction.

The layout of the foundry and its ancillary departments, owing to the wide variations of the castings both in size and quantity, is completely different from that of most other

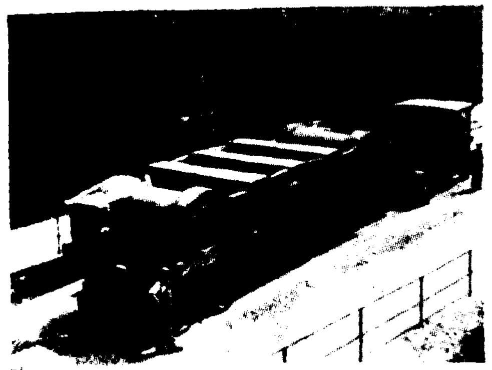


Fig. 2. Large cast steel base plate, 32 ft. long, weighing 120 tons for 12,000 ton press.

British steel foundaries. Normal production covers work ranging from mass-produced castings weighing from a few ounces up to 30 cwt., as well as individual castings of 150 tons each; there is also a wide range of intermediate sizes. To cope with this wide range of products in the most efficient manner, the foundry is divided into light and heavy departments, and each department is again subdivided into smaller self-contained sections, according to the type of moulding employed, viz. (1) green sand mass production, (2) skin-dried mass production, (3) specialized jobbing work, and (4) heavy pit and floor work. Some examples are shown in Figs. 1 and 2.

GREEN SAND MASS PRODUCTION

The green sand mass-production section has three units and is completely self-

Fig. 3. One of the bays in the E. S. C. foundry equipped with mechanized moulding and handling plant.

contained, with two sand plants and two melting furnaces. The moulding equipment for each unit comprises (a) four jolt squeeze pattern draw machines suitable for castings up to 18 in. by 21 in. and weighing up to 1 cwt., (b) four jolt roll-over machines capable of handling moulds for castings up to 5 cwt., and measuring up to 3 ft. 6 in. square, and (c) a sand slinger unit for green sand castings up to a weight of about 30 cwt.

The first unit (a) is partly isolated, two of the machines being used for the production of drags and copes, and the other two being kept in reserve in case of breakdown. This policy of installing spare machines is employed wherever possible throughout the entire foundry. The moulds are conveyed from the machines on roller tracks (Fig. 3), cored up and cast on the rollers, and transferred to an adjacent knockout site. They are cast from a nearby 2-ton electric furnace. The Corporation, which has operated in this way since 1935, claims to be one of the earliest users of the acid-electric process in Great Britain.

Adjacent to this unit is (b); here the boxes are lifted on to the machines by air hoist, closed by a monorail crane astride the track, and passed to and from there to an adjacent bay for casting. They are knocked out over the main sytem. As before, two machines are kept in reserve.

(Continued from page 53)

the complete overhead system, is proud to have been associated with the many schemes outlined herein. Its resources include well equipped factories backed by first class research facilities and a field force of widely experienced engineers. The Group is foremost in the field of new developments including the provision for British Railways of overhead equipment for an experimental high voltage section using alternating current at the industrial frequency. In addition experimental sites have been built where the characteristics of various forms of overhead construction are continuously recorded by instruments and conductor endurance and foundation tests are carried out.

The results of these and many other similar investigations will be taken into account in BICC's designs for the future and will enable the Group to maintain and improve its reputation for high quality equipment which meets the requirements of Railway Engineers in every land.

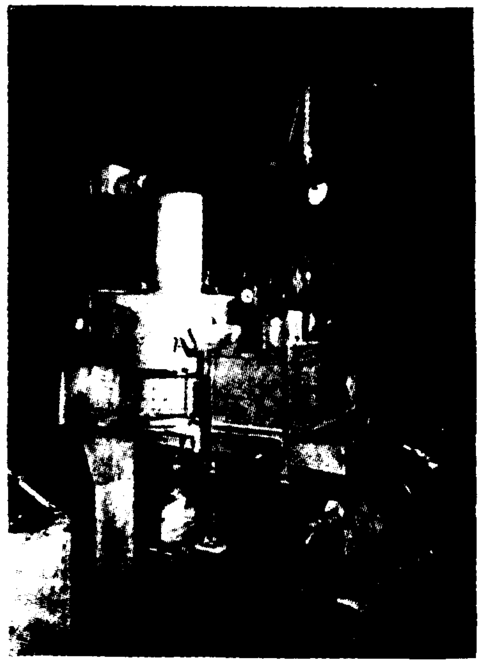


Fig. 4. A "Speed-Muller", the first of its kind to be installed in a British foundry.

The backing sand for both units is obtained from a common system. The main knockout runs the length of the casting bay, and sand from the subsidiary knockout station for unit (a) is conveyed to it by underground belt. The main belt takes the sand from both units to the foot of an elevator and raises it to a rotary screen feeding a large storage hopper, from where it is removed to feed an American "Speed-Muller" (Fig. 4), which can mill 15 cu. ft. of sand every 90 seconds. This mill, the first of its kind to be installed in any British Steel foundry, was introduced not only for more efficient milling, but also for better cooling. The latter is important, because moulding troubles due to inefficient cooling caused by an increased through put of sand had previously been experienced. The figures given above show the exceptionally high output that is now being maintained.

From the mill, the sand goes by rubber belt to the machines of both (a) and (b) units, and is scrapped off into the appropriate hoppers. By means of a simple but ingenious counter-balance system, hopper filling is done automatically without any attention from the moulders, while discharge into the moulding boxes is controlled by push-buttons. This backing material is bonded with either Wyoming or one of the substitute bentonites.

Facing sand is used for practically all mass-produced castings, and is obtained by milling the excess backing sand, carried over from the hoppers, with 20% new King's Lynn sand and bentonite.

This is done in August-Simpson type mills. The sand is stored at the side of the machines in bins which are replenished from bottom opening pans carried by overhead cranes.

Unit (c), which is also self-contained, comprises a sand slinger, a continuous sand mill, a large rollover pattern-draw machine, a mould conveyor, and a knockout station. The sand mill is fed from a separate knockout station supplying the units' own reconditioning plant, the sand then being carried to the slinger by inclined belt.

This unit produces the largest steel castings made on a mechanized basis in this country. It provides an interesting example of a layout specially planned to facilitate the quick and economic execution of fairly large work.

Fig. 5 Slow speed burning-off conveyor on which runners and risers of smaller castings are removed before heat treatment.

Although the sand slinger unit was designed primarily for the production of railway bogie castings (see Fig. 1), many of the armour castings were made here before and at the beginning of the war.

At the first station the facing sand is introduced and the box moved to the slinger for filling. By means of a pneumatically operated mechanism the end of the track is then raised causing the heavy box to move automatically towards the end of this section of the track. Here, on a Pneulec Hermann machine, the box is turned over, the pattern is drawn, and the box is deposited on the skids astride the second section of the track. As before, the end of this section rises automatically to move the box towards the coring station, and then on to the closing station, where handling is made easier by the provision of a monorail hoist. At the side of the system is a vertical jib crane positioned so as to lift the pattern from the turn-over machine and to return it to the preliminary station where facing sand is added. By this means, a continuous moulding cycle is maintained. Steel for this section is provided by a 10-ton basic electric furnace, which also supplies the medium-sized mass-production unit (b) mentioned earlier.

In this, as in all other sections, regular and frequent laboratory sand checks are made.

Fig. 6. Part of new mechanized core-making section with two of the core-blowing machines in background.

Fig. 7. Two-chamber shot-blasting unit for dressing medium-size castings up to 30 cwt.

BURNING-OFF CONVEYOR

A 26 ft. long burning-off conveyor is situated close to the three units described above (see Fig. 5). As knocked out at their various stations, the castings are carried to this by a 2-ton rail wall creeper crane and the runners and risers are removed before the castings are sent for heat treatment. The plate-type top is arranged at a convenient height for the operators and the conveyor has three speeds to permit adjustment according to the type of burning and the number of men working on it. As a rule, the speed is 2 ft./min.

HEAVY CASTINGS

A specially equipped section of the foundry does all the pit and floor work for castings weighing up to 150 tons. This section has recently undergone considerable expansion and development, which was planned in the later stages of the war and was put into effect immediately afterwards to meet the anticipated heavy demand for heavy castings for the steel industry's reconstruction programme.

Another 20,000 sq. ft. has been added to the effective heavy bay floor through the raising of the roof by an extra 16 ft. of headroom. This extension has made it possible to bring the heavy moulding bay in line with the furnaces, and the open-hearth steel now goes directly by crane to the moulding pits. This was not always possible before as many pits were in a parallel bay. There are three Siemens acid open-hearth furnaces which permit the casting at one time of 190 tons of liquid steel. Castings made in this section include press entablatures, crossheads, rolling mill housings, rolls and turbine castings (including large stainless steel types), etc.

Of particular interest are the four new casting pits, which are probably the largest in the country. They have a total length of 190 ft. and are made in widths varying from 16–24 ft. and depths from 12–25 ft. the deepest pits permitting large cylinders to be cast vertically. When the full length is not wanted, each pit may be divided into smaller sections by a system of "shutters" developed by the Corporation. The pits are served by two special 2-ton electric travelling wall "creeper" cranes which are employed solely for servicing, coring, and the lighter work required by the moulders, and thus leave the heavy overhead cranes free to pass up and down the bay. For castings 150-ton cranes are available.

Moulders' "composition" is mainly used for the moulds and cores in this section, but research now in progress should make possible its future replacement for some heavy castings by silica sand specially developed for the purpose.

ASSISTED FEEDING

Some years ago the English Steel Corporation introduced into this country the practice of assisting the feeding of large dry sand castings by the operation of a carbon arc in the molten feeder head immediately after pouring. The arc may be maintained for as long as 72 hours, according to the size of the casting, thus ensuring a sound casting and saving a considerable amount of steel by the use of much smaller feeder heads than normal.

CORE PRODUCTION

Core production is divided into two sections, one for heavy and the other for light cores.

Fig. 8. Pit mould for main cylinder casting for Loewy extrusion press.

Most of the heavy core work is done by hand, and the same sand is used as for the moulds and obtained from the respective moulding sand plants. For the smaller cores, the recent completion of an additional separate mechanized section (Fig. 7) has doubled the size and output of plant. The sand, entering by rail and trucks, is emptied by grabs into a 350-ton storage pit, from where it is grabbed when required into a hopper situated above, to feed a horizontal gasfired cylindrical drier. On the discharge end the sand is blown through pipes for a height of 35 ft. to three bunkers located above three separate core sand mixers housed on a gantry. It is then taken to hoppers feeding the core blowers.

After blowing, the core box is moved along gravity roller tracks towards the rollover machines (seen on the left of Fig. 6) where the core is removed. The box is returned to the blower along a separate track. The core, on its plate, travels along a third track to meet a belt conveyor feeding a large continuous drying stove.

In the existing light core shop, another similar belt conveys the cores to two other continuous dryers. On removal from the dryers, all cores are sprayed with a refractory wash, checked with gauges, and stored on racks. As required, they are transported on lift trucks to the moulding stations.

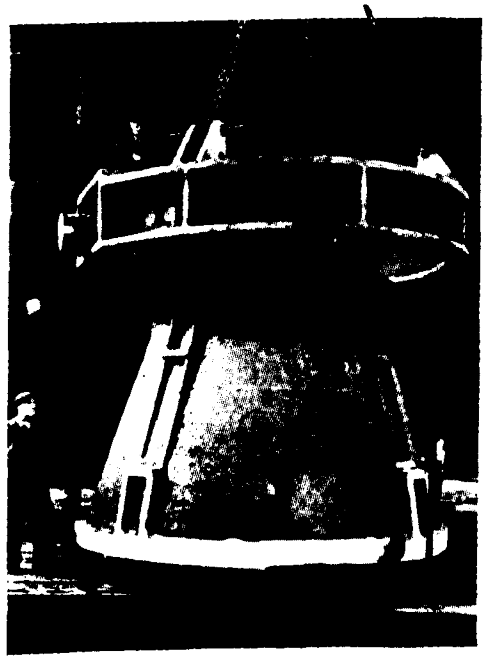
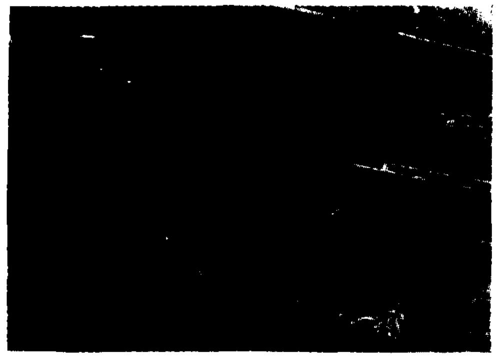


Fig. 9. Cast steel slag pot and bale for Steel Company of Wales. Total weight 15½ tons.

HEAT TREATMENT AND FETTLING

Considerable reorganization of the heat treatment and fettling departments is taking place at present; in addition to ensuring more efficient and economic co-operation, these changes are being made with the aim of completely segregating these departments, with their attendant noise and heat and other discomforts, from the foundry, which should improve the working conditions of all concerned. This reorganization, made possible by taking over shops which in some cases were previously used for the production of armaments, is affording more space, so that all bays next to the melting furnaces are now available for moulding, and in addition permit segregation of fettling work according to class and size.

The heat treatment department is housed in a single, separate building, and is equipped with the modern type of plant for heat treatment and shot blasting. Fettling, however, is spread over several shops, each reserved for one particular class or size of work, and the



2-ton Wall Creeper Crane for servicing heavy moulding pits.

type of equipment thus varies from section to section.

New plant for cleaning and fettling heavy work will include a two-gun Hydroblast for large castings and single-gun unit for smaller work. These will operate in conjunction with the shot blast plant, which will be housed in the heat treatment and shot-blasting section and will include two bogie-type cabinet units, two tumblers, and one large 15 ft. diameter rotary table Wheelabrator (see Fig. 7); another machine similar to that illustrated—suitable for castings weighing up to 30 cwt.—is to be installed shortly.

The equipment seen in Fig. 7 is a two-chamber machine. In one chamber the shot is automatically discharged by impellors as the castings are carried past on the rotary table; in the second, an operator manipulates a gun to reach those portions of the castings not previously reached by the shot. Outside the plant may be seen the two jib cranes for loading the table.

Before despatch, every casting undergoes either visual, gauge, or "marking-off table" inspection. When dealing with the smaller work, the fettler places each finished casting on a separate adjacent bench, from which it must not be removed until inspected. For larger castings this scheme is modified, the work being moved from one side of the bay to the other for inspection.

PLANNING AND RESEARCH

The foregoing has dealt only with actual production processes, for the limited space prevents a detailed description of the many other important aspects. For instance, because of the large quantities of castings of all types and sizes which are continuously passing through the various departments, it is essential to have a very comprehensive planning system. This includes the daily planning, sometimes a year or more ahead, of the loading of every machine and operator.

The company's technical staff, served by well-equipped laboratories, ensures that continuous research is carried out. Frequent conferences are held between the heads of the various departments, and by this means difficulties and troubles can generally be smoothed out before they reach serious proportions.

GENERAL

As one of the largest producers of castings, the Corporation possesses a considerable area of machine shops equipped for handling work of all sizes. Some of the machines recently installed have cost more than £ 50,000 each. A recent acquisition is a 10 in. spindle boring and horizontal milling machine. For pattern making, there is a modern light shop equipped with machines for the production of both wood and metal patterns.

For many years the Corporation has paid special attention to the welfare of its foundry and other workers, and as long as ten years ago it provided many amenities, including excellent canteen facilities, washing and bathing accommodation, clothes drying lockers, and a home-help service by means of which domestic assistance is sent in the case of illness at home.

To ensure a steady flow of personnel, the Corporation operates a comprehensive training scheme, and youths wishing to enter the foundry receive a thorough training for one or other of the various types of moulding.

(Reprinted from IRON & STEEL *November, 1951)*

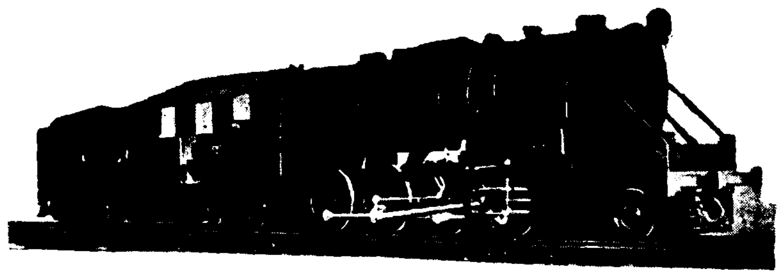
AN IMPORTANT ANNOUNCEMENT

We have pleasure to inform all our readers and advertisers that we are issuing a special Supplement sometime in September 1955 for the INDIAN RAILWAYS INTEGRAL COACH FACTORY at Perambur on the occasion of turning out the first Coach from this Factory. It is expected that the Prime Minister of India will participate in the opening ceremony.

This Supplement will contain a comprehensive review of the Integral Coach Factory and its origin, besides a number of technical articles on the various stages of Coach construction written by eminent engineers of the Indian Railways.

We take this opportunity of requesting all Engineering firms in India and abroad to extend their full co-operation for the success of this Supplement which is the first of its kind ever to be published in India.

Editor.



2-8-2 Superheated Steam Locomotive
with 4-axle tender, 5 ft. 6 in. gauge,
for the Indian Railways (N.R. and S.R.)

OUR MANUFACTURING PROGRAMME

Steam, Diesel and Electro Locomotives, all types Locomotive-repairs Locomotive spare-parts

Special wagons for main line service, industrial and field railways Wheelsets and springs, support-burnishing attachments, Hydraulic torque convertors (Lysholm-Smith-System), Forkardt-mechanically and hand operated chucks

Sheet-metal working and packing machines "Kircheis-Krupp" General mechanical engineering

FRIED. KRUPP LOKOMOTIVFABRIK ESSEN
GERMANY
Represented by
ASSOCIATED CORPORATION OF INDUSTRIES (INDIA) LTD.
P. O BOX 46A, BOMBAY

British Locomotives for World's Railways

OVER 400 EXPORTED TO INDIA IN FIVE YEARS

SINCE the war, Britain's locomotive industry has exported to all parts of the world locomotives and component parts to the value of no less than £ 100,000,000, says an article in a special trade and transport issue of the *British Trade Journal and Export World*, just published.

Today Britain can offer deliveries of locomotives as speedily as any other country. During the last five years the industry has exported no fewer than 405 locomotives to India, 468 to Africa, 395 to Australia, and 356 to other parts of the world. These were all main-line locos, some of the largest ever to leave Britain.

There have also been numerous orders for Diesel locomotives; these include 30 for Brazil, 25 for Ceylon, 94 for Ireland, and 75 for the Netherlands. Electric locomotives have also been produced in increasing numbers, and these include very large main-line locomotives for South Africa, Spain and Brazil. In 1953, no less than 93 per cent of the total production of the industry went overseas.

The article recalls that one of the largest contracts ever placed for railway equipment was awarded last year to a British firm (Metropolitan-Vickers). The Central Railway of Brazil ordered 200 complete railway coaches, to be built and equipped in Britain, and 100 sets of electrical equipment to fit into coaches being built in Brazil. The contract, financed in part by an International Bank loan of $ 12,500,000 was worth about £ 7,000,000.

U.K. MASTER PLAN

Referring to the new 15-year plan to re-equip and reorganize Britain's State-owned railways, the article observes that oversea buyers interested in this field will watch with interest implementation of various aspects of what has been called the master plan for British Railways. The £ 1,200 million programme, which will include extensive schemes for electrification, more Diesel locomotives, re-planning of stations, and improvement of rolling stock and the permanent way, may, by the time it is completed, set new standards of modern railway practice which will serve as a model for the world.

The potentialities of gas turbine and atomic power for propulsion are not being overlooked.

GROWING DEMAND FOR DIESEL AND ELECTRIC UNITS

Preston, in Lancashire, is today famous as the place where the record-breaking jet bomber and the supersonic jet fighter are made. For a much longer time, however, going back far beyond the jet age, and even beyond the age of powerful flight, to the end of the last century, these works at Preston have been renowned for the manufacture of electric and diesel-electric locomotives and trains, trolley buses and tram cars, now in use all over the world.

British-built diesel-electric locomotives or their power equipment of widely varying weights and power, have been supplied to, or are on order for, the Argentine, Australia, Brazil, Ceylon, Egypt, the Gold Coast, Holland, India, Malaya, New Zealand, Nigeria, Rhodesia, Spain, the Sudan and Sweden. The 660-h.p. diesel-electric locomotives used in New Zealand for hauling the Royal train during the recent Royal tour of the Commonwealth were supplied by a British firm. Now the same firm is to supply, this year, ten 1500-h.p. diesel-electric locomotives which will be the most powerful of their type to operate in that country. Rhodesia has ordered twenty-three 2000-h.p. locomotives and they will be the largest narrow gauge diesel-electrics in the world.

Examples of the application of diesel-electric transmission to complete trains are the high-speed five-coach express air-conditioned units supplied to the Egyptian State Railways. Modified versions have also been supplied for suburban services and three-car versions for feeder services. Forty-eight diesel-electric locomotives, each weighing 77½ tons and of 1,105 h.p., have been ordered from Britain by the Western Australian Government.

OVERSEA INTERESTS

This British industry by virtue of its wide oversea interests has evolved naturally over the years into an engineering and production group which can meet the most diverse conditions required abroad. The limitations of load gauge, axle-loading, gradients, and climatic conditions impose a considerable degree of restraint on standardisation of design. The industry has long experience of "design for the job" and does not attempt to force a standard product on oversea customers which may or may not meet their requirements.

The present high level of activity in both the railway diesel and electric traction field can be noted from the figures for export of locomotives other than steam, which have steadily increased over the last few years from £ 1.8 million in 1950 to £ 6.3 million in 1953. This compares with the steam locomotive exports of about £ 7.5 million in 1950 and £ 6.2 million in 1953.

177670

Editorial Notice

The Editor invites contributions from the Engineers and Works Managers of Railway Workshops as well as company-managed Engineering Workshops in the form of original articles, research write-up, production technique etc. relating to Workshop practices in India and abroad. Besides, suggestions for the technical improvement of various aspects of Railway Workshop practice are also invited with suitable write-ups accompanied by photographs wherever possible.

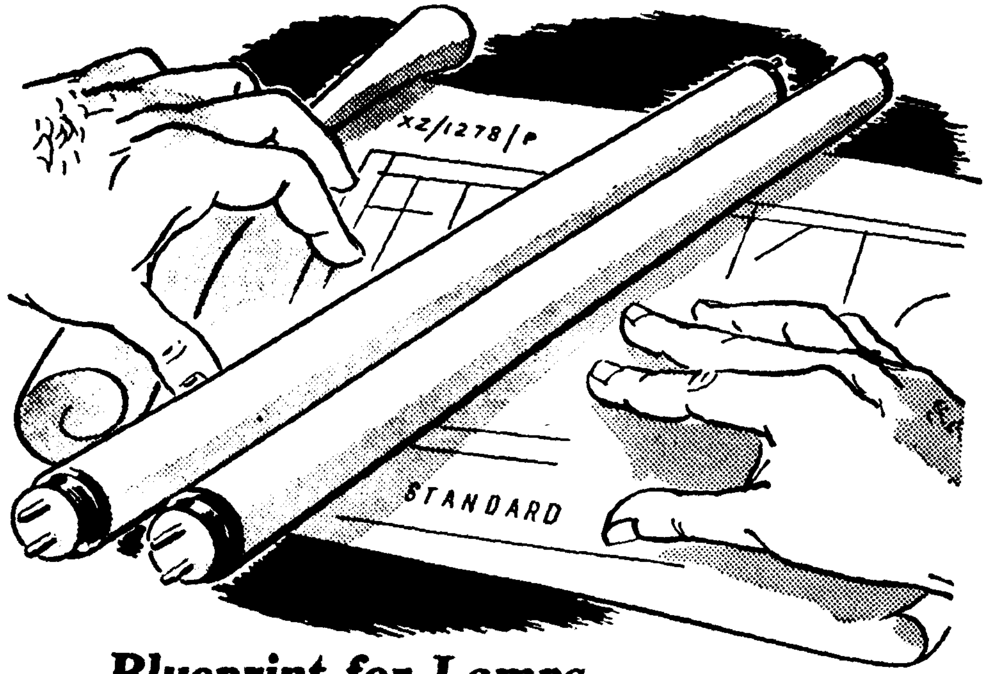
Contributions are accepted on the distinct understanding that they are sent solely to "THE INDIAN RAILWAYS WORKSHOP MAGAZINE". The Editor accepts no responsibility for the views and statements of the contributors.

All contributions intended for publication in any particular issue should reach the Editor at least 30 days prior to the scheduled date of publication. This Journal is issued quarterly i.e. February, May, August, November.

All published contributions are paid for at our usual rates.

Editor

FACTS OF FLUORESCENT LIGHTING : Number One in a Series



Blueprint for Lamps...

From the drawing board to the final stage of production Philips Fluorescent Lamps undergo rigid quality control and reliability tests. These lamps maintain an even strength of luminosity throughout their effective life—guaranteed to the established International Standards. The light output of Philips Fluorescent Lamps is three times as great as that of an ordinary incandescent lamp—for the same current consumption.

In different wattages ranging from 20 watt to 80 watt. Either straight or circular. Available in all the normal shades—from daylight to the equivalent colour of incandescent light. Philips, who have done much for the development of fluorescent lighting, also manufacture essential lighting accessories: Control Gear, Lamp Holders, Trough Fittings—all carrying forward the tradition of Philips *dependability*.

PHILIPS FLUORESCENT

PLANNED LIGHTING
For advice on lighting problems consult Philips Lighting Service Bureau. Calcutta, Bombay, Delhi, Madras, Patna, Lucknow.

PHILIPS

Lamps and Fittings

PLX-16

THE INDIAN SMELTING & REFINING CO. LTD.

"INDUSTRY HOUSE"
159, Churchgate Reclamation,
BOMBAY.

Double Hammer Brand.

Cable: ISARC, Bombay.
Telephone: 37299.

Registered Trade Mark.

COPPER & BRASS SHEETS (SIZE 4' × 4')

Equal in quality to best imported Sheets.
White Metal (Antifriction Nos. 6 to 90
Tin Solder 7 Grades.
Type Metals, Mono, Lino, Stereo, Rotary.
Gun Metal (for casting purposes purest quality)
Phosphor Bronze No. 200 and No. 500
Lead Bronze (for special Bearings).
Brazing Solder 3 Grades.
Bell Metal & Readycast Bells.
Brass Ingots.
Silver Solder 2 Grades.
All Non-ferrous Alloys and Castings.

ON D.G.S.D., STATE RAILWAYS AND ARMY H. Q. LIST.

Edited & Published by Sri S. M. Sivaprakasam for "The Indian Railways Workshop Magazine"
Post Box No. 21, Tanjore and Printed by T. S. Gopal Row at M. K. Press, Tanjore.