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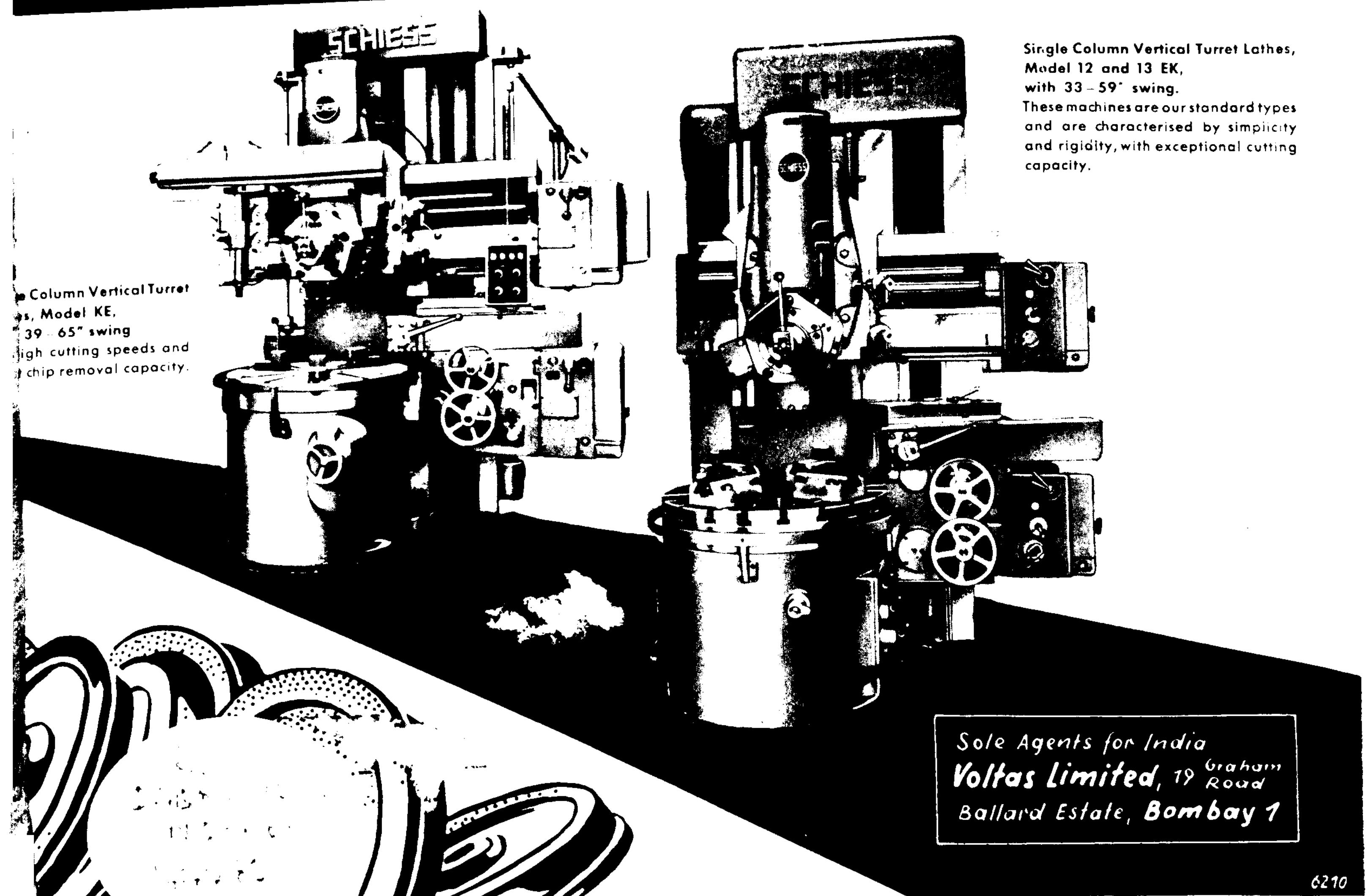

TRAVEL HABITS

★ CLEANLINESS is next to Godliness. Let us cultivate the habit of cleanliness. We can help by not throwing scraps of food, skins and peel of fruit and water on platforms or in compartments. These should be consigned to the dustbins.

★ SPITTING indiscriminately on platforms is unhygienic. It is also bad manners. Let us use spittoons.

★ Let us not use cooled and filtered drinking water for other purposes.

★ Let us avoid sitting with the feet on the seat. This is annoying to others in the compartment, and is not good manners either.

★ Booking our heavy luggage in the brake-van will give our fellow passengers and ourselves more room in the compartments.

★ It is an offence to smoke in a railway train when requested by a fellow passenger not to. Let us avoid smoking when requested, or when the compartment is crowded or the doors and windows are shut.

★ Railways are the Nation's property. We can help to safeguard these by apprehending persons pilfering or causing damage to railway property. They should be pointed out or turned over to uniformed Railway Staff on duty. Unsocial elements indulging in unauthorised alarm chain pulling could be dealt with in like manner.

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EDITOR.

SHORTAGE OF FOREIGN EXCHANGE — A BLESSING IN DISGUISE

THE shortage of Foreign Exchange and the consequent drastic reduction of Import Licences has undoubtedly adversely affected a number of our business houses and has had consequent repercussions on their employees. The smaller business houses have had to close their doors. The medium ones have drastically reduced their staff and by looking for other avenues of business have just been able to keep their head above water. It is only the important Firms which were doing excellent and perhaps monopolistic business that are carrying on with even 70% cut in their imports, because of their financial standing, hoping that the day is not far off when Licences for import will be granted by the Government more liberally.

Though in most cases the acute curtailment of Licences has caused a near calamity in the business world, it has forced the real businessman to look around for the purchase and sale of things indigenous.

Machinery importers and suppliers were one of the first to realise that the days of importing machinery were numbered and they started taking up agencies for the sale of good locally produced machines. Established machinery manufacturers in the country like Kirloskars, Investa and smaller firms in Batala in the Himachal Pradesh in the private sector and the Hindustan Machine Tools, and the Machine Tool Prototype factory at Ambernath in the public sector, have been stepping up their production to meet the growing demand.

More recently, other non-production machines such as puncher slotters, hand presses, foundry and smithy machines suitable for small scale industries are in the course of manufacture on a pilot basis in the Okhan industrial estate outside Delhi, with the help and co-operation, both technical and financial, of the Germans. When suitable manufacturers undertake the manufacture of these machines on a mass production basis, then India will be on its way to self-sufficiency in the machinery field.

In connection with the Railway Department, which used to import heavily from the U. K., its spare parts to keep its locomotives, carriages and wagons going, more than 80% of the spares are now being manufactured indigenously either in the Railway Workshops themselves or by private industry. It will not be long, once we have the heavy steel forging and castings plants to be established under Government auspices in the Banaras area that the balance of the 20% of the Railway requirements will be locally manufactured. Further, with the coming of our Steel Plants at Bhilai, Rourkhela and Durgapur and the expansion of Tata Steel and other steel plants in the country, rails, tyres, wheel centres, axles, which cost us a pretty penny when imported will be available from indigenous sources.

From this point of view, the restriction of imports by curtailing Licences or the raising of tariff barriers, is indeed a blessing in disguise for which we should be grateful, because thereby we are forced to depend upon ourselves to meet our needs whether it be in the private or public sectors.

In this connection, a little more consideration towards manufacturers is required from Railway Inspecting Staff and the Officers over them. It is the easiest thing on earth to condemn a manufacturer's product for minor defects stating that it is either not correct to drawing or specification. It is admitted that very little discretion is given to Staff inspecting material and therefore they are well within their rights to reject something which is not strictly correct to dimensions. However, if they went thru' a little trouble and told the manufacturer his error, the latter would rectify it and remember it for his next supply. It should be borne in mind that some of these manufacturers are coming into the field of Railway manufacture for the first time and if they are frightened away by an avoidable loss in their first supply, it is going to be neither beneficial to the manufacturer nor the Railway.

It is not at all outside the realms of possibility that manufactured materials are at times deliberately held up for illegal gratification and when these needs are met, then materials which were not passable before passes without complaint. Bills of suppliers are in many cases unduly held up for private satisfaction and money in the right place works wonders.

Many of these practices occur without the knowledge of the Officer-in-Charge, who has certain discretionary powers, but if the Officer concerned is genuine in assisting manufacturers, he could order his subordinate to put up cases of a doubtful nature to him for his final decision. If he cannot pass the material even after it is rectified, he should at least be sympathetic to the suppliers who stands to lose financially.

Guidance to manufacturers who are new in the field of Railway manufacture is invaluable and many of them who are keen on supplying material to the Railways make serious efforts to improve their products.

Apart from the Railways, there are many fields in which indigenous manufacture could replace foreign imports. In the Automobile trade, more and more items are now being made in the country and although in the early stages they could not compare favourably with imported parts, yet given time and reasonable purchase and sale, it will not be long before they come up to the required standard. In the Textile field, we are already making an excellent showing and the various cloth produced by our mills could stand comparison with the best imported. Similar remarks could be offered in the Chemical and Pharmaceutical trades.

In most cases, we have both knowledge and skill in the country to produce most materials which are now imported, but what is required is a proper backing in finance and encouragement and patience from industrialists towards their producers.

To be able to manufacture until self-sufficiency is achieved, should be the aim of our manufacturers and industrialists and then we can explore the hungry markets round us and export and earn Foreign Exchange instead of using it up.

That steps are being taken in this direction by the establishment of Export Trade Councils is known, but what is required is the acceleration of those demands by properly conducted market surveys, so that India which is industrially in advance of her neighbours like Iraq, Iran, Egypt and Africa may reap the benefit while the going is good. In this, we could immitate the more advanced countries of Europe and in particular the U. K., Germany, Sweden, Switzerland, etc., who have excellent organisations in various parts of the world, which help to regulate their exports and increase their earnings.

The Design and Manufacture of Light-Weight Coaches

By Shri K. Swarup

Chief Administrative Officer, Integral Coach Factory, Perambur, Madras

INTRODUCTION

IN the earlier years the design of railway rolling stock was inspired by that of the vehicles used for road transport at that period. It was soon found, however, that the railway could cope with heavier loads, and the evolution of railway rolling stock tended towards increased capacity together with the provision of comfort, a factor which upto then had been ignored. The constantly increasing speeds also made greater strength imperative and this desire for improvements led to such an increase in the initial weight, of approximately 220 lbs. per seat, that in many vehicles now in service it has reached more than half a ton, resulting in higher constructional and operating costs.

While the railway enjoyed a monopoly of transport, the results of such heavy loads did not matter, but when more modern road motor transport came into the picture it gave the public the benefit of vehicles, which though of a lower standard of safety and comfort, were much lighter and a better user, so that lower prices could be charged. This new method of transport obliged the railway to revise its policy in the case of passenger services and resulted in the appearance of passenger coaches of light construction. The method of transport which will attract the greatest number of clients, will be that which in each case offers the greatest convenience, speed, safety and economy, and these condition often run contrary to each other. It is now recognised that the best policy is to reduce the weight of the rolling stock without reducing either its strength or its capacity, not only in the case of passenger coaches but in all railway vehicles to which the technique used in the construction of passenger cars has been applied. It is a question therefore, which affects the whole economy of the railway and consequently its solution is of great interest. Considering all these aspects and the fact that India is short of good coal of high calorific value, the preservation of which is of great national importance, the light-weight construction for passenger coaches has been adopted as the most suitable for the Indian railways.

Shri K. Swarup

PRINCIPLES OF LIGHT-WEIGHT DESIGN

In the past it was generally accepted that heavy vehicles possessed better riding qualities than light ones. Experience has, however, shown that intelligent design leads to improved efficiency in operation. To properly appreciate the basis for light-weight design, it is essential to realise that old-fashioned considerations based on statics do not meet the requirements of modern design. These views had to be replaced by the dynamic conception, which takes into consideration the actual working conditions in service. The 'static' designer considered every detail as a separate unit and not as a part of the complete structure. In case of failure he usually considered any part which failed and strengthened it, which automatically led to increased weight. However, design development proceeded from the static to the dynamic conception rendered necessary by higher and economical outputs, better performance and

greater speeds. It is necessary, therefore, to consider all designs from the dynamic point of view and here to deal not with simple forces, as in the case of static considerations, but with the ability to do work. If some section of the dynamically stressed unit fails, then it is upto the designer to appreciate that its ability to do work was insufficient and therefore must be strengthened. The first and foremost, yet simplest, means to achieve this is to ensure that all stresses are adjusted to the given maximum value. Thus the designer will increase the capacity to do work of a low-stressed part by removing redundant material and this will in turn increase the working capacity of the entire structure and its ability to withstand dynamic stresses. As will be appreciated from this, the dynamic considerations force one to keep the use of materials to a minimum, which in turn leads to reduced weight, and this is the basic meaning of light-weight design.

Light-weight design and improved effectiveness are thus synonymous. If greater effectiveness is required, a reduction in the weight is necessary; if the weight is reduced improved effectiveness will be achieved. The improved effectiveness becomes economically effective in a number of ways, in increased capacity, in reduced operating expenses, in improved service and life. By taking these principles into consideration it has been possible to reduce the weight of our passenger coach from 42.5 to 35.5 tons as follows:—

	Break-up of weights	
	Conventional coach	Integral coach
Bogie frames with Brake rigging and bolster springs and bolsters	7.91	5.3
Wheels & Axles with axle boxes and springs	6.65	5.4
Total weight of bogies	14.56	10.7
Weight of underframe alone	10.55	
Weight of bare shell		11.55
Weight of underframe or Body Shell and Bogies	25.11	22.25
Weight of furnishing including electrical equipment, doors and windows (approx.)	17.39	13.25
Total weight	42.50	35.50

Fig. 1

Fig. 2

Of still greater importance, however, is the fact that stressed-skin carriages possess very favourable static and dynamic qualities. This applies particularly to the resistance against torsional and bending stresses, which is considerably better than that of the heavy standard carriages. Moreover, the vehicle possesses an extraordinary high compression rigidity, particularly over the entire length of the passenger

compartments. This ensures a greater protection in case of accidents, still further increased by the fact that the sections located at the ends, *i. e.*, lavatories, etc., possess lower compression rigidity than the passenger accommodation. In case of accidents these parts would be destroyed first and thus absorb the collision energy. This is borne out by the behaviour of these light-weight coaches in an accident which took place on the Swiss Federal Railways in October 1943 (Figures 1 and 2).

As already mentioned, the conception of the light-weight design originates in the appreciation of previously unknown physical and technical considerations, particularly in the recognition of the possibilities offered by the use of hollow girders which are far superior to solid girders so far as the utilisation of material is concerned. Typical pioneer designs as originally developed by English aircraft designers are shown in Figure 3.

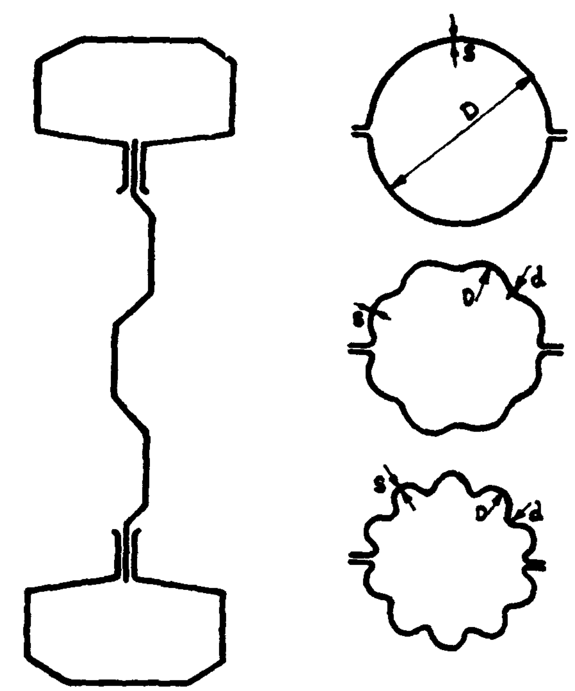


Fig. 3

This shows tubular sections with and without corrugation. The radii of curvature D and *d* and the wall thickness *s* as well as the relation of these to each other are of paramount importance so far as the buckling resistance is concerned. This is increased with an increase of the ratios D : *s* and *d* : *s* respectively. In the present example this increase amounts to 67% when changing from the upper to the lower right-hand section. The left-hand portion of Figure 3 shows an aircraft spar composed of two hollow sections connected by a corrugated shear resisting section. These sections serve to demonstrate the application of stressed-skin construction to single plan structures, the compression and shear resistance of which can be increased very considerably by the provision of suitable corrugations. These experiments prove that the static properties of materials now become of secondary importance, the elastic properties of the material and correct design being of major importance so far as the load-carrying capacity of the structures is concerned. Therefore, it is proper to state that the form-stability is determined by the elasticity of the materials employed. Only when the form-stability exceeds the strain-limit of the material that the latter becomes a further important factor.

Although hollow girders have been known for some time, it was not originally possible to utilise them to the extent now made possible by the use of stressed-skin construction. The hollow girder possesses a high moment of resistance and a high working capacity both in torsion and bending. It is thus eminently suitable for being dynamically stressed in every direction. It is at its best when uniformly thin girder walls are employed.

The very advantageous stressing made possible by the use of hollow girders is indicated by the sections, Figure 4. Either of the two girders made up of the

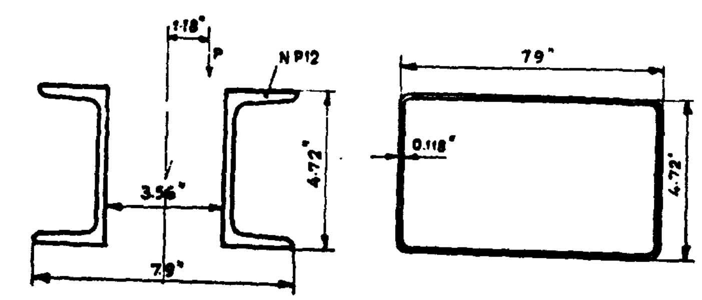


Fig. 4

sections shown here is assumed to be stressed by a centrally located load of 3,600 lbs. which can be applied to either side of the major axis. The left-hand composite girder weighs 14.7 lbs. per foot and is subject to a stress of 13,800 lbs./sq. in., while the hollow girder weighs only 6.12 lbs. per foot, the stress being 13,900 lbs./sq. in. This example illustrates the possibilities offered by the use of hollow girders.

Figures 5 and 6 show the typical frame which has been, and still is, widely used for the carriage bodies. This structure consists of horizontal girders, pillars and

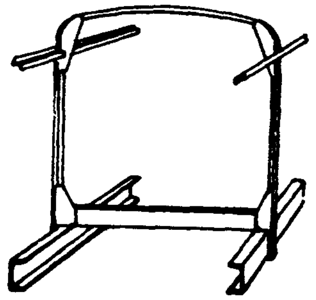


Fig. 5

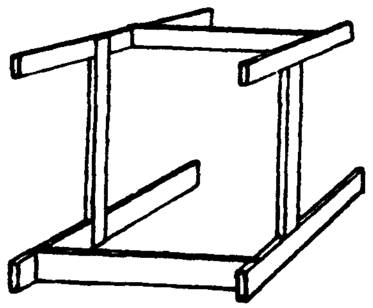


Fig. 6

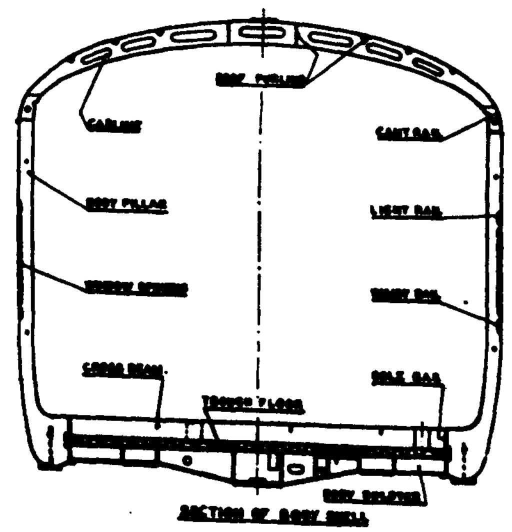


Fig. 7

sole bars which are connected by gussets. This frame is capable of dealing with side forces and torsional stresses if existing partitions provide the necessary rigidity.

However, the number and disposition of such frames is limited by the doors, windows, etc. If, however, tubular girders are used, it will not be necessary to arrange for all members of a frame to be in the same plane, since the torsional stiffness of the longitudinal members will be capable of dealing with the bending moment imposed upon the various girders. The three-dimensional framework (Fig. 6) is superior to the single plane frame not only because of its increased capacity to do work but also because it permits the provision of what may amount to any number of frames. In addition to its torsional rigidity, the hollow girder has the advantage of universal bending rigidity and this permits the use of entirely new design of frames.

The reduction in weight of the light-weight coaches has been achieved by making full use of the stressed-skin construction and by the use of light alloy fittings, etc. The underframe, sidewalls and roof are united into what might be termed as a static tube representing the thin wall hollow girder consisting of steel sheets. Since thin sheets are capable of dealing with compression and shearing stresses only to a very limited extent, the resistance must be increased. This has been achieved by the provision of suitably pressed grooves or welded ribs. The body frame is shown Figure 7, indicating the position of the welded ribs, in the sidewalls and the roof. Corrugated sheets are utilised for the floor and these deal to a large extent with the buffing stresses. The pillars together with the carlines and underframe cross members, form frames which ensure the necessary rigidity to the structure. The end walls are made of steel sheets. These together with the sidewalls, floor and roof form a compression and bending resistant tube. The lavatories and the vestibules are less rigid than the central passenger-carrying part of the vehicle. The above principles have been applied rigidly to the coach being built at Perambur.

DETAILS OF PERAMBUR DESIGN OF LIGHT-WEIGHT COACH

(Fig. 8)

The specification of the Perambur-built coach is :—

Gauge	5′ 6″
Length over Body	70′ 0″
Length over Buffers	73′ 1-13/16″
Buffer centres	6′ 5″
Width over Body	10′ 8″
Drawbar height from Rail level	3′ 5½″
Buffer height from Rail level	3′ 7½″
Overall height of coach from Rail level	12′ 9″
Floor height from Rail level	4′ 3-5/16″
Distance between bogie centres	48′ 6″
Rigid wheel base of bogie	9′ 6″
Tare weight	35 tons.
Seating capacity	80
No. of lavatories	4
No. of doors aside	4
Passengers per lavatory	20
Passengers per door aside	20
Lighting	I. R. S. Double battery system

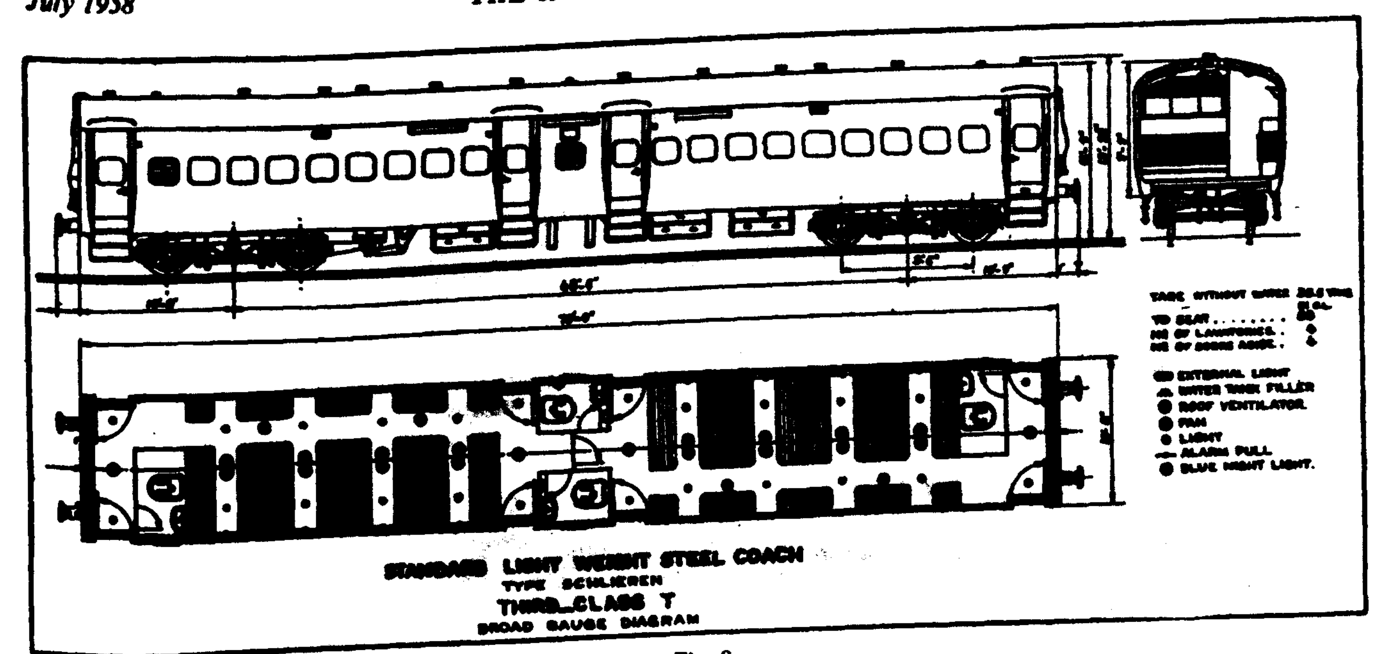


Fig. 8

SPECIFIED LOADS

(i) Vertical load of 45 tons uniformly distributed over the whole floor area of the Coach and simultaneously horizontal compression load of 100 tons on each buffer. Under this condition, the deflection at the centre of the body shell shall not exceed 3/8″.

(ii) Horizontal compression load of 60 tons at one foot above buffer centre, distributed over the whole width of the end construction.

(iii) Horizontal compression load of 30 tons uniformly distributed over the end construction.

GENERAL CONSTRUCTIONAL DETAILS

The skeleton of the shell is made up of a series of hoops consisting of the floor cross beams, body side pillars and roof carlines as shown in Fig. 7. The sole bars, waist rails, light rails, cant rails and roof purlins are the members that hold the hoops together in a rigid framework which is then covered over by the roof sheets on top and the panels on the sides and ends.

The cross beams rest on a " trough " floor, so called on account of its section, which has been adopted so as to pack in the limited space the cross-sectional area necessary to keep the stresses occurring within the permissible limits. It offers considerable resistance to crushing loads in the longitudinal directions, although its ability to carry vertical loads is practically negligible. At each end of the trough floor is welded on a specially designed headstock as shown in Fig. 9, which initially receives the draw and buffing loads and then imparts the same to the trough floor. The trough flooring and the sole bars together with the headstocks virtually take the place of the conventional underframe.

To the underside of the trough floor are welded the body bolsters which then rest directly on corresponding units of the bogie trucks as well as all the beams and supports for the vacuum brake equipment, the brake rigging and the electrical apparatus and dynamo.

The ends of the coach are again of special interest, as it is in them that the anti-telescopic structure is incorporated. (Fig. 10). This consists of four vertical stanchions each of box section 10″ deep and 4-5/16″ wide manufactured from 3/16″ thick material. These stanchions are transversely connected by 10″ deep Z-sections and are welded to the headstock beams at the bottom and to the roof longitudinals at the top. Thus, any shock received through accident is resisted by these end-stanchions, and if the shock load is high enough it is absorbed by them during their plastic deformation. Further load, if any, is then imparted to the periphery of the shell which may then buckle at the doorways, these being designed as

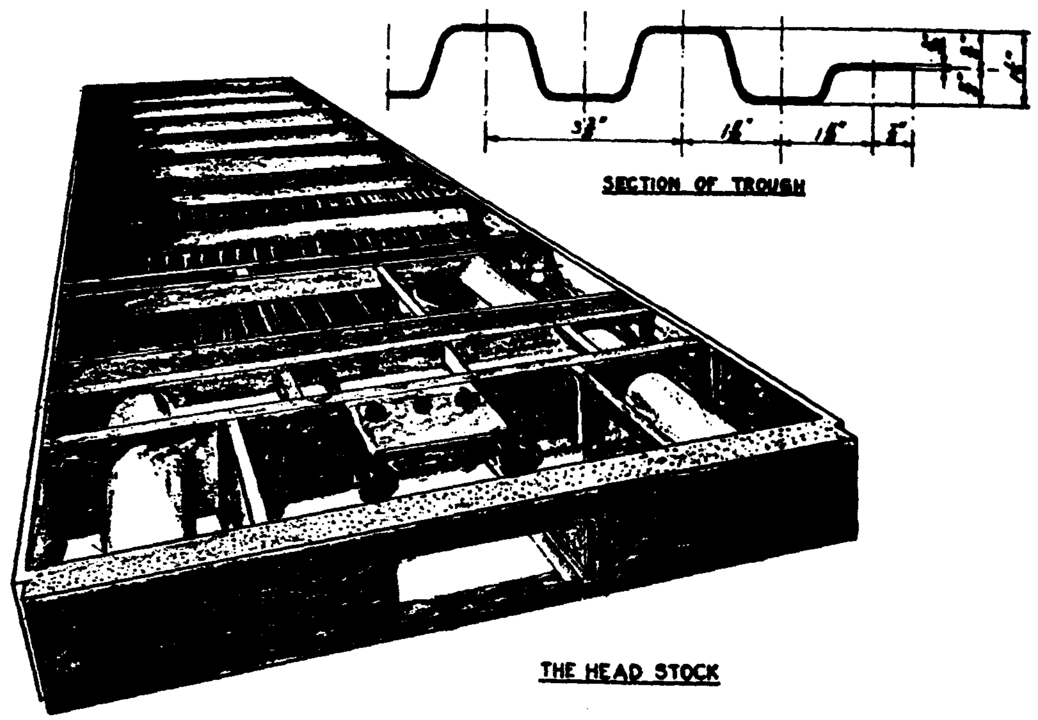


Fig. 9

the weakest sections in order to safeguard the compartments.

The thicknesses of steel used for some of the more important members are :—

Sole Bars	3/16"
Headstock Beams (Outer)	3/16"
Trough floor	3/32"
Pillars	3/32"
Carlines	5/64"
Sidewall panels	3/32"
Roof sheeting	1/16"
Headstock beams (Inner)	3/8"
Cant Rail	1/8"

VERTICAL LOADS

	Tons
Weight of body shell (furnished) excluding bogies	24.6
Pay load (Passenger + Luggage + 10% overcrowding)	12.9
Gross weight of the coach excluding bogies	37.5
Gross weight of the coach + 20% shock	45.0

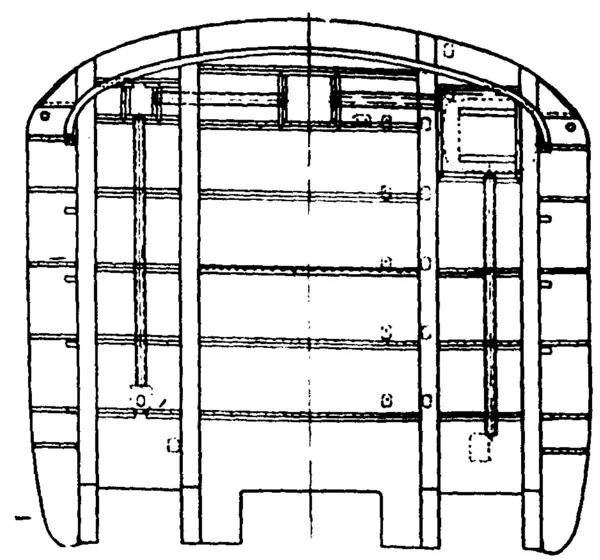


Fig. 10

CASE (1)—HORIZONTAL LOAD OF 100 TONS PER BUFFER

As has already been mentioned, the headstocks sole bars and trough floor virtually take the place of the conventional underframe. Thus, the 200 tons on buffers has to be received by these 3 structures between which, however, the trough floor is decidedly the weaker, as may be seen from their respective slenderness ratios (L/K). The case of the trough floor together with the sole bars is, therefore, alone considered here.

Assuming that the load of 200 tons is shared by the trough floor and the sole bars in proportion to their respective cross-sectional areas,

Compressive stress in each of the Sole Bars = Compressive stress in trough floor.

$$= \frac{200}{6.128+14.38}$$

$= 9.75$ tons per sq. inch.

Where 3.064 sq. inches is the area of cross-section of each sole bar and 14.38 sq. inches is the area of cross-section of the trough floor.

Calculating the critical stress for buckling according to the formula—

$F = 19.7 - 0.0724 \times L/K$ where L/K is the slenderness ratio.

Critical stress for buckling in side longitudinal = 19.2 tons/sq. in. and critical stress for buckling in trough floor = 15.32 tons/sq. in.

$\therefore$ Factor of safety against buckling in side longitudinals $= \frac{19.2}{9.75} = 1.97$

and Factor of safety against buckling in trough floor $= \frac{15.32}{9.75} = 1.57$

During actual tests conducted on the coach, where a load of 100 tons was imposed on each buffer, it was found that once the load distributed itself, *i. e.*, in the areas below windows V and VI (Fig. 11) stresses of only 5 to 7 tons per sq. inch occurred. This is due to the sidewalls also taking a share of the buffer loads. For the same reason at the door openings in the centre of the coach where there is no panel or waist-rail and light rail to convey further the load taken by the sidewall, the load flows back into the trough floor setting up a maximum compressive stress of 10 tons per sq. inch, which it will be noticed is even slightly higher than the calculated value. It should also be remembered that there is a further (+) or (−) inherent stress value already present due to the initial sheet metal operations, welding, etc., which, however, cannot be measured.

CASE (2)—HORIZONTAL LOADS OF 60 TONS AND 30 TONS

The end construction is designed to withstand the shock load of 60 tons applied 12″ above the buffer centres or 30 tons distributed over its entire surface. For purposes of calculation the 30 tons are taken as applied along the horizontal centre line as it simplifies calculation and at the same time is safer to adopt, as it presents a more severe case than if the load is distributed over the entire end wall. In dealing with this case, therefore, the anti-telescopic stanchions are considered as beams for which maximum bending moment has been taken as WL/6 being the mean between beams simply supported (B. M. = WL/4) and beams with fixed ends (B. M. = WL/8).

Treated in this manner, it is found that a greater bending stress is reached with the 30 tons applied at the centre than with 60 tons applied 12″ above buffer centres. On the other hand, a greater shear stress is reached with the 60 ton load than with 30 tons.

Thus :

Bending stress with 30 tons applied at centre	9.7 tons/sq. in.
Shear stress with 60 tons applied 12″ above buffer centres	2.4 tons/sq. in.
The factor of safety in each case is approximately	2

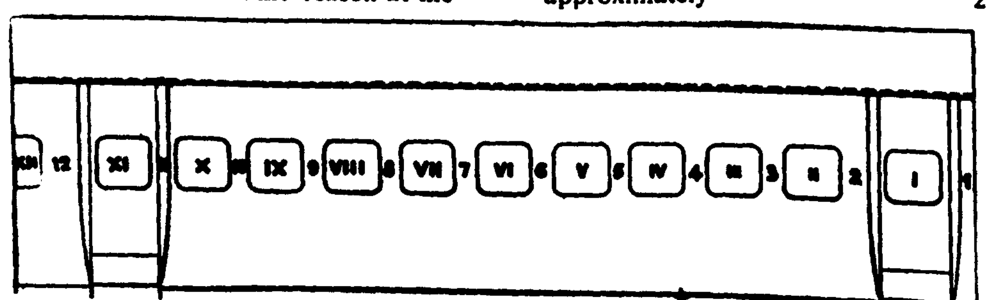


Fig. 11

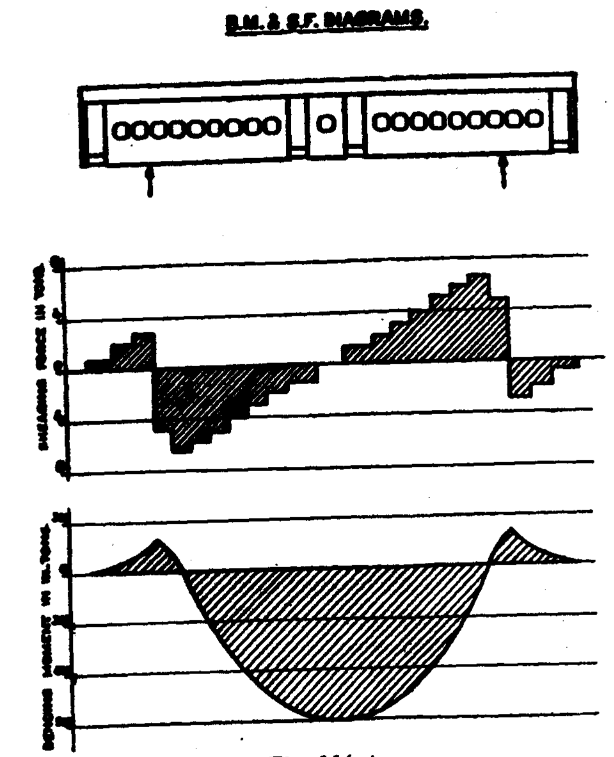


Fig. 11(a)

CASE (3)—VERTICAL LOAD OF 45 TONS

(*a*) The vertical load of 45 tons distributed over the whole length of the coach has to be carried by the floor members, but since, as mentioned previously, the trough floor is weak in this direction, the cross beams have been designed to meet this load fully.

In the prototypes and upto the 130th coach manufactured by Schlieren, 45 cross beams of 1/8″ thick steel were used.

Thus :

Load carried by each cross beam = 1 ton.

Maximum bending moment = WL/10 taken as an average between WL/8 and WL/12 due to the uncertainty of the ends support.

$$= \frac{1 \times 100.63}{10}$$

$= 10.063$ inch tons.

Maximum bending stress

$$= \frac{10.063}{1.33}$$

$= 7.56$ tons./sq. in.

where 1.33 is the ' Z ' value of the members.

Also maximum shear stress

$$= \frac{0.5}{0.907}$$

$= 0.55$ tons/sq. in.

where 0 907 sq. inch is the area of cross-section of each member.

In the present design of the coach the number of cross beams has been reduced to 23, but the section has been increased to 3/16″ to maintain the same strength.

(*b*) In calculating the strength of the side walls, the structure is treated as a Vierendeel girder bearing the following vertical loads :—

	Tons
Weight of body shell (furnished)	24.6
Maximum pay load (Passengers + luggage + 10% overcrowding)	12.9
Gross weight of coach	37.5
Gross weight of coach + 20% shock.	45.0

It is assumed for the purpose of calculation tha this load of 45 tons is shared by the sole bars, th

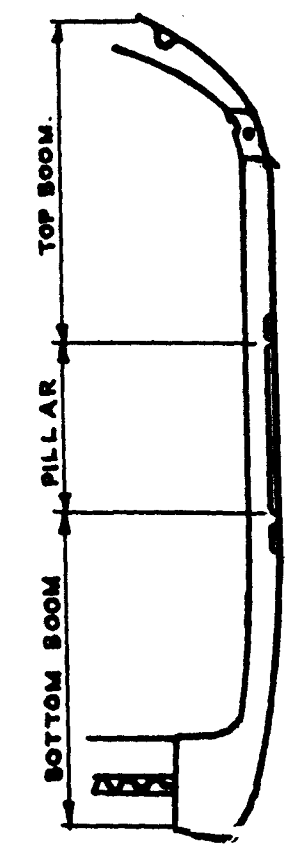


Fig. 12

side walls and part of the roof upto the first longitudinal rail only. Also initial stresses set up due to sheet metal operations, welding, etc., are not taken into account as being indeterminate.

The side wall section is divided into three parts. The portion extending from the first roof longitudinal to the top of the window openings referred to as the "Top Boom"; the part from below the window openings till and inclusive of the sole bar referred to as the "Lower Boom", and the portion connecting the top and lower booms referred to as "Girder Pillars." (Fig. 12).

In order to ascertain the likely loads that are carried by the upper boom and lower boom, it is assumed that the weight of the body shell (18.7 tons) is distributed over the periphery of the shell, whereas weight of fittings such as brake rigging, battery boxes, decolite flooring, etc. (total 5.9 tons) as also Pay Load (12.9 tons) is carried only by the lower boom.

Divided, thus, in proportion to their respective peripheries,

	Tons
Load carried by upper boom	10.8372
Load carried by lower boom	34.1628
Total	45.0000

Treated to this manner and assuming that the reaction of the Centre Pivot is conveyed only to the pillars on its either side, a shearing force diagram and a bending moment diagram as shown in Fig. 11 (a) are arrived at.

Further calculations reveal that at the following points the maximum direct stresses are reached :—

		Direct stress Tons/sq. in.
Upper boom :	At window opening III	0.316 (tensile)
Upper boom :	At window opening XI	2.595 (Compr.)
Girder Pillar :	At Pillar 12	0.611 (tensile)
Do.	4	1.626 (Compr.)
Lower boom :	At window opening XI	2.581 (tensile)
Lower boom :	At window opening III	0.238 (Compr.)

It will be found that the maximum tensile stress is reached in the lower boom, as is to be expected (though of a small magnitude) and compressive stress in the upper boom.

For calculating the factor of safety due to compression, the following formula is applied for the panel sheets, with the assumption that the edges are rigidly held all round :

Critical compressive stress for buckling, according to Schaptiz

$$= K\frac{E}{1-V^2}\left[\frac{S}{b}\right]^2 \text{ tons/sq. in.}$$

Where E = Modulus of Elasticity
V = Poisson's Ratio.
S = Thickness of sheet in inches
b = Breadth of sheet in inches
K = Corrective factor depending on $\frac{\text{length}}{\text{breadth}}$ of sheet

Results from this formula show that the weakest panels lie over window openings XII where—Critical buckling stress = 2.98 tons/sq. in.

But max. compressive stress reached in this area = 1.92 tons/sq. in.

∴ Factor of safety in this panel (least factor of safety) against buckling due to compression = 1.6.

In a similar manner critical shear stress in panels for buckling is calculated but assuming here the worst condition, that is, with the edges of the panel freely supported. This gives the following as the weakest points :

	Position	Factor of safety
Upper boom :	At window opening VII	3.8
Girder Pillar*	No. 8	7.0
Lower boom :	At window opening VII	5.5

In all the above calculations the roof members are not taken into consideration though due to the Monotype of construction a certain amount of load is shared by members of this structure. Actual tests, however, justify neglecting these members for purposes of calculation since the stresses measured were all in the region of 2 tons/sq. in. (tensile) only.

(To be continued)

*Girder Pillars 5, 6 and 7 are additionally strengthened against buckling and therefore their factors of safety have not been computed.

HEAD HARDENED RAILS

THERE has been a strong demand for rails with high wear resistance in railroad circles in Japan, because the main form of transportation are the railroads which must run through many curves and slopes due to the local topography. The Japanese rail roads, therefore, must carry heavy carriages and must sustain high speeds and make frequent trips.

Yawata Iron & Steel Co., Ltd., which has been a long time supplier of rails to domestic railroads, has long been conducting experiments in this field in order to produce rails with higher wear resistance before we started production in 1954, on a commercial basis, of head hardened rails manufactured through a high-frequency process. By this process wear resistance was comparatively easily acquired, and partial hardening of the rails was made possible. Our rails manufactured to date by this process, shown in terms of their total lineal length, are ;

P. S. 50 kg. Rail	149 kilometer
A. S. 37 kg. Rail	39
A. S. 30 kg. Rail	13
45 kg. H. T. Rail	5

and enjoy a favorable reputation.

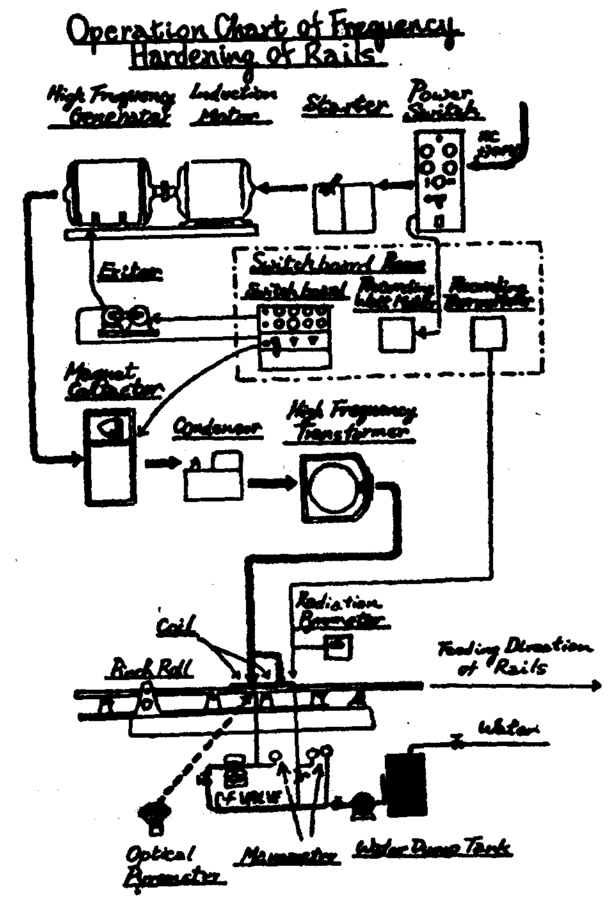
Head hardened rails show their excellent quality in the best way when they are used in curves where rails wear out quickly as well as in frogs, in tramways or in any other place where passage of carriages is considerably heavy.

They will show their excellent properties to your satisfaction and prove their economy as well.

HIGH-FREQUENCY HARDENING OF RAILS

High-frequency heat-treatment of rail heads is performed by means of high-frequency current, generated by a motor dynamo (called Tocco Type) running through a specially designed coil in which hardening and tempering heaters are juxtaposed.

High-frequency hardening operations are illustrated below :



Note :

3000-cycle high-frequency current is generated by an exciter and a G. E. high-frequency generator, revolved by a motor-dynamo.

This generated high-frequency current runs through a condensor for power factor improvement, and becomes low in voltage. High current in a high-frequency transformer generates secondary current in the rail laid inside the coil and heats the rail. An optical pyrometer measures the temperature of rails just before hardening. The rail is moved ahead on friction rollers in the direction shown by the arrow. Hardening is done by a cold water jet through a jacket, hitting the head surface of the rails immediately after its passage through the heating coil. The hardened part of the rail moves into the tempering coil before its cooling off and is tempered here to the required hardness. Tempering temperature is indicated and recorded by a radiation pyrometer placed on the side of the head of the rail. The rail is again cooled with water after the tempering process.

A series of experiments on the hardening process have made it clear that various conditions in the process affect the quality of head hardened rails. By adequate control of these conditions, head hardened rails of uniform quality are produced.

A few examples of some of these conditions and controls are:

(1) Electrical conditions

Source voltage, cycles, electric-power, etc. are those affecting the quality of rails. Minor fluctuations therein are permissible in the designed coil. Fluctuation in electric current affects the depth of the hardened layer, therefore the current is adjusted as the particular type of rail may require, in order to harden the rail to the specified depth.

A recording wattmeter records the control of this process.

(2) Mechanical conditions

a. Proper speed of feeding rails is required according to the type of rail.

Because the slipping and stopping in the process affects the depth of the layer and its hardness, the friction roller is so designed that it keeps the movement of the rails constant.

b. As hardening and tempering are done in the same coil, the tempering temperature is easily affected by the amount of water used for hardening. Accordingly, the jet of water is automatically controlled by a constant flow valve, being adjusted by several pressure meters.

c. By keeping the clearance between the rail and the coil constant, proper hardening and tempering within the temperature allowance can be carried out. To adjust the clearance so that it varies in accordance with the extent of hardening strain, special and flexible coil is employed.

d. The hardening temperature is measured and adjusted by an optical pyrometer, and tempering the temperature by a radiation pyrometer in order to keep both temperatures constant. Tempering the temperature is controlled by an automatic recorder, also.

TEMPERATURE IN HEAT-TREATMENT PROCESS AND HARDNESS OF RAIL

Temperature distribution with reference to the treatment time and depth from the surface in high-frequency heat treatment is shown by the a-f curve on diagram No. 1.

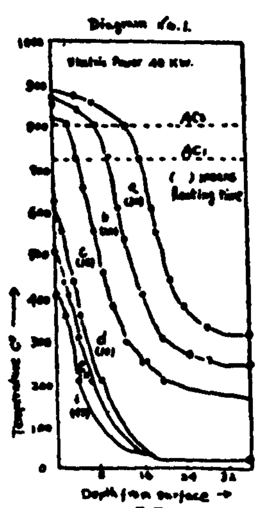
a-c in the diagram shows a temperature curve in the hardening process and d-f a temperature curve in the tempering process.

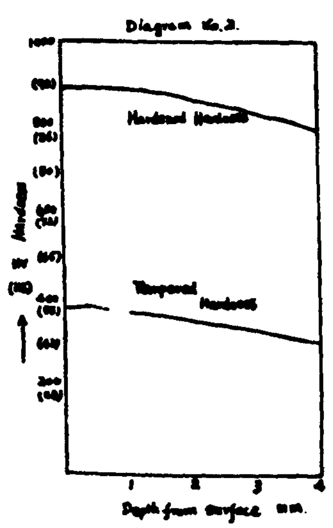
The tempering curve from the surface to AC is rather gradual as the highest temperature goes up beyond the Curie point (a little higher than 770°C (1417°F) and AC2 is approximately 800°C (1470°F). However, the curve is very sharp as it goes down.

In the case of hardening, beyond transformation point AC_3 and critical cooling velocity, the structure is perfect martensite, and it gradually transforms to imperfect martensite, troostite, sorbite and pearlite, in that order, and hardness is lowered accordingly. The tempering temperature distribution curve goes downward sharply as seen in e-f, because the highest temperature stays below the Curie point, and the decrease in hardness through tempering is of a tendency contrary to the curve mentioned above.

Distribution of hardness after hardening and tempering shows a gradual hardness curve as in diagram No. 2, therefore, exfoliations or other defects which are caused by differences in hardness do not take place.

In the case of hardened rails manufactured at Yawata Works we keep the temperature just before hardening (cooling by water) at a approximately 830°C (1520°F), and the highest temperature in tempering at about 600°C (1120°F), according to our operation standards.





PROPERTIES OF HEAD HARDENED RAILS

(1) Excellent wear resistance

The rail is hardened to 48 ± 3 shore hardness on its surface and the hardened layer reaches more than 10 mm. deep. This head hardened rail has a wear resistance of more than three times that of ordinary rails.

(2) The rail has sorbite. In spite of its high intensity, it has more toughness than ordinary rails.

(3) Uniformity of quality

Rails very suitable for hardening are used. As we practice hot scarfing on the bloom from which head hardened rails are to be rolled over, there occur very few surface defects, and differences in hardness caused by decarburization are slight. The heat treatment is electrically controlled, and a uniform hardened layer and hardness throughout the length are acquired.

As hardening and tempering are done at the same time, there is very little hardening strain on the rails.

(4) Profile of hardening

Due to the special design of the heating coil, rails with any profile of hardening can be manufactured. As the rail is hardened as deep as the fishing surface on the head position, it has very excellent wear resistance against abrasion caused by fishplates.

(5) Economically

Life of the rails can be extended by using hardened rails and you can save much in material and maintenance costs.

QUALITY

(1) Structure of High Frequency Hardened Rail

3 H 44238 C = 0.66% Magnitude 300.

(i) 1 mm. from surface
Sorbite after tempering

HV 347

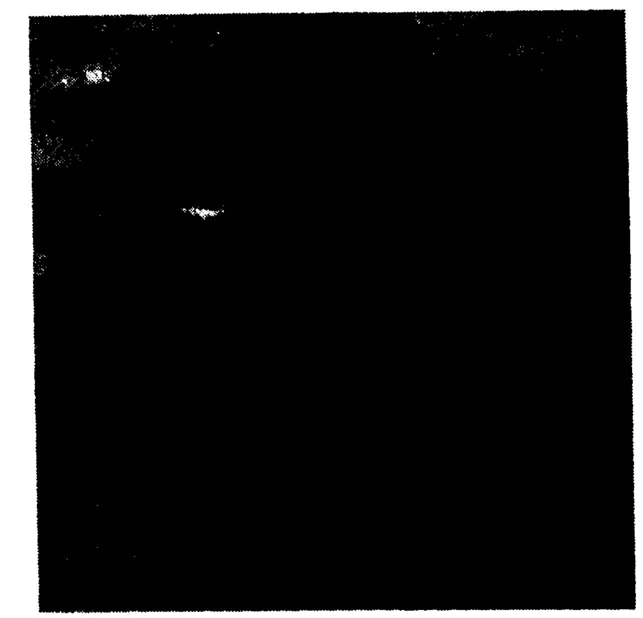
(ii) 3 mm. from surface
Sorbite after tempering

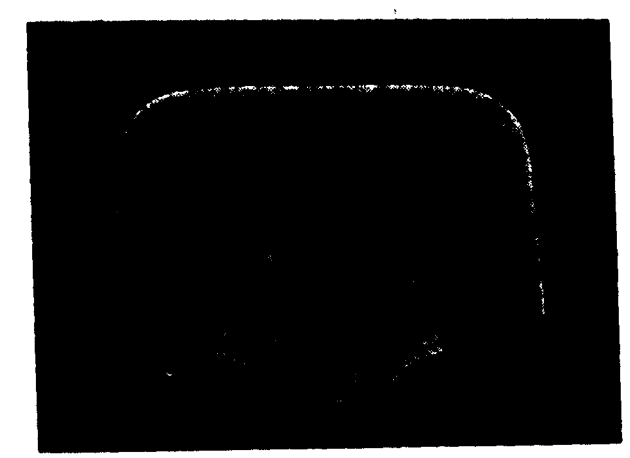
HV 324

(iii) 5 mm. from surface
Sorbite + fine grained pearlite + ferrite HV 319.

(iv) 7 mm. from surface
Fine grained pearlite + ferrite HV 317.

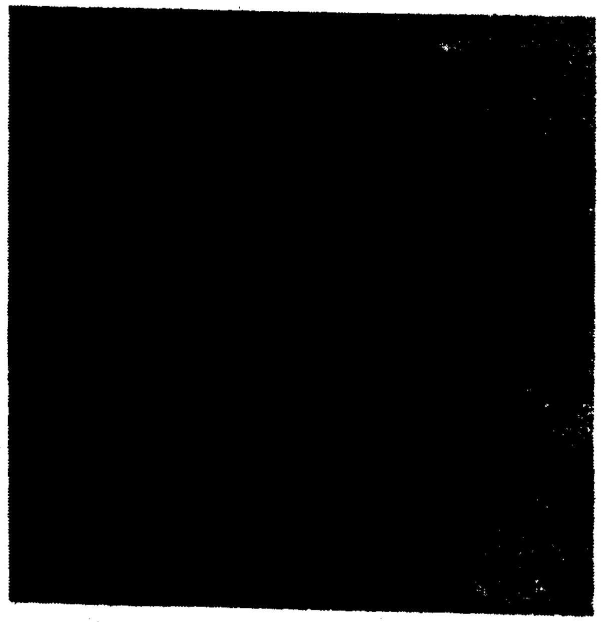
(v) 10 mm. from surface
Fine grained pearlite + ferrive (white) HV 304.





(vi) Material Rail

Ordinary pearlite + ferrite HV 218.

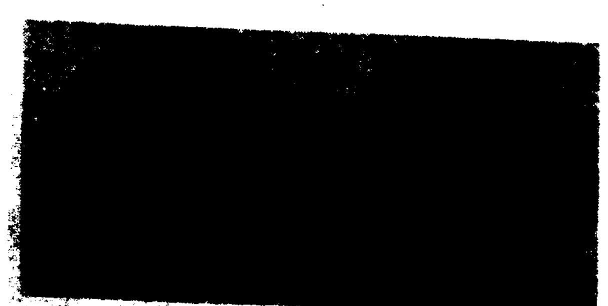


Pictures below illustrate sorbite acquired after the hardening and tempering process both by high-frequency and flames (gas, heavy oil, etc.).

Sorbite after the high-frequency heat treatment has a very elaborate, fine grain compared with that which has been flame treated.

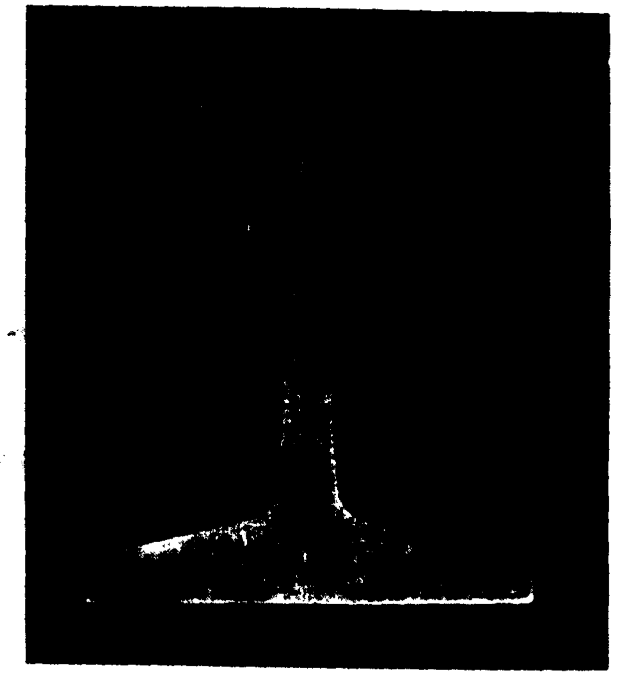
Fine grained sorbite after high frequency hardening and tempering (× 400).

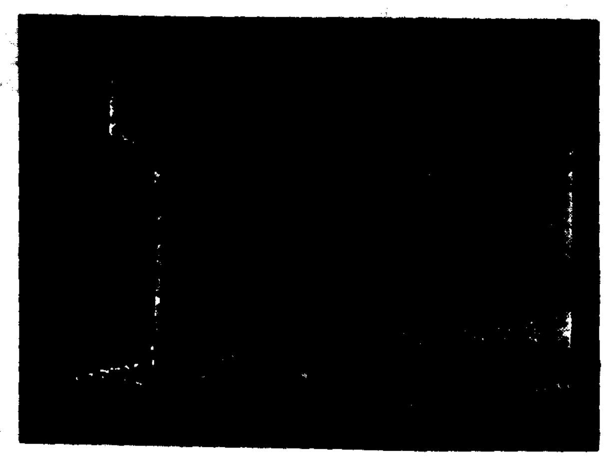
Coarse-grained sorbite after flame hardening and tempering (× 400).



(2) Depth of hardening and hardness

Conditions in the heat treatment process are under perfect control and the depth of hardening and hardness are uniform. Shown below are a few examples.

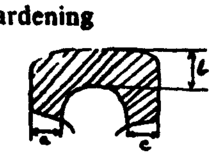




Etching: Alcohol Solution of 5% Picric Acid.

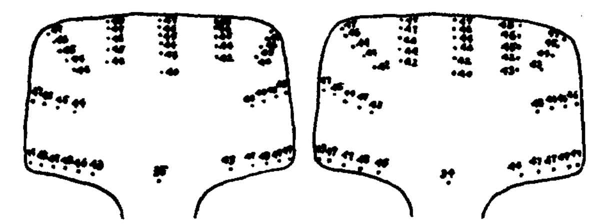
o P. S. 50 kg. Rail

a. Depth of hardening

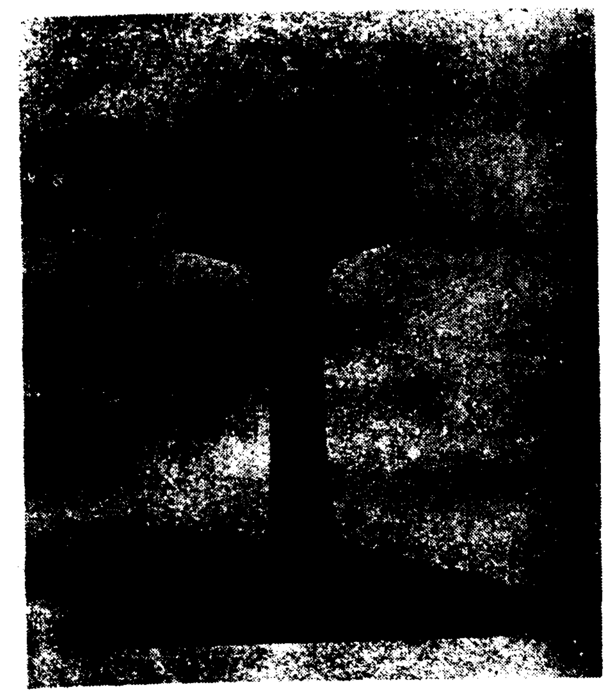


Distance	Surface Hardness (HS)	Depth of Hardening (mm) a	b	c	Distance	Surface Hardness (HS)	Depth of Hardening (mm) a	b	c
from end 0 m	47	-	-	-	13 m	48	-	-	
1 "	48	-	-	-	14 "	47	17	21	17
2 "	48	16.5	20	16.5	15 "	48	-	-	-
3 "	47	-	-	-	16 "	48	17	21	17
4 "	48	16.5	19.5	16.5	17 "	48	-	-	-
5 "	47	-	-	-	18 "	47	16.5	20	16.5
6 "	48	17	21	17	19 "	49	-	-	-
7 "	47	-	-	-	20 "	47	17	21	17
8 "	47	17	20.5	17	21 "	48	-	-	-
9 "	48	-	-	-	22 "	50	-	-	-
10 "	48	17	21	17	23 "	50	-	-	-
11 "	47	-	-	-	24 "	49	17	21	17
12 "	49	17	21	17	25 "	47	-	-	-

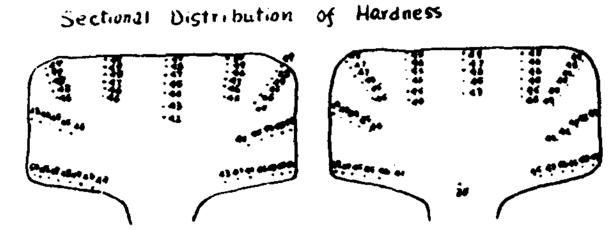
b Sectional Distribution of Hardness



o A. S. 37 kg. Rail



Sectional Distribution of Hardness



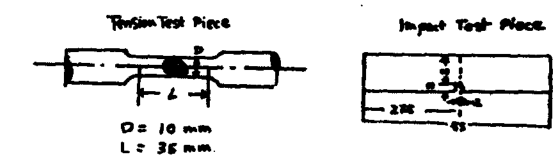
Tests (Examples for reference only)

(1) Tension and Impact Tests

An example of tests done with two test pieces cut off from a hardened 50 kg. rail.

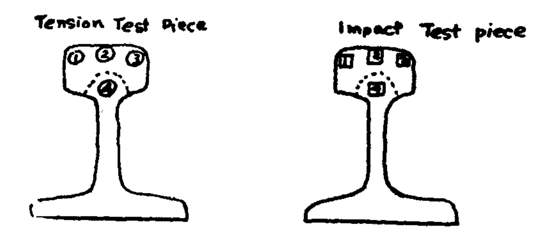
o Results of mechanical tests.

Distance	Tensile Strength (kg/mm²)	average	Elongation (%)	average	Reduction of Area (%)	average	Charpy impact value (kg-m/cm²)	average
1	107.04 108.09	107.6	20.00 20.23	20.1	51.32 49.92	50.6	3.51 2.15	2.83
2	112.73 113.03	112.9	16.29 19.71	18.0	47.95 49.19	48.5	4.56 4.14	4.35
3	115.69 116.03	115.9	18.29 17.14	17.7	47.12 45.56	46.3	2.07 2.16	2.13
4	82.54 81.90	82.2	17.14 18.67	17.9	28.24 28.24	28.2	0.45 0.56	0.51



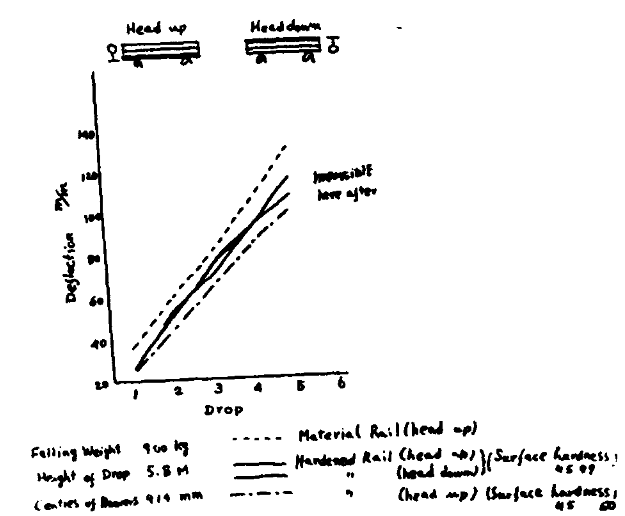
o Chemical composition and location of test pieces.

Product No.	Cast No.	CHEMICAL COMPOSITION (%) C	Si	Mn	P	S
1193	3H44238	0.66	0.16	0.71	0.016	0.032



(2) Falling Weight Test

Tests were made on two test pieces 1.5 meters long cut from a P. S. 50 kg. hardened rail and an ordinary rail, respectively, in conformity to the requirements specified by Japanese Industrial Standard (J. I. S.). After repeated tests, a head hardened rail shows better results in spite of its toughened top.



THE MANUFACTURE OF ROLLING STOCK IN FRANCE

(From our Overseas Editor)

THE French industry for manufacturing rolling stock which, unlike the French National Railways, is part of private industry in France, was one of the first of its kind in the world, and boasts an annual production capacity of:

— 300 steam locomotives,
— 300 long-run electric locomotives,
— 300 heavy and medium traction Diesel locomotives,
— 600 passenger coaches,
— 400 autorails, electric autorails and trailers,
— 20,000 cars of various types.

Total personnel in the industry numbers about 30,000. Present production has two principal outlets: the domestic market, including the French National Railways (60 %) and various other organizations (mines, forges, ports, postal services, petroleum companies, chemical firms, etc.); and the foreign market (overseas territories, foreign countries).

French construction is essentially quality construction, stemming from both the skill of technicians and labor, and from the continuous co-operation which exists between the builders and the S. N. C. F. (French National Railways) engineers. This collaboration has brought about distinguished accomplishments

Electrification with industrial AC. current (25.000 V, 50 cycles). A locomotive of the "mono-continu" group serie CC. 14.100, starts a freight train of 1800 tons with case on the Lille-Metz line.

in the fields of electric traction, thermal motor traction and autorails.

Equipment built for the S. N. C. F. is both efficient and dependable, and therefore shares the world renown of the S. N. C. F., whose recommendation is of the greatest value with regard to exports.

Here are three types of engines, which draw the fast trains on the Paris-Lyon line.
On the left a 2D2 of 144 tons (1950)
„ „ right a CC. of 104 tons (1952)
in the middle a BB of 80 tons only (1954)
-a gain in weight of 45%

Moreover, S. N. C. F. experts are continually called in by foreign countries either as speakers or for missions with other railroad companies.

Powerful and sturdy steam locomotives (23 tons per axle, 5,000 H. P., speeds up to 93 m. p. h.) are also being built by French plants, although the S. N. C. F. no longer orders such engines, for more recent methods developed have made it possible to obtain a better yield from energy sources together with greater operation economy.

In the field of electric traction on direct current, French engineers, after having designed 2D2 speed locomotives up to 144 tons, have turned to total adherence locomotives:

— CC of 107 tons, 93 m. p. h., 1000 H. P. per axle,

— BB of 80 tons, capable of pulling 1,000 tons on level track at 87 m. p. h.

Two of these locomotives, one CC and one BB, set a new world speed record in March 1955 by rolling at the speed of 206.3 m. p. h. Another CC, in late 1955, set a new record for endurance without overhauling by covering 275,000 miles in 7 months. Such achievements are indicative of the fact that French locomotives are of solid construction and are builts with wide margins of safety.

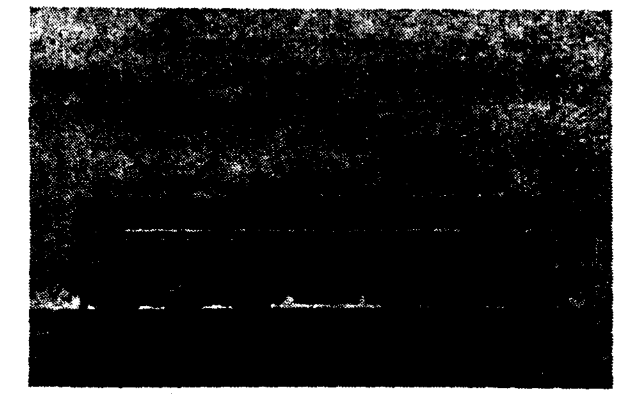
Also to be included in the list of French technical successes is the development of electric tractions on 25,000-volt alternating industrial current. For this, BB 84-ton engines are used (75 m. p. h., accelerated freight trains, passenger trains), as well as 126-ton CC's (38 m. p. h. for heavy trains up to 2,400 tons). In the near future, monophased 60-ton BB's will be able to haul trains of 2,000 tons.

* * *

The modern French tracks are made up with rails 800 meters long. Fixed on the sleepers with elastic joints.

On non-electrified lines, steam locomotives are gradually being replaced by Diesel engines, using concurrently relatively slow motors of 600 to 1,000 r. p. m. and more rapid ones of 1,500 r. p. m. For station manoeuvring, 90 to 300 H. P. engines are built, as well as locomotors of 400 to 500 H. P. For shunting and towing trains on secondary lines, locomotives of 600 to 1200 H. P. are available. French engines of 600 to 800 H. P. pull 1,200-ton trains at 15 m. p. h. on level runs, and 300-ton trains on 1% slopes.

In the French Union, where the Diesel is widely used, the most recent are of about 1000 H. P., 80 tons and 44 m. p. h. Their suspension was carefully studied in view of track irregularities which are difficult from the point of view of maintenance. The engines also have highly developed air filters for the air utilized by the motors and auxiliaries.



Electric locomotive of the CC. 6051 type specially designed for traction with AC. current, monophase 50 cycles on the Aix-Les-Bains, Roche sur Foron Line.

Weight: 104 tons
Power: under 20 KV: 4200 H. P.
Maximum Speed: 100 KM/ per hour.

Heavy engines built for the S. N. C. F. are of two types:

— 120 tons, Diesel motor (slow) of over 2,000 H. P. for heavy freight trains,

— 100 tons, 2 Diesel motors (rapid) with a total power of 1,800 H. P., destined to replace completely steam locomotives in an entire area.

Soon, the French Diesel locomotive will have a power of 2,500 H. P. with a single motor.

* * *

The rapid Diesel motor, a French specialty, is particularly stuitable for autorails, engines that are amortized quicker and of shorter life than a regular locomotive. Autorails reduce transportation costs over short distances and provide speedier service for passengers. Light but sturdy, their power varies between 6 and 10 H. P. per ton.

In France today, the following types are being constructed:

— for short runs, 2-axled autorails, 70 to 200 H. P., with speeds up to 62 m. p. h.

— for average runs, two-truck autorails with 2 motors of 300 H. P., speeds up to 87 m. p. h.

— for fast runs either between provincial cities or the capitals of Europe, "mainliners" with a rapid 825 H. P. motor, two control cabins, and speeds up to 87 m. p. h.

Electrification with industrial AC. current (25.000 V.50 cycles). A locomotive of the "mono-continu" group, serie CC. 14–100.

Deluxe "panoramic" autorails will soon be put into operation.

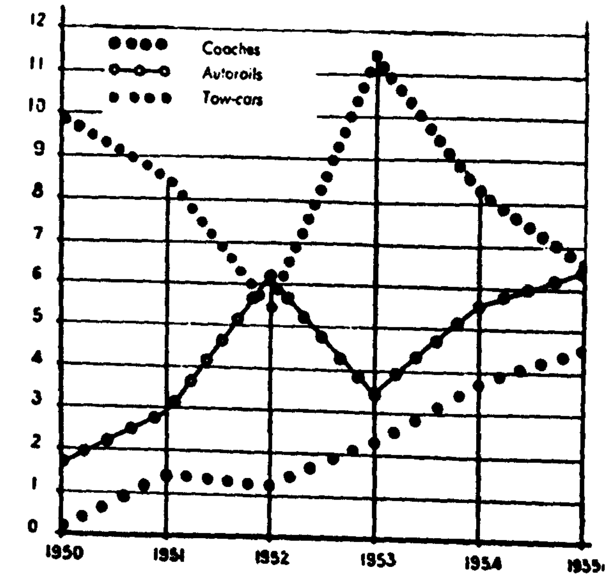
Research to make autorails as light as possible has led to a general use of light alloys and welding.

* * *

Derived from the Diesel autorail, the electric autorails, with the same main characteristics, is also very suitable for suburban service, where a rapid start and acceleration between two stations is desirable. Light electric autorail engines of stainless steel, used in the south-eastern suburbs of Paris, have 4 direct current motors with an over-all power of 1100 H. P. The 4-coach trains can carry almost 1,000 passengers during rush hours.

Electric trains used in the Paris subway include light, jointed sections with 5 trucks for 4 coaches, and other trains on rubber tires. These latter, with their increased speed and comfort, are indeed the train of the future.

ROLLING STOCK



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Comfort is, of course, a prime consideration in the construction of passenger coaches. It is largely a question of suspension, therefore of the wheel trucks. The best of these have a double suspension of extremely flexible propeller springs, combined with hydraulic shock absorbers to brake the rise. Secondly, there is the matter of interior design:

— soundproofing by means of insulated and anti-vibrating floors and walls. Flocking and other special materials are used for this, including asbestos and glass fiber. Synthetic panelled ceilings with holes in them also absorb noises;

— fluorescent lighting, along with individual lights;

— automatically controlled hot air heating, installed under the coach, serves to ventilate the coach as well. Air conditioning as such was first used in France on the stainless steel coaches of the "Mistral";

— harmonious colors and specially designed seats.

With regard to safety, French coaches of metallic construction have long been of the "tubular beam" type. The framework of the hull, made of high-resistance steel, forms a single shell; sheeting is of a light alloy. Electric welding is being used more and more, as are stamped forms, which reduce weight.

French manufacturers today are building 34-ton express coaches, and 29-ton regular-type coaches. It is interesting to compare these figures with the 50-ton metal coaches which replaced the old wooden coaches in 1925. Thus, the French railway coach is light, sturdy and streamlined.

On the non-electrified sections of the Greater Paris belt, 20 Diesel locomotives of 2.000 h. p. draw the heavy goods trains.

Products like stainless steel are being used more and more. One of the latest uses is for building new sleeping cars, with their ingenious compartment system which enables two upper compartments of the new double-decker arrangement to be joined together by simply removing the separating partition.

French railway coaches are being designed today for 90 m. p. h. speeds.

* * *

The types of freight cars used by the S. N. C. F. are limited by present international conventions. Standardization is moving forward towards greater sturdiness, less weight and easier maintenance as a result of interchangeable spare parts.

Moreover, the great diversity of special shipments has entailed an equally varied scope of special cars of increasingly specialized nature :

— cars with light alloy hoppers for phosphates

— 80-ton cars with hoppers for coal

— tank cars of all types

— cars for shipping cement in bulk

— double-decked cars for automobiles

— special cars for shipping products weighing several hundred tons.

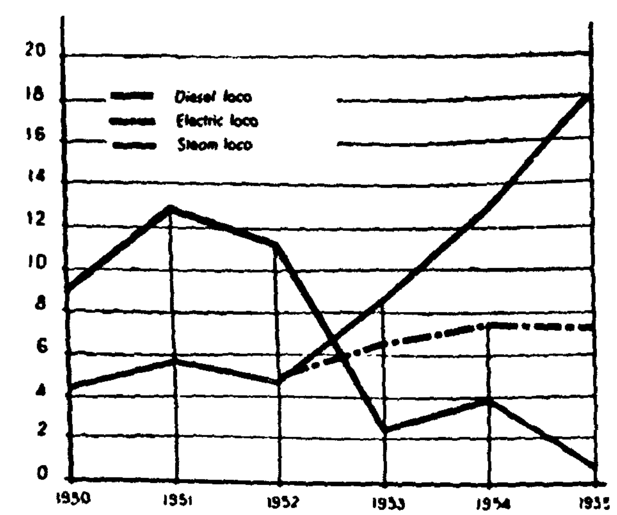
Railway car manufacturing plants are equipped for assembly line production and also for the most complex types of special equipment.

* * *

French engineers and businessmen are building equipment today which gives the public the fastest safest and most comfortable railroad service in the world. Part of this reputation is due to the excellent roadbeds over which the trains travel. The Thomas steel rails (France exports an average of 200,000 tons per year) are welded in long lengths; the concrete crossties and elastic clips used are also products of French creativeness.

TRACTION MATERIAL

(THOUSANDS OF TONS)



Since World War II, considerable effort has been made in exporting. Between 1951 and 1955, equipment delivered to other lands included :

Steam locomotives—	Brazil	90
	Luxembourg	10
	Southern Rhodesia	10
	Australia	20
	Egypt	30
	Kenya	12
	Indian Union	20
	Yugoslavia	30
	French Union	100

About 400 electric autorails and locomotives for the Netherlands, Spain, Turkey and the French Union.

Diesel-electric locomotives—	Netherlands	100	
	Pakistan	18	
	Cuba	12	
	French Union	200	
Autorails—	Greece	13	triple units
	Turkey	13	triple units
	Spain	10	
	Luxembourg	10	

PNEUMATIC SPOT WELDING MACHINE

Aston Electrical Products Pty. Ltd. at East Sydney (Australia) have produced a new pneumatic spot welding machine to meet the needs of the light gauge metal and wire working shops, using spot welding technique for metal fabrication. It is regarded as particularly suitable for the assembly of small articles manufactured for the domestic hardware and office equipment trades.

The operation of the new machine is automatic. The operator has only to press the pneumatic foot valve for each spot weld. This eliminates fatigue associated with manually operated machines and ensures a greater output of fabricated components.

Controls for the machines are conveniently placed for easy accessibility and adjustment. Welding pressure can be applied by means of an air-pressure reducing valve, a pressure gauge indicating the air-pressure applied to the operating cylinder. This means that correct welding pressure can be easily adjusted within seconds compared with the manual machine, which usually requires spring adjustment at the rear.

"Squeeze" time, the period during which pressure is applied to the weldments, is regulated by adjusting the pressure switch, mounted adjacent to the head. "Weld" time, the period during which welding current flows, is controlled electronically by a plug-in Thyratron Timing Unit.

Welding heat-taps have been provided to give a welding range from two pieces of 28 S. W. G. clean mild steel sheet to two pieces of 16 S. W. G. clean mild steel sheet on continuous production, or two pieces of 12 S. W. G. clean mild sheet intermittently, and wire work from 18 S. W. G. to 4 S. W. G.

The four controls provided i. e. "Pressure", "Squeeze" time, "Welding" time and "Welding Current", make the machine suitable for operation by unskilled process labour, as once set up correctly, weld quality will not vary.

* * *

PROCESSING OF SCRAP

In an 8 hour shift, a model 3,000 Harris baling press processes over 350 tons of scrap. For feeding the press, a mill-type overhead crane is equipped with a 65-inch, 8-coil electro-magnet and an orange-peel bucket. Matching the operating cycle of the press, the crane handles unloading, feeding of the press, and reloading the finished bundles into railroad cars.

The baling unit can reduce 3 automobiles to a bundle of scrap 60 × 60 × 24 inches in 90 seconds. Since bundles of this size are too large for the charging doors of most steel mills, normal bundles contain only 1 automobile.

Some Problems of Expanding Railway Transport in India

By K. B. Mathur

Member, Transportation, Ministry of Railways, Govt. of India.

THE history of Indian Railways since their inception over a century ago is one of continuous expansion both in their extent and the volume of passenger and goods traffic carried by them. The role played by the Railways in the development of our country is well known. Without the Railways, industrialisation would have been impossible and a balance in the agricultural economy of the country could not have been maintained. In times of scarcity, prompt and adequate assistance to deficit areas would be impossible.

Before the advent of Independence, the Railway system in India was primarily intended to serve the export of raw materials out of the country and to distribute the imported finished products from abroad to the consuming centres throughout the country. This limited role took a more extensive shape after Independence, viz. that of carrying the vital goods traffic required for the rapid development of the country on all fronts in the successive Five Year Plans. To-day, railway transport in India is like the healthy blood circulation system to the human body on which depends its robust existence.

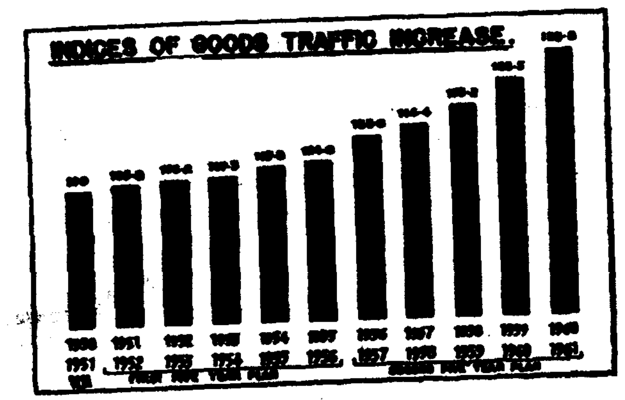
The rapid expansion of the volume of goods traffic handled by the Indian Government Railways during the last 20 years will be obvious from the chart reproduced below. This indicates the traffic

levels at important stages viz. the pre-war period, the war peak, the post-partition period and the commencement of the First and Second Five Year Plans.

Shri K. B. Mathur

It will be observed that the war time peak performance of undivided India with its regimented traffic had already been exceeded even at the beginning of the development period which began with the First Five Year Plan.

But this story of the past affords no parallel to what the new era of planned development is likely to unfold. The revised estimate of goods traffic in the Second Five Year Plan is an anticipated increase of about 50 per cent over the peak traffic in the last year of the First Five Year Plan. In fact the goods traffic might increase by about 84 per cent



during the first two Five Year Plans. Subsequent Plan periods are expected to result in a similar rate of increase over the preceding period, if not more. The increase in passenger traffic is also expected to continue at the rate of about 3 per cent per annum. In fact during the two years of the Second Plan this rate has averaged 5 per cent.

This is the overall picture, but when Railwaymen came to brass tacks for planning, they had to contend with a much greater rate of increase in traffic in certain areas. Some examples of this are the mounting suburban traffic in Bombay and Calcutta and the heavy increase in traffic of raw materials for the new and existing Steel Plants. Due to the location of natural resources like iron ore, limestone and coal in a restricted area in Bengal, Bihar and Madhya Pradesh, development of the steel industry naturally has been concentrated in this area. Against the three steel plants in the private sector functioning upto the Ist Five Year Plan period, the Second Plan contemplates the addition of 3 new steel plants besides the expansion of the existing ones. The finished steel production is expected to be quadrupled during the Second Plan period, and the real crux of the problem is the large movement of raw materials which in consequence will materialise. For the production of 1 million tons of finished steel, about 5 million tons of raw materials are required to be moved from the various sources to the steel works. To move 1 million tons of raw materials in a year, it is necessary to load on an average 125 wagons per day throughout the year. Therefore, for a new Steel Plant with a capacity of 1 million ton of finished steel like Bhilai, Durgapur or Rourkela the volume of raw materials required to be moved every day comes to about 625 wagons and for the 3 new Steel Plants and expanded existing plants, the additional traffic in raw materials and finished products will be of the order of 3,000 to 3,500 wagons daily. Similar is the story of coal. From a production of about 35 million tons a year at the beginning of the Plan the expansion contemplated in the Second Plant puts the target at 56 million tons, the major portion of which will be produced in the Bengal and Bihar coalfields which are also situated in the heart of the steel traffic area. The problem of planning the implementation of such large movements within a short period of 3 to 4 years is probably unique in the history of Railways. And it should be remembered this will repeat itself during successive Plan periods.

The object in re-counting the back ground of the contemplated development is to bring out the patent fact that the requisite planning cannot be based on mere multiplication of the existing facilities in proportion to the additional traffic. In other words we cannot think of just buying ten times more wagons and engines and run ten times more trains if the increase in traffic in any area is of this order. If we try to do this, we will be trying to repeat the story of building the Pyramids with human labour and the primitive methods in those times. In the modern age, the time factor is probably the most vital and advances in science have placed at the disposal of man, improved techniques which make it possible to undertake economically, massive tasks with comparatively insignificant human labour, in a very much shorter time. What then is the solution of this problem of expanding Railway transport and how is it being tackled? The following paragraphs attempt to indicate it as simply as possible.

Let us begin with the type of wagons to be used. The type of wagons ordinarily in use on the Indian Railways are the covered and open four-wheeler wagons. The dead weight of these wagons (called the tare weight in Railway parlance) is of the order of 10 tons and their carrying capacity about 20 to 22 tons. These wagons have served a very useful purpose in the last century of Railway existence. But for dealing with the large volumes of traffic of the future, it seems essential that the size of the wagon is increased. This may seem like increasing the size of the kettle when a larger quantity of tea is to be served. It is not, however, an easy task to design a larger wagon because this is conditioned by the standard of track and bridges, which require considerable time and money to change over. The new wagon has, therefore, to conform to the average standard of track and bridges obtaining in the country, which only permit an axle load of 20 tons. A bogie wagon with four axles and 8 wheels against the present 4 wheeler wagons, with an axle load of 20

Loading of ore from chutes in hopper wagons at Badampahar on South Eastern Railway.

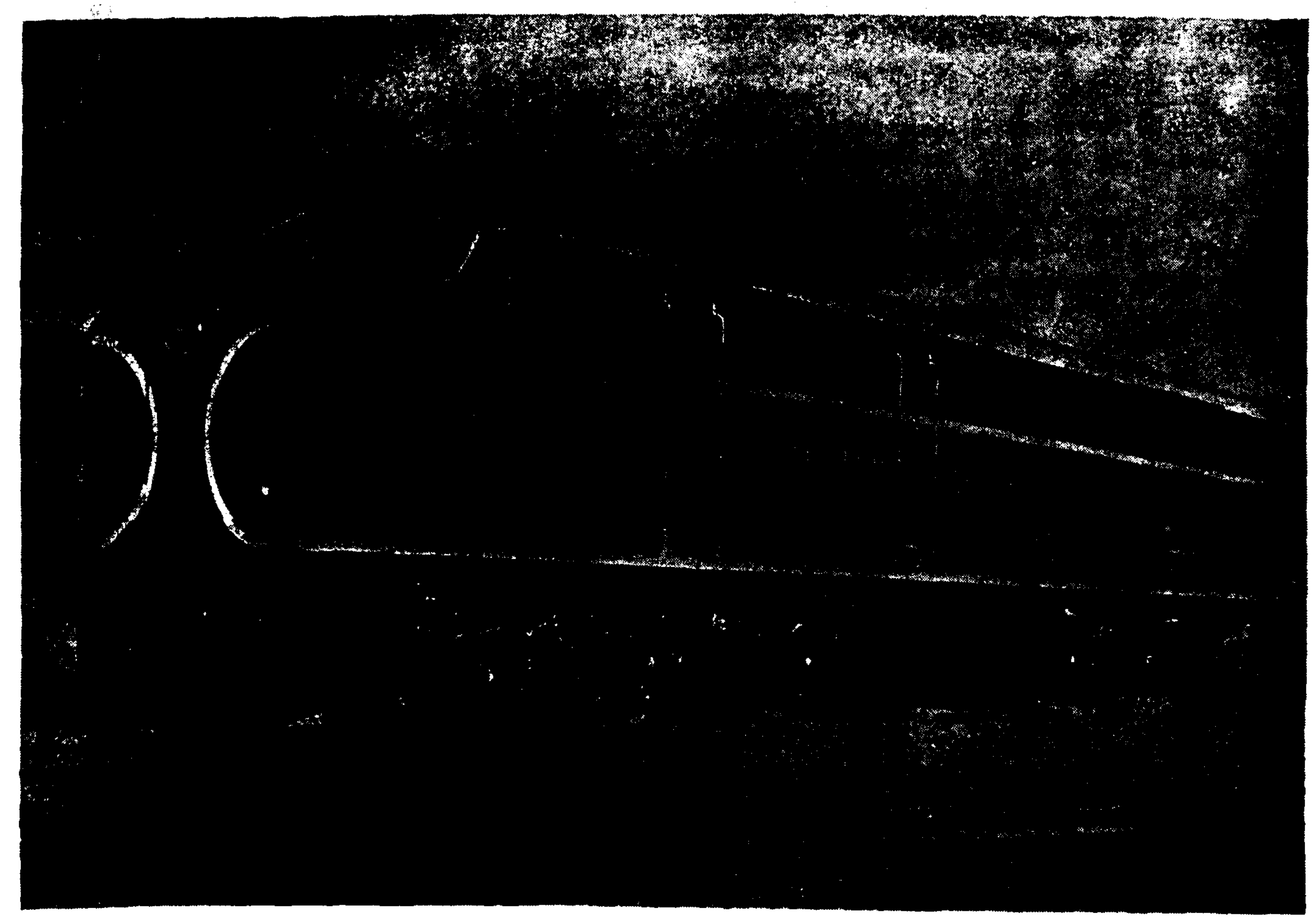
tons has, therefore, been proposed and our designers have found that within these limitations, it is possible to design the wagon with a tare weight of about 25 tons and a carrying capacity of 55 tons. This design is also the most economical in its length, as it is the length of the wagon which determines the load for goods trains which can be accommodated in the crossing loops provided at the stations. All countries of the world with long distances like the United States, Canada, Russia and China, where the development problems are or were more or less similar to ours have already switched over to the bogie wagon. With its capacity of 55 tons, where 2½ wagons of the traditional four wheeler type would have to be loaded, with the new type of bogie wagon, it will be enough to load one wagon only. Thus we get to the first step in the economy of transport including the time in handling operations.

Next comes the problem of the type of traction. It is well known that diesel and electric traction for intensively worked sections of Railways is more efficient and economical than steam traction. The servicing time required for the steam engine is very much more than that required for diesel or electric engines. The load hauled by diesel and electric engines can also be heavier. The logical step would therefore, appear to be to switch over from steam to diesel or electric traction on important routes as and when the resources of the country permit. Diesel traction, however, requires large internal resources of oil which are yet to be established. Meanwhile, this means of traction should necessarily be adopted with some reserve. In respect of electric traction we are much better placed. We have a vast potential of hydroelectric power, coal for thermal power is available in abundance any schemes for development of nuclear power are well on their way. Foundation for establishing heavy electrical industry has already been laid and it is now only a question of time when it will fructify. In our schemes for development therefore, we have laid some emphasis on electrification.

How does Dieselisation or Electrification increase the transport capacity? What is called "line capacity" in Railway language and what in ordinary language means the number of trains which can be run on any section of a line every day, is a very vital factor to be tackled in expanding railway transport. Line capacity has to be increased, if more trains have to run and more trains must be run if more traffic has to be carried. But the number of trains need not be proportionately more, if each train carries a heavier load, and this exactly is what diesel or electric traction is designed to do. There are various stages by which line capacity is increased. On a single line section, we open more crossing stations so that more trains can be run and opposing trains crossed, whenever necessary. More lines are provided at the stations so that more than two trains can be crossed at a time whenever required. Increased terminal facilities are provided so that an increased number of trains can be received in or despatched from the terminal. The signalling system is improved so that time required in running through stations or in crossing trains at stations is minimised. But there is always a limit to all this. Under Indian conditions, on sections free from steep gradients, we have been able to run a maximum of about 16 to 17 trains each way or 32 to 34 trains both ways in a day on a saturated single line section. In some cases we have even done better, but at a considerable sacrifice of efficiency of operation and speeds of trains. If the

The new dual-purpose Electric Locomotive for use on the Eastern Railway.

number of trains exceeds this figure, the first stage of development is doubling in patches. From patch doubling, with which we can achieve a capacity of about 45 trains both ways on level sections, we proceed to complete doubling of the section whereby we can obtain a capacity of about 80 trains both ways or even more. On a double line section, with the trains following each other, the problem of line capacity takes a slightly different turn and the proportion of fast to slow trains and their distribution affects the capacity. Best results are usually obtained if faster and slower trains are run in periodic flows so that the problem of faster trains overtaking the slower trains is reduced to a minimum. In the suburban areas of Bombay and Calcutta, we have quadruple lines and even 5 or 6 lines, but on the long distance trunk routes, the next step of increasing line capacity on a double line is not necessarily to provide more lines. Automatic signalling where one rain can follow another at very close intervals, and or change in the type of traction from steam to diesel or electric traction afford a remedy. With the bigger hauling capacity, sustained power, higher rate of acceleration and deceleration, and elimination of loss of time for watering, the transport capacity increases substantially with Diesel or Electric traction. Due to lack of an indigenous supply of Diesel oil, it has been decided, that initially Dieselisation should be introduced where increased capacity is urgently required as in the steel and coal belts. It should really act as the spearhead for electrification which is to follow. The Diesel locos will, therefore, perform a roving mission from one section to another, to minister to the varying needs of increased transport where other means are not readily available. Thus it is proposed to Dieselise and subsequently electrify the routes on which steel and coal traffic will come up viz. from Dhanbad to Moghalsarai and from Asansol to Rourkela, Tatanagar and Barajamda. 100 B. G. Diesel locomotives have been ordered



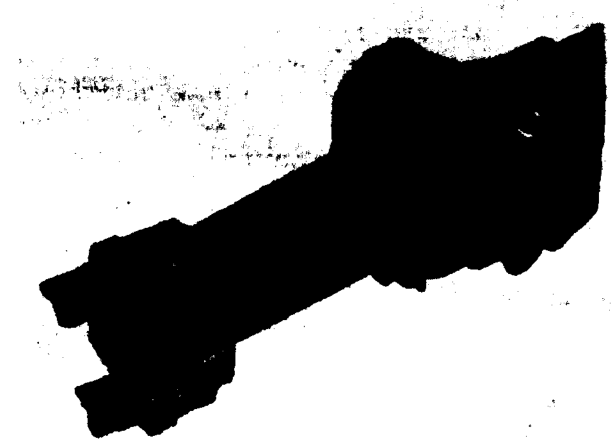
The new B.G. Main line Diesel Locomotive. 100 such locos have been ordered for use on the Eastern and South Eastern Railways.

from the U. S. A., 20 of which have already arrived and have acquitted themselves well in the task assigned to them.

The increased hauling capacity of diesel or electric traction cannot, however, be made use of without a change in the design of the wagon. The ordinary screw coupling which is used in coupling of two wagons of the orthodox type can take a limited strain. Thus whatever be the capacity of the locomotive or locomotives hauling, a train of not more than about 1800 tons gross load can at present be carried on a section with a ruling gradient of 1 in 100, which incidentally is the ruling gradient in the steel and coal belts. Against this, coupled diesel and electric locos of the type, which are being obtained, can haul loads of about 3600 tons. Therefore, we have to introduce another major change in the design of wagons, viz. the replacement of the screw coupling by the automatic centre buffer coupler. This is another development which has already proceeded in the U. S. A., Russia, China and Japan. The advantages of this type of coupler are manifold. The first is that it is automatic, i. e. when one wagon is pushed against another, the couplers are automatically interlocked and marshalling of trains is thus speeded up as against the ordinary screw coupler which has to be coupled and tightened by manual labour. The second advantage is the much greater strain which it can stand. We can thus make full use of the hauling capacity of the diesel and electric locos and run 3600 ton trains with our existing 2250 feet crossing loops where only 1800 ton trains could be run with the orthodox type of couplers. In fact if the lengths of the crossing loops is doubled, we can even go up to 7000 ton trains which might become necessary on some sections in time to come.

The new design of wagons mentioned above also has a number of technical advantages. It is equipped with roller bearings which offer considerably less rolling resistance as compared to plain bearings provided in the existing wagons. This again enables higher load haulage and quicker acceleration. The new wagon is also of welded design against the revetted design of the present wagon. Welding eliminates leaks in joints and consequent possibility of corrosion and saves steel whereby the tare weight of the wagon is less and this enables an increase in the carrying capacity within the same axle load. The intensity of loading per foot run which is obtained by dividing the gross weight of the wagon by its length has also been increased from 1.2 tons per ft. to about 1.9 tons. The practical advantage gained from this is that a goods train of 3,600 tons gross load and 2475 tons net load can be accommodated within the standard length of the B. G. loop lines of 2250′ against a train of 2240 tons maximum gross load and 1540 tons net load with the existing type of wagons. Thus we increase the work-load per train by over 60 per cent or in other words where 16 trains would have to be run with the old type of wagons, 10 trains with the new type will do.

To switch over from the orthodox coupling to the new coupling and indeed from the orthodox type of wagon to the new bogie type is, however, not a simple affair. A wagon with the old type of coupling cannot be coupled with a wagon with the new type unless some kind of transition gear is provided; and this complication introduces an additional gadget which initially will have to be imported.



The new automatic coupler.

Our plans, therefore, have to proceed with due regard to this factor. We have, therefore, to start with, decided to run such wagons in closed circuit in full train loads for which our steel factories afford ample opportunity.

With the bigger wagons coming into use, we cannot obviously stick to the orthodox methods of loading and unloading with manual labour at least where bulk operations are in question. If we do so, we will lose the time which we gain otherwise. Mechanical loading for commodities like iron ore, coal, limestone etc. will, therefore, have to be introduced. Similarly, unloading of the wagons by mechanical tipplers will be necessary. Co-operation of the trade is solicited for the purpose.

The design of wagons described above refers to

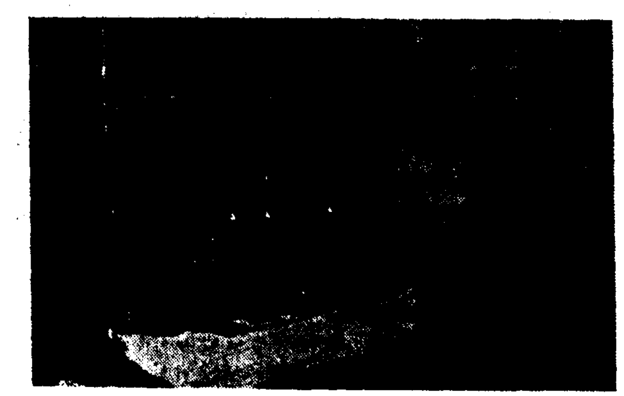
open wagons. This has been given priority as almost 70% of the additional traffic during the Second Five Year Plan will require the use of open wagons. Bogie covered wagons of a similar design are also proposed to be introduced by stages.

Linked with line capacity is the ability of terminal stations and yards to handle the incoming and outgoing traffic. The problem at terminal stations where the traffic originates or terminates is one of expeditious loading and unloading. On the journey of the wagons, however, between the terminals, marshalling yards perform a very vital function. The very nature of yard work is, however, such that the public at large have the least opportunity to appreciate its important role. A goods marshalling yard like Moghalsarai through which passes the bulk of the coal despatched from the collieries in Bihar and Bengal to consumers in north and west India, has to sort the wagons for various destinations, form them into block trains and despatch them in different directions. The sorting of wagons is done over what is called a 'hump'. The wagons are pushed over the hump in destination groups so that with the acceleration attained by gravity and different routes set after each group is pushed over, block trains for different destinations are automatically formed. The capacity of a marshalling yard, therefore, essentially depends on the amount of 'humping' which it can undertake. With orthodox methods, humping is not a very fast process. Many times the wagons get stuck on the way and very often they travel faster than necessary and bump into other wagons causing damage to the wagons. There is loss

A typical goods marshalling yard. Just beyond the signal is the 'hump'. The train in the foreground is being sorted, and one wagon is seen rolling to its nominated line.

of time in setting and re-setting of routes after every group of wagons is pushed over the hump. All this limits the capacity of the marshalling yard. Modern electrical equipment has, however, been designed which expedites humping work to a much faster rate. The hump is raised so that a higher initial speed is attained. This prevents wagons getting stuck on the way, particularly during the winter months when the rails are wet and the oil in the boxes of the journal gets thickened. There are automatic retarders so that bumps and a damages are avoided. The routes to be set can be "stored" in a kind of electric brain which sets and resets the routes in the requisite succession at a rate much faster than human effort can achieve. Thus a train can be sorted in almost less than half the time taken with orthodox methods. Obviously this doubles the capacity of the marshalling yard also. This equipment is being introduced in the biggest marshalling yard in the country at Moghalsarai. It will soon be necessary to introduce it in other yards also but the progress will depend on the availability of foreign exchange as the equipment is not produced in the country.

Centralised Traffic Control is another innovation much talked of in our country. In simple language it means control of train movements over an entire section of say 150 to 200 miles from one cabin from an electrically operated panel by one or two men. As the control is exercised electrically, the time lag between different operations is minimised and with abundant facilities for crossing, the section capacity of a single line section can be substantially increased. An important advantage of this system is its labour saving aspect which does away with a large number of switchmen and cabin men in the entire area. This aspect is most welcome in a country like the U. S. A.



C.T.C. control panel. All movements in the area shown on the panel are controlled by one man from this panel.

where labour is scarce and expensive. Its repercussions on Indian conditions where the necessity for expanding employment may continue for years to come are somewhat different. C. T. C. as it is called in short, has not yet been tried under Indian conditions, but as soon as the necessary equipment can be obtained, it is proposed to try it on a typical section in order to assess the increase in line capacity that it can provide and the way it functions under Indian conditions of operation and maintenance.

With the large and ever increasing demand for rolling stock and other equipment, the Indian Railways could no longer afford to be dependant on foreign imports involving a considerable drain on the scarce foreign exchange resources. Determined efforts were, therefore, made during the First Plan period itself to develop manufacture of Railway equipment including rolling stock in the country to the maximum possible extent. As the largest and most vital item of Railway equipment is rolling stock, the Chittaranjan Locomotive Works for B. G. locos was established late in 1950. Till the end of 1957 it has produced 625 engines, an average of about [illegible] per month. The present out turn is 14 locos per month. The Tata Locomotive and Engineering Co. Ltd. are manufacturing M. G. locos since 1945. Their original capacity of 50 locos and 50 spare boilers has now been increased to 100 complete locos. Proposals to build Diesel and Electric locos in the country are also under consideration. The Integral Coach Factory at Perambur started production in 1956. The target production is 350 coaches, expected to be reached in 1959/60. A second shift is already under contemplation which will increase the capacity to 600 coaches per year. An independent furnishing factory for furnishing the shells manufactured at Perambur is contemplated so that this work can be removed from the already over burdened Railway workshops. Wagon building has been allotted completely to the private sector. It was in its infancy at the beginning of the First Plan with a production of 3707 wagons. At present the capacity for a production of 20,000 wagons has been developed and this is being expanded up to 26,000 wagons in the near future. With the existing trends in our country it would seem that we are now in a position to export wagons to other countries.

All this relates to additional assets and equipment. But the planning must include better management and better use of the existing assets also. This has already been concentrated upon and in fact the increased work load in the first year or two of the Second Plan is mainly the result of increased operational efficiency. The Second Plan itself is based on a 10% increase in the effective usage of engines and wagons and various steps have already been taken to expedite the turn round of rolling stock to achieve this target. The following figures of the best internationally recognised criteria for judging operational efficiency of Railways will indicate the steadily improving performance :—

Net ton miles per wagon day.

	1938/39	1942/43	1948/49	1956/57
B. G.	351	451	358	570
M. G.	147	182	171	210

Net ton miles per goods engine per day (on line)

	1938/39	1942/43	1948/49	1956/57
B. G.	15144	17749	15312	22315
M. G.	7019	[illegible]	6048	9360

A certain amount of rationalisation of transport is also necessary. Thus it would be uneconomic and considerably burdensome to the Railways if consumers throughout the country were to be given the option of choosing any type of coal from any colliery. At the same time, within reasonable variations, the quality of coal required, has to be supplied. Therefore, it is essential that supply of coal should be restricted to the nearest colliery subject to the requisite quality being available. Similar considerations apply in distribution of food grains, salt and other commodities which move in bulk. A system of zoning of the distribution areas is necessary. Imported food grains should be moved by rail from the nearest port. Rationalisation of this type can be enforced to the extreme in totalitarian systems but its scope in a democracy like ours is obviously somewhat restricted but it has to be conditioned by public interest.

The problems of the human element created by continuously saturated rail transport are manifold. Conditions are unlike the days before the war when even on the trunk routes, the traffic rarely exceeded

about 50 to 60% of the capacity. Such a state of affairs made the task easier for the transport operatives. The train-clerks [illegible] between two trains, they could sit back and relax. The marshalling yards were half empty and congestion in yards was almost unheard of. If there was a breach or an accident, the flexibility allowed the loss in capacity to be easily made up. If a few more men were sick in the summer, it did not matter much. But the present conditions in many areas have introduced intensive working. The line capacity and yard capacity is almost fully saturated on all the trunk routes. There is just no scope to make up, if the capacity is lost in a train or two not running due to any unusual occurrence. The loss has just to be put up with, but this is exactly what is not acceptable in a developing economy. The Steel Plants cannot be starved of [illegible] even for one day and so their flow [illegible] maintained, day after day throughout the year. If there is no cushion to make up any shortfall, the only alternative is to see that there is no shortfall. And this brings into prominence the human element. The smallest details have to be watched as [illegible] goes wrong and gradually this has to be done at higher and higher levels as the repercussions become more and more important. Thus if the coal loading drops even by 5%, the matter must receive the attention of the highest authority in the country. Thus the increase in the quantum of work for the transportation operatives is much more than proportionate when compared to the increase in traffic. It is almost like a small increase of a couple of degrees in the temperature of the human body from 98° to 100° or may be more which converts health into disease. It is like the proverbial last straw on the camel's back. With the limited resources, both internal and external, it will take a long time before sufficient increase in line capacity can be created so that the cushion for making up lost capacity can be created all over to mitigate the rigours of work for the Railwaymen.

Railwaymen in India are, however, prepared and undaunted to face the situation confronting them and in fact they consider it their privilege that they have to play such a vital role in the development of the country to the ultimate good of the common man. They are gradually getting attuned to the nature of their task but it would certainly help if the public at large were fully conscious of the position and through their undivided co-operation, environments were kept free of influences which might deflect the Railwaymen from the course which they should follow consistant with their growing responsibilities. They, however, crave the indulgence of the people whom they serve, for any short-coming that may come to their notice.

[illegible] MILLS TO BE SET UP SOON

The Government of India has agreed to the setting up of four new steel re-rolling plants, one each in Kerala, Andhra, Assam and Bihar (north of the river Ganga) as suggested by the Saksena Committee.

Announcing this in Calcutta, the Union Minister for Steel, Mines and Fuel, Sardar Swaran Singh, told the annual meeting of the Steel Re-rolling Mills' Association of India that with the rise in the production of steel, the supply of scrap would also increase. The problem of dwindling availability of scrap was not a long-term one. Admitting that the availability of scrap was an important consideration in regard to the installation of electric furnaces, Mr. Singh said the question of installing furnaces was under examination and a decision on their location would be taken shortly.

INDIGENOUS MATERIALS

The Minister emphasised the need for the industry to rely ultimately on indigenous raw materials, of which a sufficiency was planned.

Mr. Swaran Singh said the days of scarcity of pig iron were over and from next year onwards, supplies would be plentiful. It was also expected that steel-making facilities and re-rolling mills would be ready for operation at Rourkela and Bhilai next year. All rolling mills and all plants, except the cold-rolling mill at Rourkela and the wheel, tyre and axle plant at Durgapur, would be ready by 1960.

He also disclosed that two new furnaces, one at Bhilai and the other at Rourkela, will be in operation by the end of this year or early next year.

Eastern Railway's Role in India's Industrial Development

By Kripal Singh

General Manager, Eastern Railway.

The history of the Eastern Railway, it is said, is the history of coal in India. The Railway serves the coal producing areas of Bengal and Bihar and carries 75 to 80 per cent of the total coal produced there. It also serves a large range of industries based in the territory it covers. The Railway is going full steam ahead with its plans to create the additional capacity that will be needed during the second Plan period. These plans include the electrification of main lines, remodelling of Moghalsarai and other yards, construction of new lines, maximum utilisation of rolling stock etc.

COAL plays a very important part in the industrial development of a country. As a matter of fact, industry is most likely to thrive in areas where coal, ore and limestone are found together or near each other. That explains the high degree of industrialisation of the areas in and around the Bengal and Bihar coalfields and the Orissa and Madhya Pradesh ore areas.

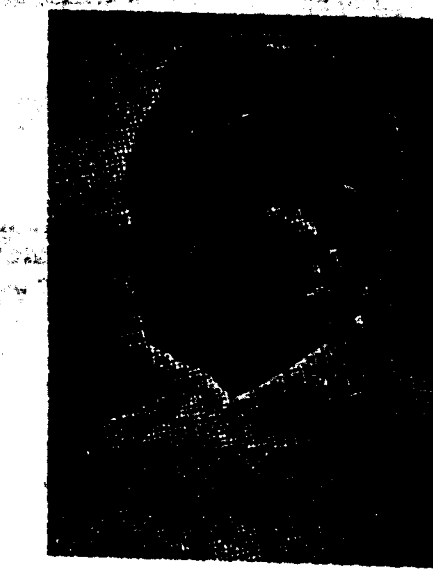
The biggest and the best coalfield area in India lies on the Bengal-Bihar border. About 80 per cent of the total coal raised in the country every year comes from this area. The production from this area amounted to 34.78 million tons in 1957, of which the zone served by the Eastern Railway alone accounted for 23.18 million tons.

The second Five Year Plan envisages an increase in the production of coal from 38 million tons to 60 million tons. Of this 22 million increase, the Bengal and Bihar coalfields alone would contribute 12.8 million tons, the production here rising from 30.8 million tons to 43.6 million tons.

It is the Eastern Railway which has to undertake the heavy task of clearing 75 to 80 per cent of the coal raised in the Bihar and Bengal coalfields and to carry it to destinations spread over the entire country. This will enable the wheels of industry to move, creating more employment and producing more wealth for distribution amongst the people and raising their standard of living. But for this movement of coal most industries will completely close down in just a few days and many cities would be rendered dark.

COAL LOADING UP

In 1955—56, the ast year of the first Five Year



Shri Kripal Singh

Plan, the Eastern Railway loaded an average of 2,426 coal wagons every day, which went up to an average of 2,772 wagons per day (up to February 1958) in 1957—58. At present the figure stands at 2,850 wagons a day.

It has so far been possible for the Eastern Railway to clear all the coal that has been produced by collieries belonging to both private and public sectors situated on the Railway. Work is going ahead on many sections and in many railway yards to create adequate capacity to enable this Railway to make sufficient transport available to meet the increased requirements of the coal industry during the second Five Year Plan.

The principal work is the electrification of the main lines from Howrah to Moghalsarai which would pass through the coalfields. Work on Asansol-Gaya and Asansol-Durgapur sections is to start soon. The main line A. C. electrification organization has already been set up, the French National Railways having been appointed as consultants. Contracts will soon be placed for erection of overhead equipment and other works on the above sections.

REMODELLING OF YARDS TAKEN IN HAND

In the meantime work on the remodelling of principal yards in the coalfields is going ahead. The remodelling of the Moghalsarai yard which is expected to deal with about 3,500 wagons daily in each direction has already been taken up. The yard is at present handling every day about 2,200 wagons in each direction as against only 1,450 in 1952. Some interim additional facilities have already been provided in some of the coalfield yards and at Moghalsarai to enable the Eastern Railway to increase to some extent the capacities of certain coal pilot sections and to handle the daily increasing volume of traffic through these yards.

Twenty diesel electric engines have been obtained and placed in service on the Gomoh-Gaya section, the most steep gradient section on the Eastern Railway, with a view to obtain a higher put-through of coal and goods traffic. The length of loop lines at a large number of stations on the trunk lines has been increased so that the length of goods trains may be increased from 60/65 to 70 wagons.

NEW LINES UNDER CONSTRUCTION

Some new crossing and line clear stations have also been opened to reduce the running time of trains on long sections and thus to increase the capacity of the section to take more trains.

Construction of a new line from Chandrapura to Muri-Ranchi for the movement of coal from the Eastern Railway to the new steel plants at Bhilai and Rourkela and to serve the heavy machine industry proposed to be set up near Ranchi, is progressing satisfactorily. Another new line is being constructed from Damodar railway station on the Adra-Asansol section to Kalipahari on the Asansol-Durgapur section for the movement of iron ore and lime stone from the South Eastern Railway to the new steel plant at Durgapur. An additional line is being laid between Ondal and Ukhra to enable more coal to be raised and cleared on this section.

Similarly, new lines are being constructed to tap the Kathara coalfield and the Karanpura coalfield near patratu and across the Damodar river in the same area. The terminal yards in the Calcutta region and the other yards up-country are also being expanded and remodelled for smooth and efficient handling of traffic.

The Eastern Railway also serves the Calcutta Port which deals with the major portion of Indian imports and exports. In 1955—56 this Port loaded on an average 261 wagons every day. In 1957—58 this figure went up to a daily average of 351. Heavy machinery and other goods for setting up new industries or expanding the old ones in eastern and northern India are unloaded in the Calcutta Port. On the Eastern Railway falls the responsibility of carrying most of this heavy machinery to the consignees.

CARRYING OF OVER-SIZE CONSIGNMENTS

A large proportion of the imported machinery exceeds the normal maximum moving dimensions and their transport over hundreds of miles of railway lines to their final destinations is a job requiring detailed and meticulous planning, and close-watch throughout the journey. These movements take place in special types of wagons, more of which have been purchased recently and put into service to meet the demand.

The number of such over-dimensioned movements in 1956 was 1,078, increasing to 2,251 in 1957. One or two special trains run every day from Calcutta to up-country stations carrying these over-sized consignments, adversely affecting the movement of other goods traffic enroute on account of the great caution which these consignments require to be exercised.

The Eastern Railway has now two 130-ton bogie well-wagons as against one in 1955—56. The number of bogie well-wagons of 50-ton capacity is now 21 as against 20 in 1955—56. The South Eastern Railway has also at present four 130-ton and thirtysix 50-ton bogie well-wagons. Besides these, the Tata Iron and Steel Co. Ltd. has now acquired fifteen 50-ton, seven 90-ton and two 130-ton well-wagons, all being used to carry heavy loads for their construction programmes from the Calcutta Port.

The number of bogie rail trucks, demand for which has gone up considerably due to the heavy import of long consignments, has also been increased. Out of a total of 975 bogie rail trucks ordered by the Indian railways, 525 have already arrived at Calcutta Port. A majority of them have been put into service after assembly and erection in Lillooah and Kanchrapara workshops.

The volume of traffic to and from the Calcutta Port is on the increase and to deal with this traffic, the Calcutta Port Commissioners have decided to remodel their principal yard at East Dock junction where the traffic from and to the Eastern Railway is interchanged with the Port Commissioners' Railway. The work has not yet started but it is likely to be taken up soon.

The Eastern Railway is going ahead with its plan for electrification of all the important sections mentioned above. The work is expected to be completed by the end of the second plan period. In the meantime the number of wagons in trains would be increased to 70 as soon as the lines in the terminal yards have been lengthened, thus enabling more tonnage to be hauled.

THREE WASHERIES BEING PUT UP

To meet the metallurgical coal requirements [illegible] various steel plants, three washeries are being put up on the Eastern Railway—one at Dugda near Chandrapura railway station where the work is already in hand, another at Kargali where the washery is nearing completion, and the third near Patherdih where plans are in the process of being finalized. Suitable quality of coal from collieries would be moved [illegible] these washeries and after washing, blo[illegible] washed coal would be moved to the steel p[illegible]

It is proposed to move most of this wa[illegible] wagons with a carrying capacity of 55 tons [illegible] train loads of 3,000 to 3,600 tons gross. [illegible] reduce the number of trains required to b[illegible] the heavily congested sections resulting in [illegible]rable economy in operation. These trains would [illegible] moved either by electric or by diesel electric locom[illegible] For this purpose the section from Asansol to R[illegible] and Raj Kharsawan to Barajamda on the So[illegible]ern Railway is also being electrified simultan[illegible] with the electrification of the Eastern Railway [illegible]ord line.

INDUSTRIES SERVED BY EASTERN R[illegible]

Apart from serving the industries situat[illegible]ver India by carrying coal and machinery t[illegible] the Eastern Railway has many important indu[illegible] own system. Petrol, oil and lubricant[illegible] special tank trains and ordinary wagons [illegible] from Budge Budge. Jute, paper, iron and steel fabrication, glass, carbide, enamel and porcelain, textiles machinery, wagon-building, road rollers, aluminium, iron foundries, railway equipment, leather, plastic and chemicals, light and heavy engineering, fertilizer, cigarettes and electric industries are concentrated near about Calcutta and Howrah—mostly along the banks of the Hooghly. A large number of wagons have to be moved daily to and from them.

There are glass, cycle manufacture, iron and steel, pipes, refractories, lead, paper, cables, fertilisers, locomotives, coke and coal tar, and cement factories in the Asansol and Dhanbad areas and sugar, paper, cement and chemical works in the Dehri-on-Sone and other areas in the Dinapore division.

The volume of traffic to and from these industries is quite considerable and not only do most of them have [illegible]sion plans but new ones are also springing up, for example the coke oven plant and allied industries and refractories in the Durgapur [illegible] and some iron [illegible] products manufacturing [illegible] places [illegible] The area between Ondal and Durgapur is likely to develop into a big industrial centre, consequent upon the building up of the iron and steel works and the coke oven plant at Durgapur. Transport needs of all these expanding and new industries have to be looked after by the Eastern Railway.

[illegible] total lo[illegible] of coal [illegible] the [illegible] Railway has already gone up from an average of 4,217 wagons in 1955—56 to an average of [illegible] in 1957—58 (upto February 1958), the [illegible] loading being about 5,100 wagons a day. At the [illegible] the second Five Year Plan this figure is expected to go up to 7,000 (4,000 coal and 3,000 other goods traffic). The Eastern Railway is going ahead with it[illegible] for creating the required capacity for this movement.

EFFORTS TO GET MAXIMUM OUT OF RESOURCES

In the meantime, a drive is on to get the [illegible]um out of the present assets and resources. Efforts are being made to load every wagon to the maximum extent upto its carrying capacity, to cut [illegible] idle time of wagons and [illegible] at terminals and marshalling yards, in loco [illegible] sick lines and workshops and [illegible] sidings, and to accelerate all [illegible] of engines and [illegible] for repairs has been [illegible] efforts are continuing [illegible] days spent in workshops for periodical overhaul. Free time for loading and

unloading has been cut down to five hours, and wherever practicable and beneficial, wagons are placed for loading and unloading more than once a day (in some places round the clock), for better utilisation and turn-round of wagons.

The coal and other industries and trade are giving full co-operation to the Eastern Railway in this direction. Much more can, however, still be done, specially by putting better load in every wagon so that no wagon space is allowed to go waste and every train runs with the maximum load the engine is capable of hauling.

With public understanding and goodwill and the whole-hearted enthusiasm, co-operation and goodwill of its employees, the Eastern Railway hopes to deliver the goods the country expects of it.

ALUMINIUM PLANT AT SALEM

It is proposed to construct a major aluminium plant with an output capacity of 10,000 tons per annum in Salem District, Madras State, where bauxite deposits as well as cheap power are available.

Project reports are being completed by the French firm of Pechiney and the Italian firm of Montecatini who are both bidding for contracts. If the French get the contracts they are likely to collaborate with the National Industrial Development Corporation and the Plant will be run by the public sector.

The Italians, who are already engaged in a survey of the bauxite deposits in the district, are negotiating with private interests in Madras. Possibilities of the latter getting the contract are bright, because, the Government of India are anxious to conserve their foreign exchange resources.

PRODUCTION OF INTEGRAL RAILCOACHES AT HAL

INDIAN Railways have now entered the Era of the Integral Coach. The accent today on Rail travel in India is on stream-lined comfort for the Janata traveller and the integral coach ensures smooth and comfortable travel.

But only ten years ago railway travel in India was still medieval. An already unsatisfactory state of affairs had been aggravated by the Second World War. Our coaching stock had dwindled to a parlous state. The so called composite type of carriages were antedeluvian. Rail travel, especially for the third class passenger was often a test of endurance and not infrequently a nightmare with a lack of an adequate number of trains, overcrowding etc.

It was at this juncture that the Hindustan Aircraft (P) Ltd., Bangalore came into the picture. It had just then been decided by the Government of India that HAL should be developed as the centre of future aircraft production in India. A decision was also taken at the same time that HAL should embark upon the manufacture of rail coaches as a major subsidiary project. It was thus given to HAL to make a revolutionery contribution to the Indian Railways, namely, the manufacture of modern all-metal broad-gauge coaches for third class travel. In view of its experience of aircraft construction, HAL was in a position to apply aircraft construction technique to its design of a modern rail coach. The design was perfected in consultation with the Railway Board and the first all metal railcoach rolled out of the production lines in 1948. This was known as model 404. By the time a hundred coaches of this model had been turned out, an improved design styled Model 407 had been developed and the coaches manufactured since have all been of this pattern. As of today over 1200 coaches have been produced by HAL and these are operating on the various Railway systems in the Country. HAL has thus ushered in a revolution in Third class travel on Indian Railways and travel by these coaches is comfortable to the point of luxury.

These coaches embody many safety features like the anti-telescopic structure, heat insulation and the elimination of fire hazard. A high standard of passenger amenities is provided by the inclusion of a large number of fans and lights, wide seats and bunks etc. The lavatories are well furnished with stainless steel pans and wash basins, together with mirrors, shelves and towel rails. The Ladies compartments have been specially equipped for safety and comfort. A special feature in all the compartments is the provision of night lights. These light up the compartment with dim blue light automatically when the main lights are switched off. Also "external lights" which are automatic in action illuminate the exterior of the train during halts and slow speed. These coaches are also provided with a special type of insulator to keep the interior of the coach cool during the hot weather.

And now exactly a decade after the first Coach rolled out of the factory, the third phase of production is due to start, namely the manufacture of integral coaches (the first two stages having been the production of Model 404 and model 407).

It may be of interest to mention here that even as early as 1949, when plans were under way for the switch-over to the production of model 407, HAL actually made two prototypes of an integral coach but for some reason or other, the project was then shelved.

The integral Coaches at HAL will be produced in collaboration with M. A. N. a leading railcoach manufacturing firm in Germany while the Integral Coach factory at Perambur is producing Coaches according to a Swiss Design. The first integral coach from HAL has already been handed over to the Railways and production at the rate of 5 Coaches per month is expected to get under way from October this year. It is hoped that by 1960—61 HAL would be turning out 300 Coaches per annum. In the early stages Coach shells will be imported from Germany but within the next five years HAL will be in a position to manufacture these coaches in their entirety within the factory.

The new integral coaches to be produced by HAL are expected to provide the acme of comfort for the Third Class traveller. They will be about 4 to 5 tons lighter than the present conventional type of coaches (namely Model 407) and 8" wider. The

(Continued on page 44)

Production of Railway Materials in Britain

Century-old company has an integrated plant using own resources from raw materials for iron and steel to finished product

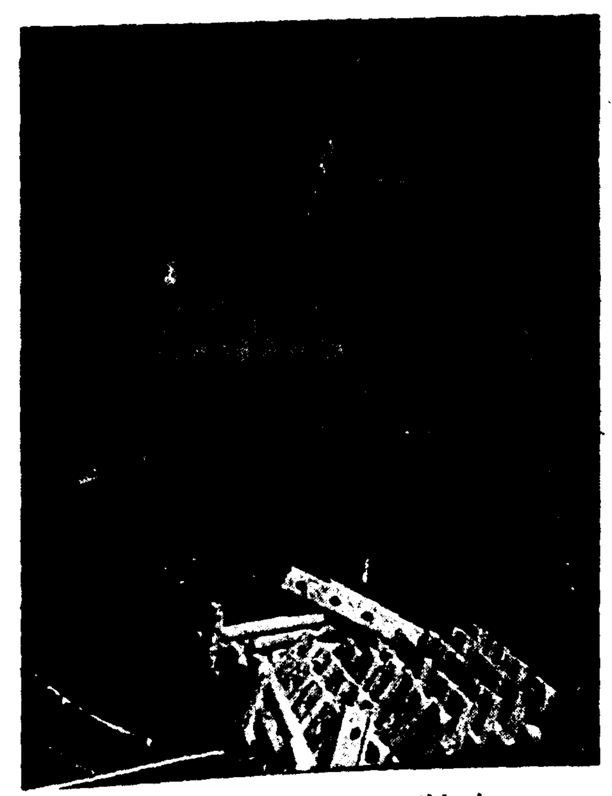
FOUNDED just over a century ago, Workington Iron & Steel Co. is to-day the largest producer of railway materials in the U. K., and rails, fishplates, soleplates and steel sleepers made there are supplied to railways all over the world. In Britain alone, nearly one-third of the country's home requirements come from Workington. Rails at Workington are made from acid Bessemer steel whose virtues have been proved in railway track for over a century. Since 1917, Workington Iron & Steel Co. has been part of The United Steel Companies group, whose other main works are in the Sheffield area and in Scunthorpe. In common with these other branches, Workington benefits from a number of joint services, including the resources of a central research and development department at Rotherham, which is one of the largest private research organizations in Europe.

Workington Iron & Steel Co. is an integrated plant, i. e., it uses its own resources as far as possible from the raw materials to the finished product, ancillary products of one stage being used at a later stage to give a balanced process. The company mines iron ore and limestone; makes its own coke in batteries of coke-ovens; uses the coke and limestone to smelt the ore in blast-furnaces to make iron; and converts the molten iron to steel in the Bessemer plant. Ingots of steel are then rolled in the company's mills to take their final shape before despatch to customers.

The coking plant contains 64 Woodall-Duckham Becker compound regenerative ovens, in two batteries, with a total throughput of 10,000 tons (10,160 tonnes) of coal per week. The remainder of the plant consists of coal-handling, stocking and blending systems, chemical recovery plant and a benzole refinery. Coal supplies are drawn from the Cumberland coalfields and blended with further supplies from Durham and South Wales, the high volatile content of the local coals being tempered by the lower content of the others to produce a strong coke most suitable for blast-furnaces. Coal is taken to the blending bunkers, and from there either to the coal stockyard or to the crushing plant. The crushers reduce the raw mixed coal to 85 per cent below $\frac{1}{8}$ in. (3.2 mm), the most suitable size for carbonization, and a belt conveyor system takes the crushed coal up to the main service bunker. There is a mechanized coal stockyard capable of holding 15,000 tons (15,240 tonnes) of blended coal.

While the two batteries of coke ovens are separated by the central coal bunker, the same machines service both. The ovens are 41 ft long × 13 ft high (12.5 × 3.96 m) with an average width of 16 in (406 mm) tapering 2 in (51 mm) from the coke side to the machine side: they hold approx 14.5 tons (14,730 kg) of crushed coal each. Every tenth oven is discharged in rotation, this schedule enabling the temperature of the battery to be maintained evenly. The heating flues of the ovens are fired by coke-oven gas, the temperature being maintained at 1,320 deg C by pyrometric control. The average carbonizing time of each coal charge is 16$\frac{1}{2}$ hr. After discharge, the coke is quenched and then returned to a wharf for drying. Rubber belts convey it to a coke screening station from which coke over 1$\frac{1}{4}$ in (32 mm) goes direct to blast-furnace bunkers. The undersize coke is crushed further for use as a fuel in the sinter plant and for mixing with the coal charged into the ovens.

Gas is drawn from the ovens by steam-turbine-driven exhausters and cooled to condense the tar and moisture. The moisture condenses as ammonia liquor and distilled, the ammonia returned to the gas stream, and then passed through dilute sulphuric acid to form ammonium sulphate. After further cooling the gas is scrubbed with creosote which absorbs the benzole. Distillation of the creosote separates the benzole and the creosote is cooled and returned to the scrubbers. On leaving the scrubbers, the gas is collected in a 3m-ft^3 (84,950-m^3) holder whence it is distributed to consuming points. The coke-oven gas production is some 15m ft^3 (424,750 m^3)/day. Approx 12m ft^3 (339,800 m^3) are consumed by the works for oven heating, steam-raising, and metallurgical purposes, the rest being available to the local gas grid and nearby industrial units. The crude coal tar is refined in a Wilton still at the rate of 450 tons (457 tonnes) per week; crude benzole is refined to produce various grades of benzene toluene and xylene and related products.



Dipping fishplates in oil bath.

Cumberland iron ore is mined 5 miles (8 km) south-east of Whitehaven by the Beckermet Mining Co., Ltd., a subsidiary of The United Steel Companies and one of the two remaining mining companies operating on the concealed hematite ore field in this locality. The shafts are situated at Beckermet and Haile Moor, which together yield about 2,500 tons (2,540 tonnes) of ore per week. The quality of this ore is high, averaging 47 per cent Fe, 15 per cent SiO_2, 3 per cent CaO, 0.5 per cent S, and 0.01 per cent P. For some years, however, the supply of Cumberland hematite iron ore has not been enough to satisfy requirements and similar ores have been imported from Scandinavia, southern Spain, and North Africa. These ores are of a quality comparable to indigenous supplies in iron and phosphorus content. Manganese and manganiferous ores for the production of ferro-manganese and spiegel also arrive from India, West and South Africa, and Russia.

After weighing, the ores are taken by belt conveyors to the crushing plant where they are reduced to 3 in (76 mm) max. Following this, screens separate the material below $\frac{3}{8}$ in or $\frac{1}{2}$ in (10 or 13 mm) as required; this then passes to the sintering plant. The screening plant also provides for the separation of a proportion of the ore between 1$\frac{1}{4}$ in and $\frac{1}{2}$ in (32 and 13 mm) for use as "bedding" in the sintering process. The oversize ore leaving the final screening stage is directed either to the stockyard or to the blast-furnaces by a 50-ton (50,800-kg) transfer car.

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spring action of these coaches will be such that it is expected to do away with the lateral listing and the bumping usually experienced while travelling. The internal fittings in these carriages will be more or less on lines similar to those on the current Model 407 excepting for such changes as may be necessary. With the completion of a hundred coaches of the integral type it is likely the internal fittings on further coaches may be modified in the light of experience gathered on the first hundred.

Apart from its contribution to the modernisation of third class travel in India, HAL's railcoach manufacturing project has helped the country save much needed foreign exchange. In the construction of the present conventional type of coaches, more than 95% of the materials and fittings used are of indigenous origin. Even wheels are obtained locally. The only major item which is still being imported is the underframe. With the complete manufacture within the factory with cent per cent Indian material of the integral coaches within the next few years, the factory's dependance on foreign imports is expected to disappear altogether.

For the time being the existing model 407 will continue to be produced simultaneously but their number will progressively decrease with the increase in the production of the integral type of coaches.

The factory has also currently in hand the production of 60 military coaches of an improved design and a number of these coaches have already been handed over to the Railways.

As part of its future plans, the factory may take in hand the production of Electric multiple unit coaches.

The sintering plant consists of a 3-pan Greenawalt installation with a capacity of 900 tons (914 tonnes) of sinter per day. Undersized ore from the screening plant, flue dust, undersized sinter screenings, and coke breeze are fed to a mixer where water is added from a spray. The mixture is delivered to the top of the plant together with a supply of "bedding" from the screening plant. After ignition from a gas-fired hood the sintering action, maintained by a strong suction, proceeds progressively throughout the depth of the pan; when sintering is complete, the pan is inverted to allow the sintered mass to fall into a hopper below. The sinter is screened to remove undersized material and then drops on to a conveyor belt on which it is sprayed with water. The conveyor feeds the sinter to a stockpile from which it is taken to the furnaces by the transfer car.

The Workington blast-furnace plant consists of three furnaces with hearth dia of 20 ft. 16 ft. 6 in. and 15 ft. 9 in. (6,100, 5,030 and 4,800 mm.). The two larger furnaces produce approx 1,000 tons (1,016 tonnes) of hematite per day and the third furnace is normally engaged on the production of ferro-manganese or spiegel. The largest furnace is equipped with a McKee distributor and the other two are fed by bucket hoist. All charging gears are interlocked and electrically operated. Air for each furnace is heated by three hot-blast stoves. The air blast is maintained at about 1,400 deg F (760 deg C) on the hematite iron furnaces and 1,800 deg F (982 deg C) on the ferro-manganese furnaces. The hematite iron furnaces are tapped at approx 5-hourly intervals on a strict schedule to ensure a uniform supply of iron to the steelworks. The ferro-manganese furnace is tapped on a similar schedule. About 100 tons (102 tonnes) of iron are produced per cast and conveyed in 50-ton (50,800-kg) ladles to the mixer in the Bessemer shop.

Ferro-manganese is taken direct to the pig-caster for casting into slabs. This machine is a twin-stand machine with a capacity of 100 tons (102 tonnes)/hr. The slabs produced weigh approximately 80 lb (36.3 kg). The machine comes fully into use at weekends, or at other times when the steelworks do not require the molten iron.

Blast-furnace gas production is 140m ft^3 (4m m^3)/day, and all this has to be freed from its dust content, which in the case of gas from the ferro-manganese furnace is relatively high. This is done by washing with water in towers, followed by passage through high-speed disintegrators. A final

Rail passing through roller straightener.

dust content of 0.04 grain/ft^3 (0.09 gram/m^3) is obtained. Part of this gas goes to the hot-blast stoves for heating the air blast while the remainder goes to the boiler plant for steam-raising for blast and power generation, and to the steelworks furnaces.

The central boiler plant consists of four modern Stirling water-tube boilers each with a maximum continuous rating of 100,000 lb (45,360 kg)/hr of steam at 400 lb/in^2 (28 kg/cm^2) and 700 deg F (371 deg C). Coke-oven gas and liquid fuel can be used to supplement or replace blast-furnace gas. There are four blowers for the blast-furnaces, the first of which, installed in 1956, is a BTH blower capable of blowing 62,000 ft^3 (1,760 m^3)/min at 18 lb/in^2 (1.3 kg/cm^2). Other units are two blowers rated at 45,000 ft^3 (1,270 m^3)/min at 15 lb/in^2 (1.1 kg/cm^2), while there is a standby unit of 35,000 ft^3 (991m^3)/min capacity at 13 lb/in^2 (0.9 kg/cm^2).

The steelmaking units at Workington are two 25-ton (25,400-kg) acid Bessemer converters and one 20-ton (20,320-kg) electric arc furnace. Acid Bessemer steel represents the greater part of the production, some 5,000-6,000 tons (5,080-6,100 tonnes) of steel being made each week in the two converters. The arc furnace is used to supplement the Bessemer plant and also to make certain special qualities of high-grade steel.

The range and sizes of products of the rail mill are rails from 45 to 110 lb/yd (22.3 to 54.6 kg/m), fish and bearing plate bars, sleeper plates from 11½ in to 14 in (291 to 356 mm) in width, and billets and slabs from 40 to 145 lb/yd (19.8 to 71.9 kg/m), together with certain rail and sheet bar sections in

high manganese steel. About 150,000 tons, (152,410 tonnes) of rails are produced annually.

The fishplate mill is a 3-stand, 3-high, 18-in (457-mm) mill, consisting of first roughing second roughing and finishing stands, driven by a 1,200-h. p. steam engine. Extensively modernized last year, the fishplate mill is equipped with a reheating furnace capable of 50 tons (50,800 kg)/hr throughput for the heating of 2½-5-in (63.5-127-mm) billets and blooms required for the production of a wide range of fishplate bar sections, bearingplate sections, spring bars, rounds and other sections. After hot sawing to length, the bars are fed on to cooling banks from which they go to be finished. The mill's output is approx. 11,400 tons (11,583 tonnes)/annum.

The rail-finishing plant consists of a 50-in (1,270-mm) roller straightening machine, four rail drilling and ending machines, and certain gag-straightening machines. Here, rails are straightened, inspected, cut to length, drilled in the two pairs of machines and passed outside for customer's final inspection in the loading bays. Those for U. K. railways are loaded direct on to bolster wagons for immediate despatch while rails for overseas destinations are transferred to Workington Dock along the company's own line.

Although, in terms of tonnage, rail production is by far the most important activity of the Workington Iron & Steel Co., other permanent way materials are also manufactured on a substantial scale. Steel sleeper bars are rolled either flat or trough-shaped according to the type of sleeper being manufactured. After cooling they are transferred to the sleeper plant where they are cut into plates of the desired length. The plates now pass slowly on a conveyor system through a heating furnace, attaining a surface temperature of 850 to 900 deg C. Holes for the rail fastening are then punched into the plates under a hydraulically operated press. This operation is immediately followed by pressing to shape in a second similarly operated press. The output of the plant is between 25,000 and 30,000 tons (25,400 to 30,480 tonnes) of sleepers annually.

MINING COAL BY WATER POWER

Hydraulic mining trials, in which powerful jets of water will be used in place of drills and explosives to break down coal from the face, are to be started in a Welsh mine at the end of this year.

Making this announcement in London, the National Coal Board says that in this process coal is extracted by the power of high-velocity water jets directed at the seam from a powerful hose. When the coal is broken down, the water jet is used again to clear the floor of the working place and drive the coal along to the collection points.

"There is no explosive danger with water power, and—apart from the pumping plant—the equipment used for getting the coal is quite simple", the Board states.

Experiments in the hydraulic transport of coal are already being carried out at two other British mines—one is Scotland and the other in England. At one, coal is being pumped up a vertical shaft, and at the other lump coal is hauled through a 1,000 ft, long pipe on the surface.

The Board says that the main object of these two experiments is to develop more efficient methods of pumping and transferring coal into the pipeline without losing pressure. "The new mining project could be adapted for the hydraulic haulage system to replace the existing conveyors if the trials prove successful", it adds.

Hydraulic mining is practised in New Zealand and gives a high rate of output. The equipment is easy to operate and move. Although a considerable amount of power is required to supply high-pressure water this can be generated on the surface, where the plant is accessible and does not require expensive housing or flame proof electrical equipment.

* * *

STEEL PLANT FOR EGYPT

Egypt joined the world's steel producing countries when President Nasser inaugurated on July 28 a West German-built steel factory at Hellwan, about 20 miles from Cairo.

The steel works has a capacity of 235,000 tons a year.

In an impromptu speech, President Nasser hailed the establishment of an Egyptian steel industry as "the realization of a long-cherished dream", and said it would not only serve Egypt and Syria but the entire Arab world.

New Diesel-Electric Locomotives for the Indian Railways

THE COMPANY: Until April 1955, ALCO was known throughout the world as the American Locomotive Company—for more than 100 years a foremost builder of railroad locomotives. During the days of steam locomotives—and since 1948, the diesel-electric unit—the company has built power for nearly every railroad in the world. It has 7,652 diesel locomotives in service today.

The corporate name of the company was changed in 1955 in order to reflect a diversification program that has given ALCO a product line of more than 56 separate items for 11 major markets. All of this, of course, while the company continues to produce diesel locomotives.

Among ALCO's present product line are drilling rig power packages for the oil production industry, diesel engines, special steels (including a new leaded-steel that has been tested and proved), guided missile components, pre-fabricated pipe, rings and forgings, heat exchangers, all types of pressure vessels, atomic power plants and nuclear components.

PLANTS: ALCO operates seven manufacturing plants in this country and is affiliated in Canada with the Montreal Locomotive Works. Domestic plants are at Schenectady, Auburn and Dunkirk, N.Y.; Latrobe, Pa.; Chicago Heights, Ill.; Cincinnati, Ohio and Beaumont, Texas.

The company employs approximately 10,000.

DIESEL ENGINES: ALCO diesel engines through the years have been used in nearly all types of applications where reliable, powerful motive force is required. In addition to powering ALCO diesel-electric locomotives in use by nearly every railroad in the United States and many railroads overseas, they have been adopted also for many stationary and marine applications where dependability is a requisite.

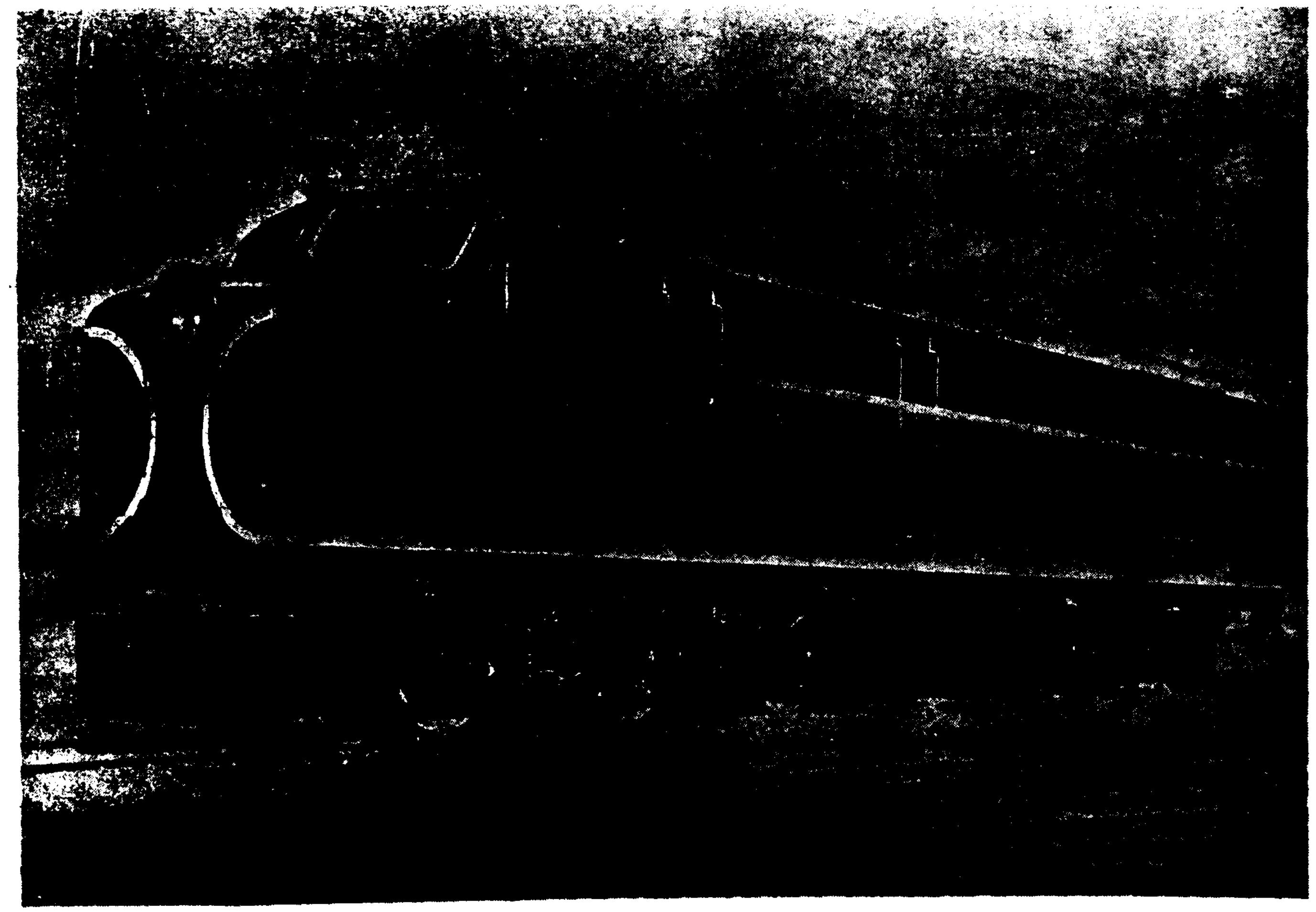
THE order for 100 diesel-electric locomotives of 1800 HP which the Railway Board has placed with ALCO Products, Inc., New York, N. Y., has been reported in earlier issues of this publication. The first lot of locomotives is to be supplied during the fourth quarter of 1957 and the balance will be shipped to India during the second half of 1958. In recording this order, we should take note that this is a new milestone in the modernization of the Indian Railways which is being vigorously carried out by the Railway Board, as these locomotives will be the first main line diesel-electric units to operate in India.

The need for this new type of power arises from the traffic congestions which are developing on the South-eastern Railway and on the Eastern Railway in connection with the enlargement of existing steel mills and the establishment of three new integrated steel mill plants in Rourkela, Durgapur and Bhilai. Plans are going ahead to electrify the railway divisions which will service these various industrial centers, but until these plans materialize it is intended that the diesel-electric locomotives will fill the gap and meet the mounting traffic pressure. After completion of the electrification, the diesel-electric locomotives will be used to alleviate traffic problems in other congested areas of the sub-continent.

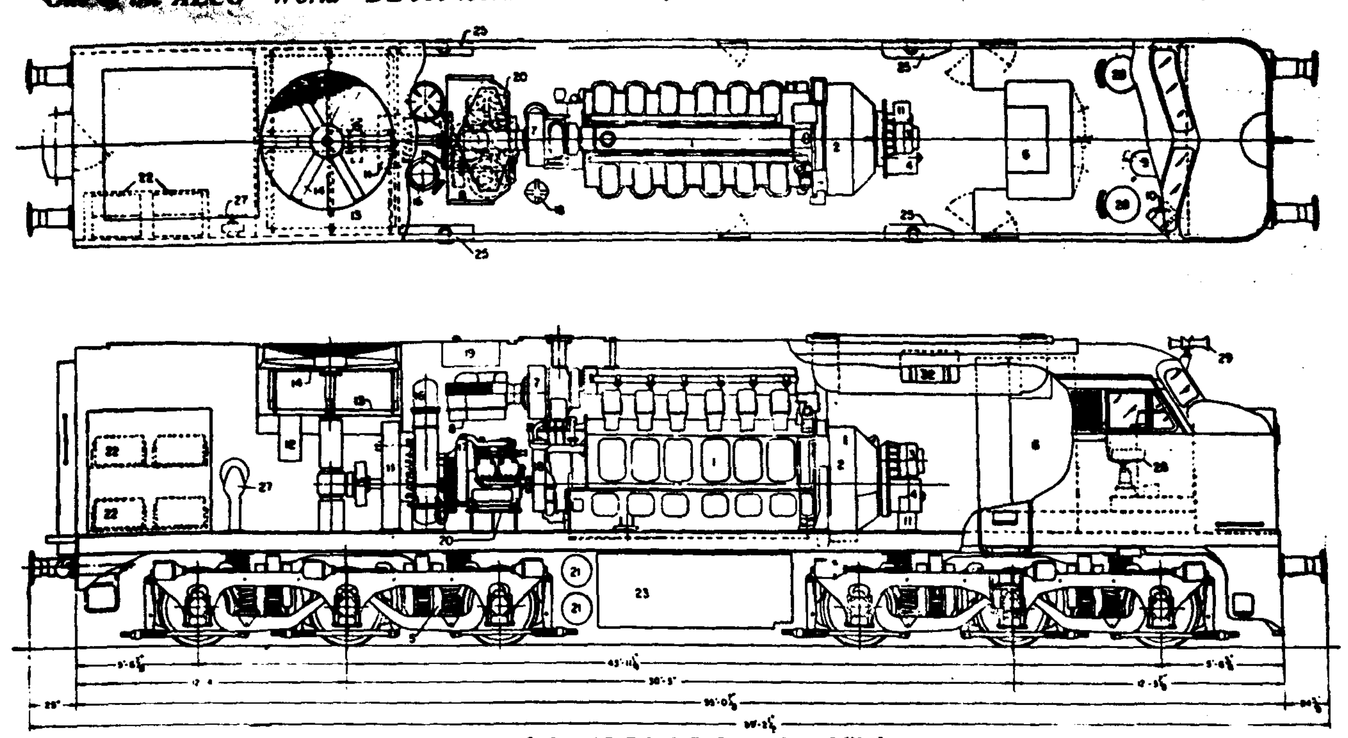
The South-eastern Railway will bear the brunt of the traffic created by the erection of three new steel mills, as the plants at Rourkela and Bhilai are situated on its main route from Howrah to Nagpur. In view of this, it is intended by the Railway Board that 80 of the ALCO units be assigned to that Railway. The third steel plant, located at Durgapur, is on the main line of the Eastern Railway but it also will draw most of its supplies of iron ore and limestone from areas served by the South-eastern Railway. However, the Eastern Railway is meeting constantly rising traffic density on the line to Moghal Sarai and 20 of the ALCO units will be put into service on that section, operating out of Gaya, to assist in speeding up the heavy coal traffic.

The diesel-electric locomotive serves ideally in eliminating traffic congestion due to the outstanding flexibility of the unit. The modern diesel-electric locomotive delivers constant horse-power at all speeds, while the horse-power output of a conventional steam locomotive is quite small at low speeds and rises as the speed increases. As a result, the modern diesel-electric locomotive can haul far heavier trains at the usual operating speeds or handle the usual trains at higher speeds over the grades that restrict steam operation.

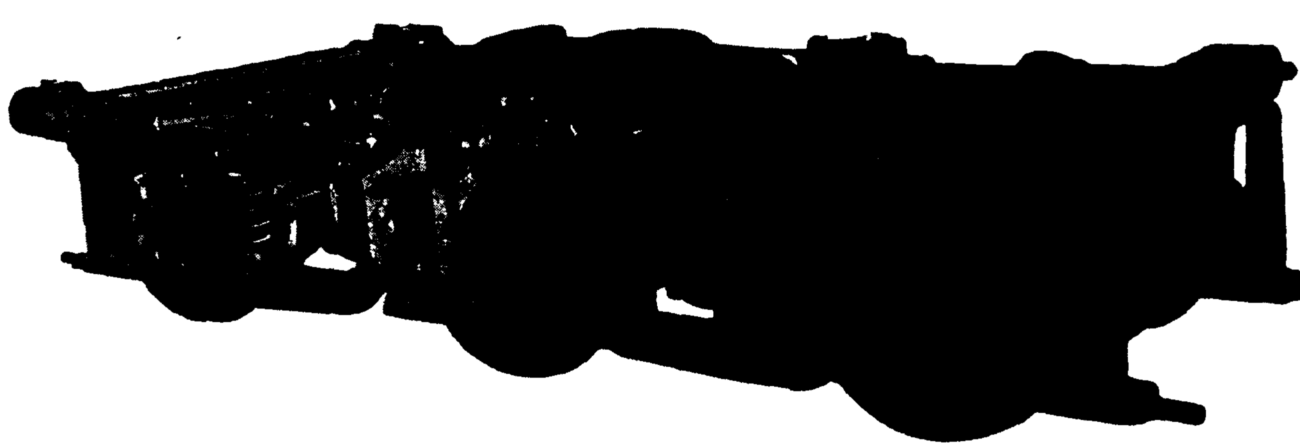
Another favorable characteristic of the diesel-electric locomotive, equally important, is its rapid turn-around time. After delivering a train at a given point of the system, the diesel locomotive is



One of the ALCO "World" DL-500 locomotives built by ALCO Products, Inc. for the Railway Board of India.



Cross section of the ALCO DL-500 "World" locomotive.



ALCO-designed bogie, or truck, for the "World" locomotive. These are designed to provide the best riding qualities on poor or light-weight track.

immediately available for coupling to another train and for continuing work twenty-four hours of the day. The steam locomotive, by contrast, will need to take time out at terminals for running maintenance at the running shed and for cleaning of the fires. Also, while enroute, the average steam locomotive is required to stop at intervals of 40 to 50 miles in order to take on fresh water and fuel.

The diesel locomotive does not require watering except for the occasional few gallons which may evaporate from the cooling system of the diesel engine, and its large fuel tank and high efficiency enables it to operate over a distance of 800 to 1,000 miles without taking on new diesel oil. Heavy overhauls on diesel locomotives are likewise performed at longer intervals than for steam locomotives, and the time required to carry out such repairs is greatly reduced.

All these properties make the diesel locomotive available for actual transport use over a far greater period than the steam locomotive. Experience has shown that the availability of the diesel locomotive can easily be maintained at 90%, while a considerable effort is required to achieve 50% with steam locomotives. The greater availability enables the diesel locomotive to averge over 10,000 miles per month hauling trains, while the average for steam locomotives in India currently is around 3,000 miles per month. It is generally found that a modern main line diesel-electric locomotive will perform the same work as 2 or 2.5 steam locomotives.

The high overall efficiency of the diesel locomotive makes it an economic unit to operate. A modern unit, such as the ALCO locomotive purchased by the Railway Board, will easily attain an efficiency of 28% measured at the wheel rims, as against an average efficiency of 5% maximum for steam locomotives. The advantage in fuel economy of the diesel-electric locomotive may not be a significant factor on railways serving the coal fields, as Indian coal is favorably priced. However, freight rates on coal have risen considerably in recent years and the diesel locomotive will show a distinct savings in fuel costs in areas away from the coal fields, such as in central and southern India. Other substantial savings are found in the lower maintenance cost of the diesel-electric locomotive. These savings in repair costs are due primarily to the absence of steam locomotive boiler repairs.

The collaboration agreement which the Railway Board has entered into with ALCO Products, Inc., also covers for the training of railway personnel on the part of ALCO, and engineering assistance in the design and layout of maintenance facilities. The study of the latter facilities, in cooperation with the manufacturer's engineers, has already been completed and running repair sheds are under construction at Gaya on the Eastern Railway and at Anara on the South-eastern Railway. Some items of maintenance equipment are being imported from the U. S. A.

For the advance training of personnel, the Eastern and the South-eastern Railways have each sent a group of eight men to the U. S. A. for training at builder's plant and for observation of maintenance practices on some of the U. S. railways. The manufacturer operates a special Locomotive School in which crews from all over the world are given courses

(Continued on page 51)

Design and Erection of Overhead Equipment For Main-Line Electrification

By

British Insulated Callender's Cables Ltd., Bombay

PRELIMINARY INFORMATION

WHEN it is decided to equip sections of a Railway for operation by electric traction, it is first necessary to consider the system to be used. For urban schemes with dense passenger traffic low voltage D. C. with feed to the trains by conductor rails has been favoured in the past, whereas for main-line electrification of both passenger and freight traffic it is more usual to feed by overhead equipment at a nominal voltage of 1,500 or 3,000 volts D. C. or high voltage A. C. The latter is being increasingly used nowadays at the industrial frequency of 50 or 60 cycles per second at 25 kv.

Having decided the voltage, convenient sites for sub-stations are determined, and the operating department supplies information concerning the spacing and weight of trains required. It is then possible to determine the copper section required to ensure that at no point of the system will the voltage drop be excessive. In this calculation, account must be taken of wear on the contact wire which may have reduced its area over a number of years.

In large electrification schemes carried out in India and many other countries, the British Insulated Callender's Cables Group have provided the overhead equipment designs, surveyed the tracks, prepared layouts, supplied and installed the equipment. A brief description of such work follows :

BASIC DESIGNS OF EQUIPMENT

The specified copper section is normally provided by a copper contact wire and copper catenary or copper may be replaced by a copper alloy. The lightest contact wire normally recommended for a 25 kV. A. C. system is 0.166 sq. in. and the catenary consists of a suitable stranded conductor. It is necessary to know the range of temperature and the wind conditions under which the equipment will have to operate, and in cold climates ice formation on the wires and structures has to be taken into account.

For large temperature ranges, and when high speeds require an extremely level contact wire, it is often necessary to keep a constant tension in the catenary and contact wire by means of balance weights. In other cases it may be practicable to fix the terminations of the equipment and provide a level contact wire at normal temperature. Thus the tension will increase

(Continued from page 50)

on the maintenance and operation of the ALCO locomotive. Training periods in the U. S. A. last about three to four months. Other groups will follow the first two sent to the U. S. A. and it is expected that a total of about forty men will have been trained by the time the 100 locomotives are in service.

Training in the U. S. A. is supplemented by instruction imparted in India by ALCO engineers sent out for the purpose and by Railway engineers previously trained in the U. S. A. The manufacturer will send three experienced engineers to India for the instruction of Railway personnel.

The diesel-electric locomotive has been subject to intense development and considerable improvement over the past ten years, notably in the U. S. A., so that it represents a highly reliable machine in its modern form. The high operating efficiency and excellent reliability have combined to make the diesel-electric locomotive a strong economic factor in the modernization of railways around the world.

In the U. S. A. over 90% of all steam locomotives have been replaced by diesel-electric unit. Dieselization has progressed in other countries, although at a slower rate. It is not likely that full dieselization will ever be contemplated in India where coal is abundant. However, the Railway Board has decided to embark upon a course of partial dieselization in order to benefit of the advantages of this type power in areas where the Indian Railway system will profit most.

in cold weather causing the equipment to rise in the centre of each span, and the tension will decrease in hot weather causing the equipment to be lower in the centre of each span.

Knowing the type of termination required, the wire sizes, the climatic conditions and the maximum permissible distance the contact wire may be blown to the side of the track under severe windage conditions without leaving the contact strips on the pantograph, it is possible to prepare the basic designs of the equipment. These normally show standard spans for tangent and curved tracks, bridge and tunnel equipment, together with detailed drawings of the fittings, supporting steel work and foundations required. The fittings which carry current are made of copper and in areas where there is considerable atmospheric pollution the fittings may all be of non-ferrous materials. In less polluted areas certain ferrous fittings can be used with a resulting reduction in cost. Nowadays it is usual to use galvanized steel for the structures, although painted steel is sometimes used.

SURVEY OF THE TRACKS

Before detailed design of the equipment can commence it is necessary to obtain an accurate layout plan of the tracks. Often the only available drawings are old, and since their original production new drainage may have been put in, signal positions changed, tracks slewed, points moved and crossing angles changed during relaying. It will be appreciated that plans to a large scale are required for complicated terminal station and junction areas, whereas smaller scale plans or simple diagrams are sufficient for the open route between stations.

The Railway Civil Engineering Department can usually produce plans of stations which can be brought up-to-date. For the open route a common method of producing plans is for a surveyor to measure the tracks from a datum mile post. All items of interest, such as culverts, signals, bridges and lineside structures are noted by the surveyor and his notes are used to produce a suitable plan. Curvature of the tracks may be taken by means of string-lines, the survey team, working along the tracks, take down particulars of all bridges and tunnels. If standard equipment can be used notes are made of clearances and basic measurements to allow the equipment to be allocated, but in some cases a fully-detailed drawing of a bridge is required in order to design new equipment.

A method becoming more popular for producing plans of difficult areas, where suitable information is not readily available, is aerial photographic reconnaissance. First a gang travels over the route painting drainage covers, the toes of the points, outlines of buildings and other features with light paint. The aeroplanes then flies over the route at a constant predetermined height and a series of overlapping photographs are taken. Prints from these photographs are enlarged to whatever scale is required. The distance along the track between painted marks is measured by tape to give an accurate check for scaling off distances between locations shown on the prints.

Any alterations which may be required by the operating department, such as lengthening of platforms, repositioning of signals and alterations to the tracks are decided on and entered on to the plans. The layouts can then be prepared and the basic designs can be adopted to suit particular locations.

PREPARATION OF LAYOUTS

The basic designs show maximum possible spans between structures for tangent tracks and also a few selected curves. The engineer preparing a layout has to locate the structures to enable the equipment, including section insulators, knuckles, etc., to be supported and registered to provide good current collection on the pantograph, whatever the temperature and wind may be within the specified limits. He must use the least possible number of steel supporting structures in order to reduce costs as much as possible.

When the height of the equipment has to be reduced due to obstructions, such as overbridges or tunnels, the spans may have to be reduced. It is also essential that structures do not obstruct a driver's view of signals.

Once a provisional layout has been produced, it is usual for a walk-out inspection to take place when representatives of the various departments of the Railway inspect structure locations on the ground. Walk-out reports are agreed by all concerned and then the detailed design can start.

DETAILED DESIGN

At each structure location a cross-section of the track is prepared, except on straightforward open routes where the information normally shown on a cross-section can be entered on a data sheet. Vertical loads due to the weight of equipment and the

maximum horizontal loads due to radial pull stagger and windage are assessed and added to the cross-section drawing. This diagram is then handed to a structural designer who allocates a standard structure from the basic design range or designs a special structure if necessary.

The cross-section shows the height of the equipment above the track, thus whenever the height varies from the standard it is necessary to make a profile of the equipment before cross-sections are produced. Such variations happen at many overbridges, tunnels, stations and level crossings. Bridges and tunnels vary considerably in shape and construction and on lines, such as in Britain, where there are many such, a design team may be engaged for a considerable time on the special equipment arrangements.

It is essential that design goes ahead quickly as steel structures are on fairly long delivery, and also orders have to be placed for fittings and conductors long before they are required to ensure there are no delays to the wiring programme. The lengths of conductors for each tension length are calculated from the layout plan and the drum is often marked with the tension length details before it leaves the factory. Form the layout plan and cross-sections the estimating engineer can assess the quantities required for each type of insulator and fitting.

MANUFACTURE AND STORAGE

Nowadays much steelwork for railway electrification is galvanized and it is, therefore, desirable that the structures should be fabricated in works which have a galvanizing plant equipped to deal with the longest members required. Many are over 30 feet in length, and a few may be as long as 60 feet.

Solid grooved contact wire drawing is a specialized technique for which only a few factories are equipped. The stranded catenary is similar to that used for other purposes, but is often made to a size, and of a copper alloy, which is peculiar to railway work. The BICC Group has over 40 years experience in the design and manufacture of conductors and fittings for railway electrification.

Insulators are made by specialist manufacturers, who have a particular difficult problem in designing insulators suitable for 25 kV. operation on lines which may carry steam locomotives with consequent pollution.

To ensure smooth and steady progress once construction work begins, it is necessary to have an adequate supply of all materials in Depots with good rail and road access. To construct and stock such stores with concrete rafts for the heavy cable drums, open storage space for steelwork, covered stores for cement, fittings and insulators, workshops, offices and ample siding space for the special construction trains require careful planning.

INSTALLATION OF FOUNDATIONS AND STRUCTURES

The method of working and the amount of mechanized equipment used depends on the time of occupation of the track permitted by the Railway Operating Department and the availability and cost of labour. If adequate labour is available the customary method of working is to excavate for the rectangular foundations by hand with picks and shovels in normal ground and with the additional aid of compressed air tools in rocky ground. Foundation materials may be delivered to each site by train and the concrete mixed by hand—mechanized concrete mixers on railway wagons being used for the bigger foundations.

In foundations on the open line a central core-hole may be provided, the steel mast lifted into the core-hole by the crane in a steelwork construction train, and the mast held in position by wedges while the core-hole is filled with grout. In other cases bolts are embedded in the foundation and the structure has a base suitable for fastening to the bots.

Where labour is expensive or in short supply and when daily track possessions of 4 or 5 hours are

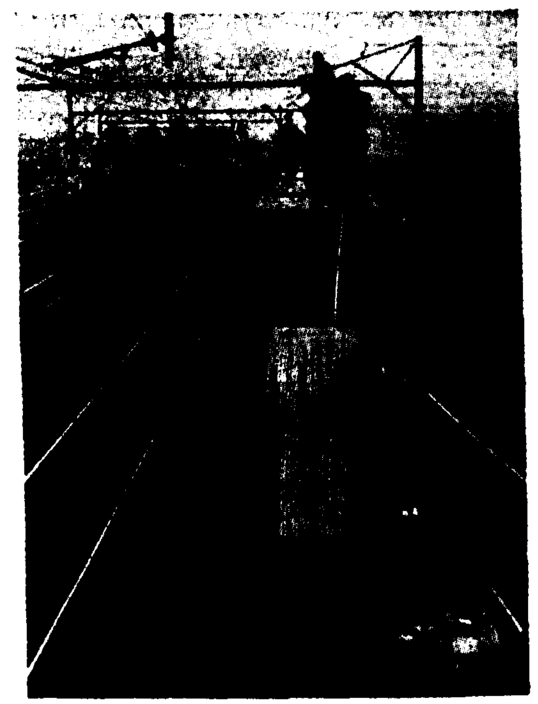
Pouring concrete into a hand-excavated foundation from mechanical mixers mounted on a train

A crane lifting a galvanised mast into position for clamping in a ground frame.

provided, an economical method is to use an earth auger and special concreting train. A rail-mounted earth auger, on a special frame which allows considerable movement and tilting to position the auger very accurately, drills a cylindrical hole—incidentally a cylindrical foundation requires less concrete than a rectangular foundation having similar properties. This is followed by a steelwork train, the crane of which places a mast in the correct position in a special frame. A third train carries the concrete materials, concrete mixers and special discharge apparatus for placing the concrete in the foundations. A diesel generator van provides electricity to drive the mixers, discharge apparatus and lights for night working, water for the mixers and compressed air for vibrators and other tool. Foundations can be completed and masts erected alongside a mile of single track in a four-hour block, but hand-dug foundations are still required when drains, running sand or rock are encountered.

WIRING

Running out of wire cannot commence until all structures in a tension length have been completed—so it is of little use to erect all simple structures and leave the anchor masts and other more complicated structures till later. First the cantilevers are made up and erected on the masts, small-part steelwork is fitted to bridges and tunnels and rollers fixed in place. A customary construction method is to pull out the catenary from its drum mounted on a reel wagon in the locomotive hauled wiring train. The crew pass the catenary over rollers at each structure and it is pulled up to a calculated tension.



A specially equipped wiring train in use for running out contact wire.

The wiring gang then put up the droppers which support the contact wire from the catenary. These are made-up in advance according to a table which shows the correct lengths and spacing for varying spans and varying distances between the catenary and contact wire. The contact wire is then pulled out, clipped into position and pulled up to its correct tension. Highly skilled linesmen then go over the line to check the height, stagger and gradient of the contact wire, to ensure wires are at the correct relative levels at knuckling points, to cut-in section insulators and to connect up feeders.

EARTHING, BONDING AND SWITCHING

To ensure that the circuit-breakers come out quickly if an insulator fails it is normal to provide an earth connection from each structure. Where

there is track-circuiting an earth wire connected to each structure may be provided along the route. A more usual method is to instal a structure to rail bond from the base of the mast to the nearest running rail carrying the return current. This may be a steel or copper bond bolted or welded to the mast just above the top of the foundation. When it has been installed the top of the foundation is capped to ensure rainwater runs off it, and often a protective coating of special paint is put on the base of the mast. To provide a good return circuit it may be necessary to connect with copper bonds, rail joints and points and crossings.

The overhead lines are divided up into electrical sections so that traffic can continue to operate over most sections whilst others are earthed for maintenance or correction of a fault. Thus in the feeders and at other sectioning points there are switching arrangements, which are normally designed and erected along with the overhead equipment, although some of the switches, especially if remotely controlled, may be provided by specialist switchgear manufacturers.

When the linesmen have completed all their adjustment, it is usual to carry out mechanical checks with a steam locomotive hauled pantograph train, and electrical tests to ensure that the standard of insulation is correct.

While the overhead equipment construction is proceeding, work is also going ahead on the transmission lines or cables required to supply power to the traction sub-stations from the electricity supply system. Other work is being carried out on telecommunication cables alongside the route to be electrified. After all these tests have been conducted to the satisfaction of the Railway Engineers the line is handed over and the first electric trains make use of it. In some cases the Contractors may retain a small organization on site for a Guarantee Period after handing over. During that period they may train the Railway maintenance gangs who will later look after the equipment.

ARC WELDING SAFETY DEVICES

A new range of low voltage safety devices, for use with arc welding plants, has been recently introduced by Quasi-Arc Limited, the world famous suppliers of arc welding equipment.

It is possible to receive electric shock from accidental contact with live parts of welding equipment such as electrode holders. The effect, under normal conditions, is not serious but when working at a height, in cramped spaces or in wet surroundings, it could be hazardous. A device to obviate this risk, when using A. C. current in these conditions, has for long been advocated.

The functions of the new devices are to reduce the relatively high open circuit voltage to a safe value when the operator breaks the arc and to return it to normal striking voltage when the electrode again comes into contact with the workpiece.

A low voltage safety device, however, should not be detrimental to welding performance or to the natural characteristics of the welding set. If it makes arc striking difficult, or it is so sensitive that it operates with fluctuations of the arc, an operator may be tempted to discard the entire arrangement. These two problems have been solved in the new Quasi-Arc devices.

Three versions of the new device have been produced :—

(i) *Type SD. 350*—for use with single operator A. C. sets with an open circuit voltage range of 80-100 and a maximum output of 350 amp.

(ii) *Type SD. 450*—similar to the SD. 350 but suitable for use with sets capable of giving currents up to 450 amps.

(iii) *Type SD. 450M*—specially designed for use with the regulators of multi-operator A. C. sets of 350 amp. and 450 amp. capacity.

The principle of operation of the three devices is identical and none of them interferes with the welding operation. They effectively reduce the open circuit voltage from 80 or 100 to 30 volts. The speed of response when striking an arc is such that even an experienced welder cannot detect the presence of the device. At the same time normal fluctuations of the arc do not cause the device to operate since the circuit incorporates a present time delay. Correct operation of the device is indicated by a small low voltage neon lamp which is illuminated when the set is on open circuit at the reduced voltage. The lamp is extinguished when welding is in progress or should a failure occur in the device when the set is on open circuit.

Quasi-Arc Limited of Bilston, England, are represented in India by an associated company, Indian Oxygen Limited, who not only supply all Quasi-Arc equipment but also manufacture a comprehensive range of Quasi-Arc welding electrodes.

Economy in Permanent Way Maintenance

From A Technical Correspondent

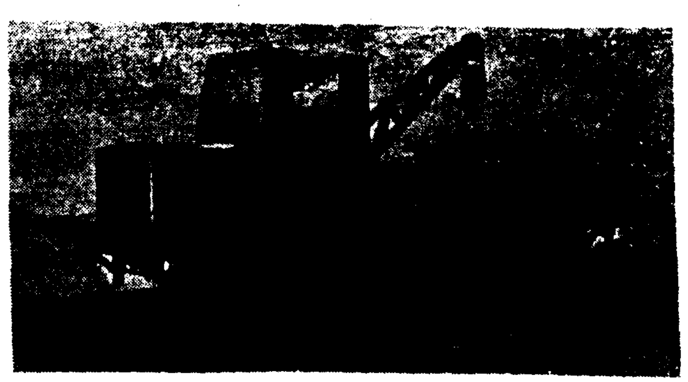
THE considerable cost involved in the continuous maintenance of railway tracks, which is an important factor in the safety of rail transport, has induced the Federal German Railways to mechanise construction and maintenance work on permanent ways. Various large units are already in operation and have resulted in important savings. Among others, a large number of railcars of the type illustrated below have been put into service and have proved to be most economical in use on maintenance work, ever since they were first introduced.

These vehicles are used for the speedy transport of crews, constructional machinery and equipment, fuel, rails, sleepers and other materials on the site.

The Ganger's Railcar R 11 is always ready to start. Rails, points, masts etc. are easily loaded and unloaded with the crane without danger to the crew. The lifting and lowering movements of this crane are directed by the engine of the vehicle. Even in case of accidents etc. this vehicle renders valuable services as first aid.

The railcars are powered by a robust, air-cooled Deutz diesel engine of 72 h. p., driving through a four-speed gearbox with forward and reverse drive. The breaks are generously dimensioned. The drive is transmitted to both axles, so that even under the worst weather conditions the railcar can take in its stride the steepest gradients encountered in railway practice. To protect the driver against bad weather, an enclosed cabin is provided.

The illustration shows the railcar made by Robel & Co., of Munich, Germany, manufacturers of special equipment for the railways. The Robel railcar represents the latest product of many years of experience in this field.



Because of the economy in operation of this railcar and because of the considerable savings in time and labour which can be achieved through its use, several railway organisations outside Germany have now followed the example of the Federal German Railways and have purchased railcars of this type.

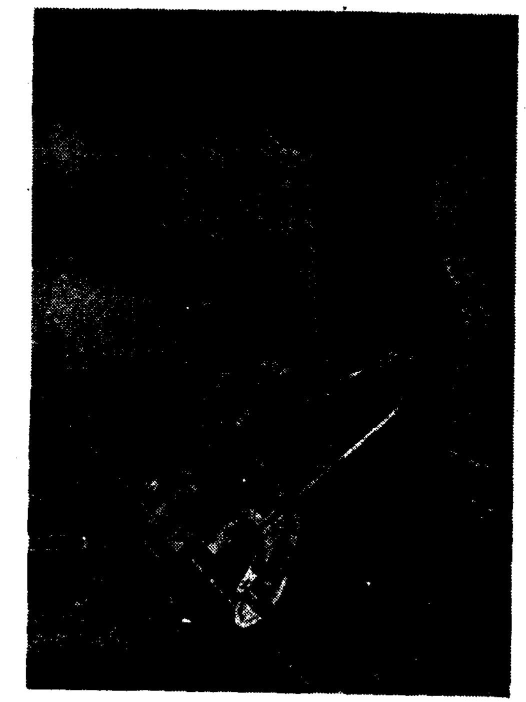
The fish-plated rail-joint has always been one of the chronic troubles of the permanent way and its maintenance and care in Germany absorbed a disproportionately large percentage of the total expenditure on track maintenance. It was also found that a considerable number of broken rails were due to the holes at the rail-ends.

For a long time, means had been sought to eliminate the weakness at the rail joint connection but none of these attempts led to any satisfactory results.

Only the welded rail method led to a solution of this problem. Much time passed however, between the first experiments and the arrival of the throughout welded rail but for some years now, welded rails have been introduced in steadily increasing numbers on concrete as well as wooden and iron sleepers and not only on straight track-sections but also on curved sections.

This left a solution to be found for a quick and economical way of grinding-down the welded rail-joints, i. e., the removal of the surplus welding material which occurs during welding. The industry concerned has developed various grinding machines for this purpose.

The machine illustrated on page 58, which is built by the well-known manufacturers of permanent-way machines, Robel & Co., Munich 25, deserves to be mentioned specially. Patent applications for this machine have been registered in a number of countries.



The machine is supplied, driven either by a petrol engine or by an electric motor. One of the particular advantages of this model is a device which indicates the grinding depth. This indicator device shows, greatly magnified, any deviation from the intended level, on a disc. This device eliminates the necessity of having to lift the machine off, once or even several times, during operations in order to check the progress of grinding by means of a ruler.

The distance between the two running wheels has been kept large, in order to achieve long and exactly level grinding areas. The motor of the machine has an auxiliary power take-off, which serves to drive a flexible shaft to which a grinding wheel can be attached with which particularly hard welds can be initially ground and with which point frogs etc. can be machined.

This new model will give good service, not only to railway undertakings but also to those branches of industry which are engaged in the production of points and crossings.

METHODS OF CHEMICAL ANALYSIS OF IRON ORE

India is a major world supplier of iron ore and large quantities are regularly exported from various Indian ports. These exports are expected to further mount up, with the canalisation of exports through the State Trading Corporation of India (Private) Ltd. With the setting up of more steel plants in the public sector, India's consumption of iron ore will increase considerably. The prices paid to the mineowners for iron ore are directly linked with the contents of iron, phosphorus etc. The Indian Standards Institution feeling, that a standard for the methods of chemical analysis of iron ore, will be extremely helpful in co-ordinating the methods followed by the public analysts engaged in analysing the export consignments and the laboratories attached to the steel plants, has brought out a draft Indian Standard Methods of Chemical Analysis of Iron Ore [Doc: SMDC 2 (66).]

The methods of analysis prescribed in this standard have been prepared with a view that they shall be useful as reference methods. Due consideration has been given in the preparation of this standard to the facilities available in the country for such analysis.

This standard specifies the methods for the determination of moisture, silica, iron, alumina, phosphorus, sulphur, titanium, manganese, calcium oxide, magnesium oxide, ferrous oxide, vanadium and combined water. For export purposes, the determinations of lead, copper, arsenic and zinc are sometimes required. Methods for these have also been prescribed.

Modifications of the procedures for the determination of various constituents have been prescribed taking into account the variations in the chemical composition as commonly found. No account has been taken of the unusual presence of a constituent like chrominum which may be rarely found in iron ore.

Comments on the draft standard are invited from interested persons by *20 September 1958* and copies of the draft standard are available free on request.

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METAL TUBE PLANT IN INDIA

It is understood that a Bombay firm proposes to establish a factory for the production of non-ferrous metal tubes. The necessary licence has already been obtained, and negotiations are under way for the purchase of the main press and auxiliary machines for the extrusion plant.

Although the cost of the plant is estimated to be Rs. 12.50 lakhs, the company has been granted an import licence for only Rs. 4.5 lakhs. The promoters, Devidayal (Sales) Private Ltd., have, therefore, approached American and Indian financial institutions for loans to purchase machinery. The demand for non-ferrous tubes in the country is estimated at about 1,800 tons per annum and is expected to go up to 2,700 tons by 1961-62.

Morganite Carbon Current Collectors for Electric Tram and Railway Bows and Pantographs

THE use of carbon as a current collector on tram and railway bows and pantographs has been gradually developed in Europe over the last 30 years.

From the outset The Morgan Crucible Company Limited has devoted its attention to the problem of current collection and was early in this field with a hard carbon material for use on tram pantographs. Gradually the use of carbon spread to the more onerous applications of current collectors for electric railway traction.

Morganite Collector carbons have been adopted by several European Railway authorities as the best means to deal with the very complex problem of electrical current collection at high speeds from a relatively light, overhead copper wire. Based on their experience during the last thirty years, The Morgan Crucible Co. Ltd., has developed special carbon grades for use on electric tram and railway bows and pantographs.

ADVANTAGES OF CARBON CURRENT COLLECTORS

(1) A greatly reduced rate of wire wear owing to the smoothness and polish produced by the carbon collector as opposed to the roughness by the metal collectors.

(2) Reduction of radio interference—The earlier applications of carbon collector were intended chiefly as an aid to suppress radio interference, coinciding as it did with the onset and expansion of wireless communication (i. e., the years 1920 and onwards). This advantage is the result of considerable improvement in contact stability between overhead wire and collector. This contact stability arises out of the smoothness and polish developed on the wire with carbon.

(3) This polishing of the wire contact surface in turn resulted in longer life of the carbon current collector compared with that of a conventional metal collector.

CARBON SECTION AND MATERIALS

Morganite pantograph carbons are available in a variety of sections. Figs. 1 to 4 show some of the standard shapes. It is of interest to note that the large sections are used exclusively for single piece bows whereas smaller sections are used for lining

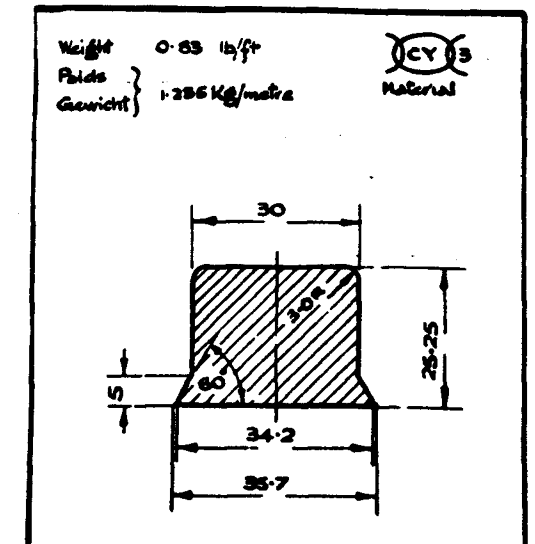


Fig. 1. PC 1 formerly 562/A

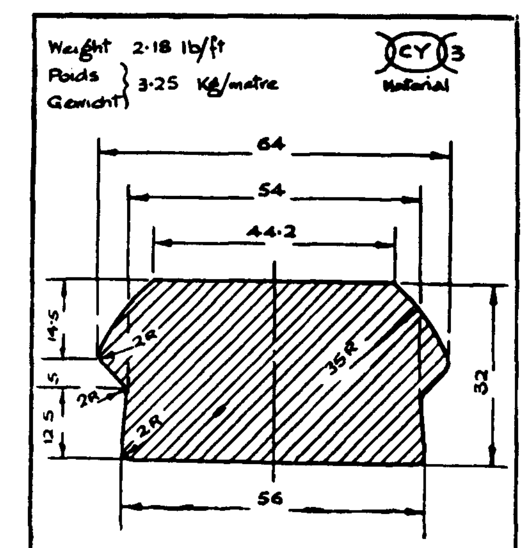
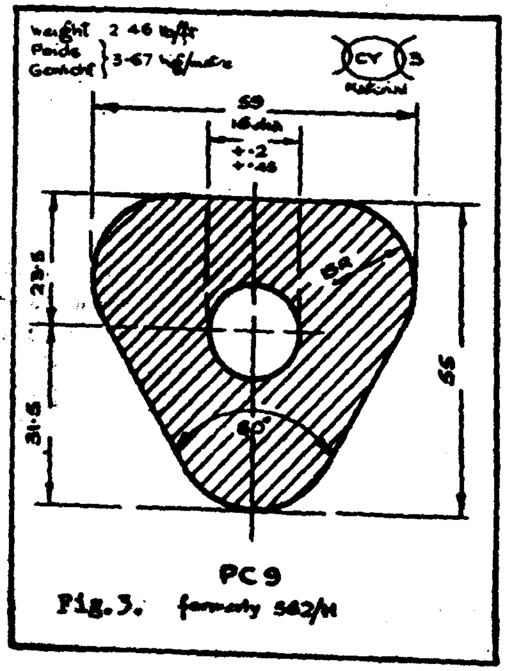
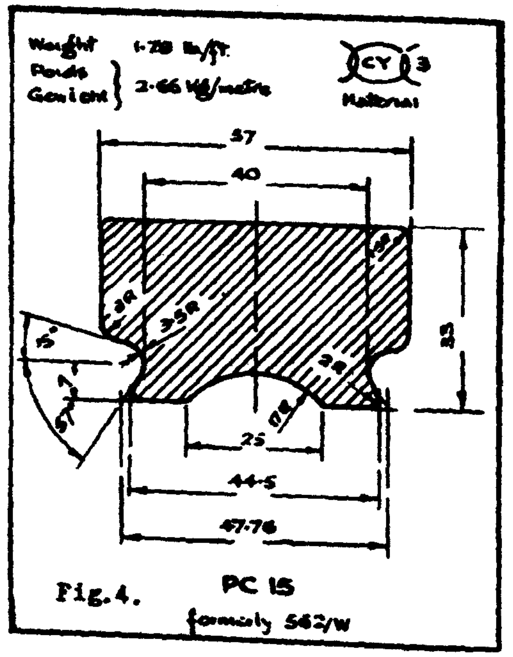


Fig. 2. PC 18 formerly 562/C



PC 9

Fig. 3. formerly 562/H



PC 15

Fig. 4. formerly 562/W

pans. These sections are available in either Hard or Metal Carbon.

The Hard Carbon is known as Link CY3T or CY3TA: (both wax impregnation but TA withstands a higher temperature). These impregnations render the carbon impervious to moisture. These materials are available in lengths up to 36" (914 mm.).

The metal Carbon is called Link MY7D, (This material is hard carbon incorporating Copper lead). It is available in lengths up to 14" (355 mm), longer lengths being made up of short pieces which can, however, be held in a common metal sheath. The number of pieces per sheath should, however, not exceed two.

RATE OF CARBON WEAR

The rate of wear of a pantograph carbon is directly dependent on the total current to be collected and the efficiency or stability of the contact between collector and wire.

To quote an instance of a D. C., 1500 volt railway, the carbon—life per pan was about 50,000 miles (80,000 km.) on coach unit trains fitted with Link MY7D and half this value on the locomotives also fitted with Link MY7D. In this case the current loading on the pans of the locomotives is a little more than twice that on the coach units. On the locomotives the Link MY7D material is near the limit of its capacity whereas on the coach units the Link MY7D is well within its limit. A plain carbon under similar conditions on the coach units would give a life of about 40,000 miles (65,000 km.) compared with 50,000 miles (80,000 km.) with Link MY7D. On the locomotives the current to be collected would be quite beyond the current carrying capacity of a plain carbon.

For maximum life much depends on the distribution of wear over the carbon and on the amount of wire stagger. If the stagger is wide and very even then a wear factor of 70% may be achieved. (Wear factor = *volume of carbon worn*—total volume of carbon)

A carbon current collector must at all times work within its current—carrying capacity.

Greasing or oiling of carbon current collectors should be definitely avoided because such lubricants collect abrasive dust and cause abrasion and rapid wear both of the carbon and the wire. In sandy areas it is of very considerable importance to keep the collector and wire quite clean so that the wire develops a good polish; in fact, in all circumstances if the wire does not develop a polish then the life of the carbon will be short.

Where a steam train service is inter-running with an electric service "sooting" of the wire may be encountered particularly at stopping points of the steam locomotive. If the amount of "sooting" is small or the electric service is sufficiently frequent to clean off any soot before it has time to build up then the effect of such sooting will be negligible. I

however the electric service is small in relation to the steam service then the large amount of soot on the wire may cause an increase in the rate of wear of the carbon collector.

When applying carbon collectors to a railway system which has previously been operating with metal collectors considerable carbon wear is to be expected if few carbon collectors are used, and in such a case only metal-carbon collector material should be used; plain carbon should not be used in this case. If an immediate and complete changeover is made from metal to carbon collectors then plain carbon or metal-carbon may be employed, as may be determined by current loading on the collector. The initial rate of wear will be considerable in this case but will rapidly improve as the wire is smoothed by the carbon. When applying carbon collectors to a line, metal smoothing collectors of cast iron or steel should not be used as a means of smoothing the surface of the wire; they may do considerable damage to the wire and so not assist the running-in of the carbon.

WIRE WEAR

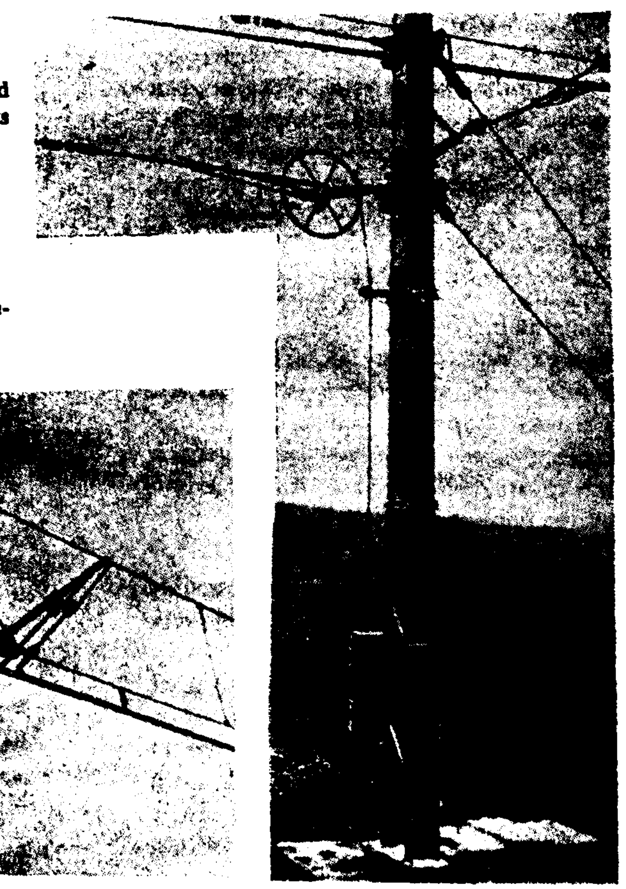
Wire wear when using metal collectors has always been a cause of concern with railway operators. Where carbon has been used as a current collector the rate of wear has been of the order of .005" (.125 mm.) per year compared to .020" (.5 mm.) for a copper collector.

OVERHEAD WIRE AND EQUIPMENT

Whilst there is very little that the carbon manufacturer can do to influence the design of overhead equipment, the use of carbon is, as already stated, very much dependent on the state and type of overhead gear. The average contact wire cross

Contact line suspension on the 1,500-Volts Paris—Le Mans line. (French State Railways)

Right: One of the welded and riveted masts supporting the tensioning weights for the contact line



Below: Detail of the overhead suspension gear

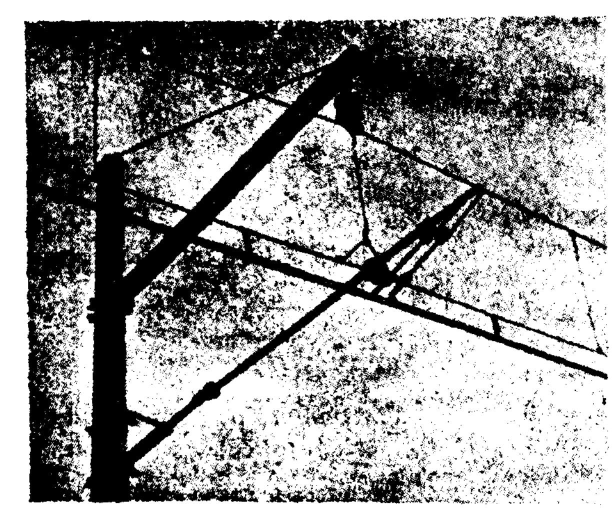
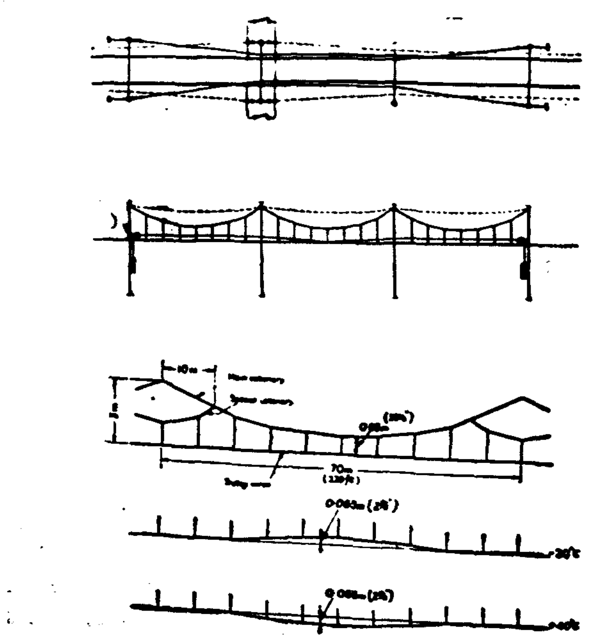


Fig. 5. Illustration of twin wires with locating arms and also section wire tensioning post with tension weight and tension multiplying gear.

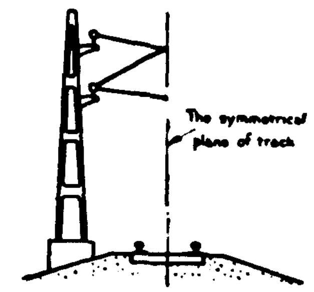


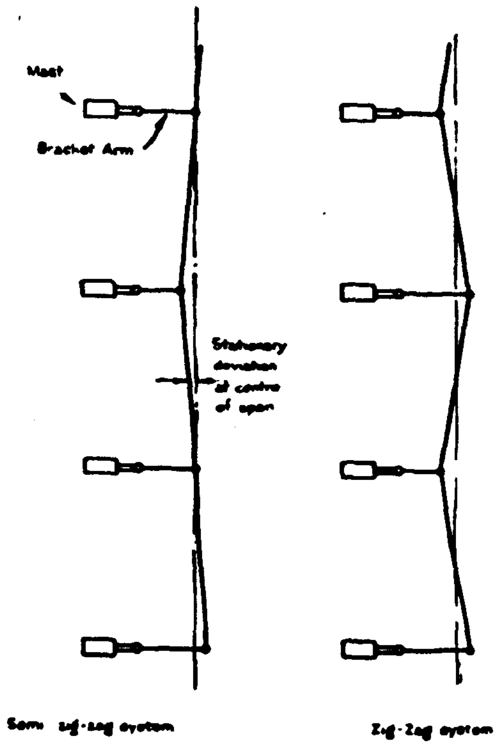
section is 100 sq. mm. With extra high voltage lines 20,000 volts, A. C., the single wire carries all the contact current. At 1,500 volts D. C., twin wires are used, together with D. C. supplementary feeders to reduce voltage drop in the contact wire. The contact wires are suspended from catenary cables and are connected thereto with short dropper wires which are adjusted to maintain the contact wire in a level position.

WIRE STAGGER

In order to maintain control over the height adjustment of the wire, and to give lateral stability to the wire against side winds, the wire is staggered in a zig-zag fashion across the main centre line of the track. This stagger is very beneficial with carbon bows since it tends to equalise the wear of the carbon over the length of the pan.

On the Netherland Railways this stagger amounts to 22" (550 mm.). This has been found to be a very satisfactory value and results in a very good wear factor of the carbon of about 70%. Most of the other railways employ a stagger of only 12" (300 mm.). This causes very rapid wear in the centre section of the carbon and has the objection that it causes steep steps or ridges on the carbon between the centre section and the side sections. As a result of this, the overall life of the carbon is very much reduced, the centre section receiving all the wear and the end sections hardly any.





It has been suggested to several railways that if the stagger on the wire cannot be increased, that the centre line of the 12" (300 mm.) stagger be displaced by 6" (150 mm.), on consecutive line sections on either side of the centre lines of the track. This would give an overall stagger for any two sections of 24" (600 mm.). It would smooth out the carbon wear and improve its life without increasing the mechanical tension or side load on the supporting frames of the overhead gear.

SUMMARY

- Carbon-lined pantograph collectors are employed chiefly to reduce wire wear.
- They reduce radio interference.
- They also increase the collectors life and reduce maintenance costs.

(Continued on page 63)

1800 H.P. DIESEL-ELECTRIC LOCOMOTIVES FOR INDIAN RAILWAYS

IN March, 1957, the Government of India entered into an agreement with ALCO Products, Inc., of New York, N. Y., U. S. A., for the supply of 100 broad guage main-line diesel-electric locomotives, having an output of 1800 HP to the generator. The first lot of 20 locomotives will be delivered in India in 1957 and the balance of 80 units will be supplied during the second half of 1958.

ALCO Products, Inc., formerly the American Locomotive Company, is a well known firm of locomotive builders whose first plant was established at Schenectady, N. Y., in 1848. Since that date the company has delivered in excess of 80,000 locomotives to railways of the world. ALCO was one of the diesel-locomotive pioneer companies and its first commercial diesel-electric locomotive was sold in 1925. The diesel-electric locomotives put into service by the firm in the thirty years since elapsed have passed the 8,000 mark, most of which were built since the Second World War, when dieselization began its upswing.

One of the noteworthy features of ALCO's diesel-electric locomotive manufacturing program lies in the thoroughgoing standardization which the company employs. ALCO's ten different types of locomotives make use of three different engine sizes, with outputs of 900, 1800 and 2400 HP. Interchangeable parts are used in all three diesel engines, the difference in output being obtained by varying the number of cylinders. The same braking equipment is available in all units and electrical control components are standardised as well. Only two sizes of traction motors are used to cover the full spread in locomotive size.

In its locomotive roster ALCO differentiates between the heavy domestic type locomotives built for use primarily on U. S. railroads, where the high rail weight enables locomotives to run with axle loadings up to 27.5 tons, and the lighter weight designs intended for use abroad on systems where much lighter rail is employed. The axle loading of the latter units varies from 11 to 18.5 tons.

In addition to being called upon to meet the lower weight limitation of railways outside of the American continent, the company's export units also are built to fit within the international clearance diagram. A further requirement which ALCO has aimed to meet in its design is that the bogie design be conceived to enable satisfactory riding even on track in indifferent or poor condition.

The ALCO "World" locomotive, which is the type ordered by the Indian Government, is ALCO's representative design in the 1800 HP class for use in railways outside of the U. S. A.

(Continued from page 62)

- Carbon material available, hard carbon Link CY3T and CY3TA and Link MY7D metal carbon.

The current-carrying capacity of metal carbon is twice that of hard carbon and the material is much more resistant to wear.

For best results with any grade of carbon it is necessary to maintain stable contact under all conditions and to distribute the wear as nearly as possible over all the carbon.

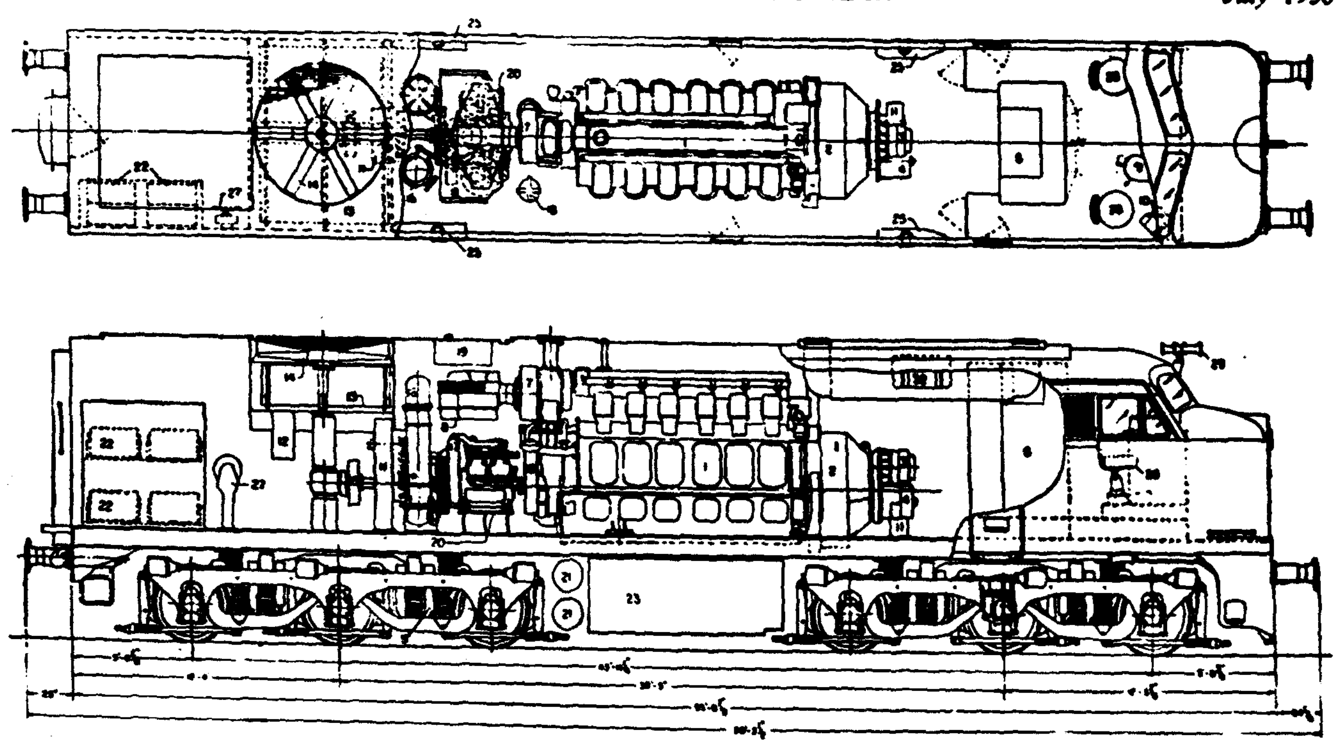
With carbon collectors, wear of collector and wire is reduced with increased contact pressures; with metal collectors wear is increased.

To maintain stable contact it is necessary to maintain uniform pressure between carbon collector and wire, providing ample pressure, keeping down collector weight, avoiding windage effects, avoiding mechanical oscillation on the pantograph and maintaining pantograph springs at required tension.

For best results carbon must be used within its current carrying capacity.

Correctly used the carbon current collector is a well established and economic accessory in electric railways with overhead collection.

Carbon is not a magic wand to overcome shortcoming in overhead equipment.



DESCRIPTION OF THE LOCOMOTIVE

A view of the first of the locomotives built for India is shown elsewhere in this issue. Buffers and couplers are not shown, as they will be applied in India.

With the minor modifications required by the Indian Railways guage, the basic dimensions of the locomotive are as follows:

Height (Roof)	12′ 9-1/2″
Height (Maximum)	13′ 1-3/4″
Width (Over Cab Handrails)	9′ 4″
Length (Over Body)	55′ 7/8″
Length (Overall)	58′ 11″
Weight on Driving Wheels	246,000 Lbs.
Weight on Total Locomotive	246,000 Lbs.
Supplies: Lubricating Oil Capacity	200 Gallons
Fuel Oil Capacity	1600 Gallons
Engine Cooling Water	260 Gallons
Sand	14 Cu. Ft.

The frame of the locomotive is built of steel sections electrically welded and it consists of a main frame made of two H section beams running the length of the locomotive and two side frames of welded truss construction. The nose of the locomotive is reinforced specially to give additional protection to the engine crew in case of a collision.

The main transverse members of the locomotives carry the bogie pivot castings. The general arrangement of the components is shown in the illustration above, which is the longitudinal cross section of the locomotive.

The major components identifiable are the following:

1. Diesel Engine
2. Main Generator
3. Exciter
4. Auxiliary Generator
5. Bogie
6. Electrical Control Compartment
7. Turbosupercharger
8. Oil Bath Type Air Intake Filters
11. Traction Motor Blowers
13. Radiators
14. Radiator Fan
15. Radiator Fan Drive Magnetic Coupling
16. Lubricating Oil Cooler
17. Lubricating Oil Filters
18. Lubricating Oil Strainer
21. Main Reservoirs
22. Batteries
23. Fuel Tanks
32. Dynamic Braking Resistors (applied in some locomotives)

POWER PLANT

The power plant consists of an ALCO Model 251-B 12 cylinder, 4 stroke turbo-supercharged diesel engine of 1950 BHP at 1000 RPM. The engine is described elsewhere in this issue and it is of ALCO Products design and construction.

The engine is directly coupled to a General Electric Model GT-581 main generator designed specifically for traction purposes.

This is a 10 pole shunt-wound DC generator with commutation poles. It is a single bearing machine with a gear case at the outboard end from which the exciter, the auxiliary generator, and the traction motor blower for the front bogie motors are driven.

All the air brought into the engine room goes through impingement type panel filters. The air inducted into the engine goes through a bath type oil filter which ensures dust free air and therefore prolongs greatly the life of all the wearing elements of the engine.

The exciter is a GTA AC generator manufactured also by the General Electric Company. The function of this machine is to provide excitation current and excitation control current as well as described later.

Battery charging and other auxiliary loads are operated by a General Electric Model GY 27, 4 pole commutating pole shunt-wound DC generator. The whole assembly of main generator, auxiliary generator, traction motor blower drive and exciter can be removed at once from the engine. This is because it is hung from the engine frame without any independent support on the locomotive. The type of mounting has been traditional with ALCO for a great number of years.

The combination air compressor and vacuum exhauster, and the radiator fan are driven mechanically from the diesel engine. Between the compressor exhauster and the right angle drive gear for the radiator fan, a magnetic coupling has been installed for purposes that will be explained later.

Two of the first twenty locomotives for India will be equipped with dynamic braking. The resistors are located in their standard position, suspended from the roof of the locomotive ahead of the diesel engine.

RUNNING GEAR

The locomotive wheel arrangement is Co—Co.

The pivot pitch is 30′ 5″ and the rigid wheel base of each bogie 13′ 9″.

The bogies, are of ALCO design, meant especially to provide the best riding qualities on poor or light weight track. The locomotive weight is carried by large size bogie pins and transmitted to a bogie bolster, which is a cast steel piece H shaped, that sits astride the center motor. This bolster is carried on two sets of leaf springs that rest on special planks suspended by swing links from the cast steel bogie frame. The bogie frame rests by long deflection helical springs on equalizers which transmit the load to the axle boxes. Timken Standard Roller bearings are used, grease-lubricated and the axle box guides are of manganese steel.

Following standard American practices, the traction motors are nose supported and rest on the axles by large bronze bearings lubricated by means of wick type lubricators, single reduction spur gearing is used and the gear ratio is 94 : 17, giving a maximum track speed of 65 miles per hour.

This type of bogie design is typical of high speed American practice, and has been employed in many thousands of main line ALCO diesel electric locomotives built to this date.

Individual brake cylinders are used which apply clasp type brakes using two shoes per wheel.

A 1600 U. S. gallons (1340 Imperial gallons) capacity fuel tank is suspended from the locomotive frame between the two bogies.

BRAKE SYSTEM

The locomotives are equipped with the Westinghouse 6 SLV-1 brake schedule. This provides for straight air brakes for the locomotives and vacuum brakes for the train actuated from a standard 6 SL automatic brake valve on the engine main stand. This brake equipment is also suitable for handling air brake equipped trains by means of very small additions to the equipment applied to the locomotives.

COOLING SYSTEM

Following ALCO standard practice, the diesel engine cooling is done by a means of two large radiators located near the roof in the rear part of the locomotive.

The large radiator fan is driven from the diesel engine through a magnetic coupling, the excitation whereof is regulated by water temperature.

This system, which has been used by ALCO for a great number of years, allows the fan speed to be kept fairly constant throughout momentary fluctuations of engine speed. It does away with the troubles normally associated with direct fan drives while avoiding most of the complications associated with electrically driven fans.

An alarm located in the cooling water system returns the engine idling and lights a warning light on the driver's control stand when the water temperature reaches 195° F.

LUBRICATING OIL SYSTEM

The diesel engine is equipped with a gear type lubricating oil pump driven from the crankshaft with a maximum displacement of 314 U. S. gallons per minute at full engine speed.

The lubricating oil from the engine is forced through a battery of cotton waste packed filters, then through a heat exchanger, where it is cooled by the diesel engine cooling water, and finally through a metallic strainer. After the strainer, it is returned to the engine where it feeds the working parts at pressure as explained in the article covering the diesel engine.

The total capacity of the system is 200 gallons.

FUEL OIL SYSTEM

These locomotives have a capacity of 1600 U. S. gallons of fuel oil (1340 gallons) in a single tank located between the two bogies and suspended from the mail frame.

An electrically driven pump forces fuel oil from this tank through primary and secondary filters and feeds the engine main headers from which the fuel is taken by the individual Bosch type fuel pumps.

Excess fuel oil used to lubricate the moving parts of the pumps and injectors is returned to the main tank by means of drain lines.

CONTROL

The standard control used in ALCO locomotives is installed in these units for India.

The driver controls the operation of the locomotive by two levers located in the engineman's stand.

A throttle lever with eight motor notches and one idle notch regulates engine speed and maximum generator excitation at the same time, thus for each throttle notch, a fixed engine power and fixed horse-power are transmitted to the traction motors.

The reverse handle has three positions, forward, neutral and reverse and it is suitable interlocked with the throttle to prevent reversing of the motors with power on.

The traction motors are connected across the generator in two major connections, each of which has a shunted field step. The reconnections or transitions are made automatically according to locomotive speed, the action being governed by an axle driven AC generator and a relay panel.

The transitions are two parallel series of three motors, shunted fields, three parallel series of two motors and shunted fields.

A third handle in the engineman's stand provides supervisory control over these connections and, in the case of the locomotives equipped with dynamic braking, controls the excitation of the traction motors which for these purposes are connected as DC generators against a resistor grid.

Traction motor load is indicated by a colored band meter located at the engineman's position. A green band in this meter indicates the loads under which continuous operation without time limit is permissible.

Time limited operation is shown in yellow with numbers indicating the maximum number of minutes for which the load in question can be held.

With the 65 miles per hour gearing used in the locomotives for India, the continuous tractive effort is 45.900 Lbs. at 12 miles per hour corresponding to a factor of adhesion of 18.6%. This means that the full capacity of the locomotive can be utilized for hauling heavy loads at low track speed.

(Continued on page 67)

MACHINE SHOP SUPPLEMENT

MACHINE TOOL INDUSTRY IN BRITAIN

Some Recent Developments

By A Special Correspondent

THE efficiency of a nation's major manufacturing industries, and the consequent prosperity of the nation, depends to a large extent on the vitality of its machine tool industry. Britain was an early pioneer in the machine tool field, producing some of the first basic types of machines in the late eighteenth century, and this pioneering spirit still prevails today. In the development by a number of leading United Kingdom manufacturers of 'transfer lines', and in the current research into the use of electronic control in the machine tool field, Britain is already looking forward to the not too distant future when the completely automatic factory may become, not merely a possibility, but a fact. In more conventional designs, also, United Kingdom manufacturers are constantly seeking improvements, and there are big outstanding orders for both home and export, particularly in the range of borers, grinders, lathes and presses.

The machine tool industry consists largely of small independent firms with a high proportion of private companies; it employs about 50,000 workers. The industry is centred mainly in the Midlands, Yorkshire and Lancashire, and to a lesser extent near London and Glasgow. The Machine Tool Trades Association of Great Britain is the representative body of most of the machine tool manufacturers and importers and is responsible for the International Machine Tool Exhibitions held in Britain every four years. A highly successful exhibition was held in London in June-July 1956, and the next exhibition will take place in 1960.

Production engineering stands today at the threshold of tremendous changes—changes vaster in concept and implication than any it has known. The manner in which machine tool designers and manufacturers are facing the questions and problems thus

(Continued from page 66)

DYNAMIC BRAKING

Some of the locomotives for the Indian Railways are equipped with Dynamic braking, which consists in reconnecting the traction motors across suitable resistors, as separately excited direct current motors. For this purpose, the traction motor fields are connected in series with the main generator. The driver may control the intensity of the braking effort by regulating the excitation. This is achieved by moving the selector handle across the braking range at the controller. By placing this handle as far forward as possible, self-regulating maximum braking effort is obtained at all locomotive speeds, reaching a peak of 37,500 lbs. at 20 mph.

This means that a trailing load of 2050 tonnes may be brought down a one in 100 grade by one of these locomotives, at 20 mph, without requiring the use of vacuum or air brakes to hold the speed constant.

This feature is used by a majority of the locomotives that must operate in territories with severe grades. It results in longer wheel life, a decreased consumption of brake shoes, and a greater safety in operation. The smooth handling of the train provided by dynamic brake results also in less damage to the goods carried.

occasioned is reflected in the wide range of new and improved tools which Britain has to offer.

MULTI-TOOL AND PROFILE-TURNING LATHE

An important new development by Churchill Redman is the type P.5 automatic multi-tool and profile turning lathe. It has an overhead copy-turning carriage mounted on a vertical bed, and a rear auxiliary in-feed slide. Separate slideways at the front of the lower bed carry the tailstock, which is operated automatically in sequence with the hydraulic chuck. All machine movements are hydraulically operated and electrically controlled, and both profile turning and multi-tool turning may be performed simultaneously. There are no lever controls on the machine. Up to four successive cuts can be taken automatically by the copyturning carriage, while the machine sequence and the number of cycles are determined by setting rotary switches on the control panel.

Carriage feeds are steplessly variable, and two different rates can be automatically brought into use during the cutting cycle by setting trip dogs. The lower range maximum feed rate is 30in./min., and the higher range maximum rate is 60in./min. Rapid power traverse at the rate of 20ft./min. is provided, and if required the carriage can be arranged to give automatic skip feed. For multi-pass copy-turning, a template of circular cross section with plate inserts is employed, and is automatically indexed.

PRECISION HOBBING MACHINE

A precision hobbing machine recently built by Craven Brothers (Manchester) will handle gears up to 90 in. dia. with a face width (for spur gears only) of 34in. The maximum pitch that can be cut is 1 D. P. or 25 module, and the maximum helix angle is 30deg. Since the machine may sometimes be used for the very accurate cutting of turbine gears, it has been built in accordance with the limits of accuracy laid down in the British Standard specification for Grade A hobbing machines used in the production of turbine drives. Of the moving table, fixed-column type, the machine permits spur and helical gears to be hobbed with vertical feed, and worm gears to be cut with fly cutters, or with taper or parallel hobs. Facilities are also provided for straight spur and helical teeth to be milled singly with a disc-type cutter and vertical feed of the hob slide. This procedure facilitates roughing-out large-pitch gears in preparation for hobbing.

The same company has also completed a 60 in. centre lathe for the Electricity Supply Commission, Rand Undertaking, in South Africa. Although it will be used mainly for checking the accuracy of large electrical rotors and carrying out light corrective operations on them, the lathe is suitable for light duty work on shafting and large engine crankshafts; re-turning of journals and tyre treads of locomotive wheel-sets; and skimming of blade tips and shrouds of wheels which have been re-bladed. Facilities are provided for cutting screw threads from 0.05 in. to 3in. pitch, and helical grooves for cooling can be cut for the full length of a rotor body.

HEAVY DUTY LATHE

A 33¼ in. centre heavy-duty roll turning lathe recently built by Craven Brothers (Manchester) for the Steel Company of Wales has provision for performing knurling and ragging operations. Knurled rolls prevent the sheets skidding during rolling, while ragged rolls assist in breaking up the scale which forms on the sheets. The lathe will swing a maximum diameter of 57½ in. over the saddles and admit lengths up to 22 ft. between centres. Drive to the geared headstock is from a 35 h. p. motor through a fourspeed primary gear box, and a total of 16 spindle speeds from 0.37 to 38.6 r. p. m. is provided. The tailstock is traversed on the bedways by a separate motor drive, and is fitted with a revolving spindle, which, like the headstock spindle, carries a 48 in. four-jaw chuck. When re-turning only is to be undertaken on the working surface of a used roll, the latter is usually gripped at one end by the headstock chuck and supported at the other end by a V-shaped stay. Two saddles, mounted on the front bedways, are arranged for sliding and surfacing feeds, coning by gearing for their entire longitudinal travel, and rapid power traverse.

The same firm has lately completed a roll grinding machine with a taper neck grinding attachment. Incorporating a traversing wheelhead which is moved on guideways at the rear of the 40 ft. long bed by means of a screw, this machine is intended for grinding rolls up to 24 in. dia. by 31 ft. overall length for the paper-making industry.

FOR SHARPENING DUTIES

A 5¼ in. centre-hob sharpening machine for straight-and-helically-gashed hobs and form-relieved cutters has recently been introduced by Craven Brothers (Manchester). For normal hob sharpening duties, the machine is supplied with a single horizontal spindle which will take a 6 in. diameter grinding wheel. Alternatively, two horizontal spindles can be provided, the lower, high-speed, spindle being intended for use with a pencil-type wheel for grinding hobs with deep, high-angle, gashes. The maximum diameters of hob that can be ground with the disc-type and pencil wheels are 10 in. and 6 in. respectively. A high-angle dressing attachment is available for mounting between the workhead and tailstock centres, which enables a curved profile to be formed on the disc-type wheel. A wheel dressed in this manner will grind true radial faces on hobs with high-angle gash spirals, and interference problems are largely avoided.

A new lead measuring machine has lately been added to the range of gear testing equipment made by J. Goulder and Sons. Based on an original idea of Mr. H. E. Merritt, who acts as consultant for J. Goulder and Sons and other companies, this machine provides for the generation of steplessly-variable right—and left-hand helices with leads from zero to infinity for checking spur and helical gears, worms and hobs. It also enables the involute forms of worms and hobs to be checked. Gears up to 14 in. dia. by 5 in. long which weigh up to 50 lb. can be mounted on the faceplate. Alternatively, an attachment may by fitted which enables gears up to 8 in. dia. with integral shafts from 7 in. to 12 in. long and weighing up to 100 lb. to be held between centres.

MILLING AND BORING MACHINES

The first of two 10 in. spindle, ram-type, horizontal milling and boring machines for the new Larne factory of the British Thomson-Houston Company was recently completed at the Shrewsbury works of William Asquith. The spindle slide has a movement of 15 ft. on the column ways, and the travel of the column on the bed is 33 ft. A traversing speed of 8 ft. a minute is provided for these motions by 30 h. p. motors, and separate motors, 5 h. p., are fitted which give a sliding speed of 0.1 in./min. In addition, steplessly variable feeds ranging from ⅛ to 20 in. a minute can be applied to the column and slide, for milling by 20 h. p. motors. Steplessly variable speed D. C. motors with Ward-Leonard control, and a patent system of gearing, are employed for the drives to the spindle and the horizontal and vertical feed motions. In consequence, mechanical gear changes for the feeds have been entirely eliminated, and, inconjunction with the 50 h. p. driving motor, only four gear changes are required to give any spindle speed from 10 to 276 r. p. m. Both the column and slide feed motors can be controlled simultaneously so that the spindle can be fed along a straight path in any direction in the vertical plane.

A 24 ft. vertical turning and boring mill was built recently by George Richards and Co. for the Broken Hill Pty., Australia. A maximum height of 12 ft. is admitted under the cross slide and under the tool bars, which have a vertical adjustment of 7 ft. Of 22 ft. diameter, the T-slotted work table runs on an outer flat and an inner conical white metal bearing, and is driven through an 18 ft. diameter single-helical gear ring. A Ward Leonard generator set is used, and the main drive motor has a 3 to 1 speed range, which, in conjunction with a six-speed gearbox, enables table speeds from 0.333 r. p. m. to 10 r. p. m. to be obtained. Mechanical gear changes are power operated by a separate motor and are controlled by push buttons on a desk at the front of the machine. The cross slide tool bars are arranged to swivel through 30 deg. in each direction, and they can be fed vertically, horizontally or at an angle.

CRANKSHAFT GRINDERS

Two new crankshaft grinders with fully automatic working cycles have been introduced by the Newall Engineering Company. One of these machines, known as the type U/HAC, is intended for grinding both journals and crankpins and, will take maximum and minimum lengths of 84 in. and 36 in. between the spindles of the workheads. Both workheads are driven, from a 5 h. p. motor through a shaft extending between them, to obviate the risk of twisting the crankshaft while grinding is in progress. A seven-speed gearbox provides work speeds from 35 to 72 r. p. m. The machine will take grinding wheels up to 42 in. diameter. During the grinding cycle four different rates of in-feed are automatically brought into use for facing the webs of the crankshaft and for taking roughing, semi-finishing and finishing cuts on the crankpin or journal. At the beginning of the roughing cut a Newall Electro-sizing gauging head is automatically brought into engagement with the work for controlling the diameter being ground. Automatic positioning of the work-table for presenting pre-selected crankpins or journals to the wheel is obtained by a hydraulically operated plunger which engages with a spacer-bar at the front of the machine.

Designated the type A/HAC, the second machine is intended for grinding crankpins only, on crankshafts for four-cylinder and six-cylinder petrol engines.

RADIAL DRILLER

The duplex, bogie-type, radial drilling machine, recently built by Frederick Town and Sons for the South African Railways and Harbour Board, is designed to move on rails set at 13ft. centres. The centre distance of the columns is 7 ft. and the collector gear fitted allows the radial arms to be swung through 360 deg. without cable interference. Maximum and minimum distances of 73 in. and 13 in. are obtainable between the spindles and columns, while the spindle heads have a capacity for drilling holes up to 2 in. dia. from the solid in mild steel. The high-tensile steel spindles have a travel of 15 in., and a maximum distance of 30 in. is obtainable between their nose ends and the rails. A single adjustable lever on each head serves to lock the head to the arm and the arm to the column simultaneously.

A machine for performing such operations as trimming, beading, curling, swaging, and thread rolling on tubes and deep drawn parts has been introduced by Moon Brothers. It will handle components from 1⅜ in. to 6 in. diameter and up to 15 in. long with wall thickness up to 12 s. w. g. An adjustable magazine chute is provided for the automatic loading of components, although, if required workpiece blanks can be delivered to the machine by a conveyor.

SURFACE GRINDER

An abrasive belt surface grinder recently introduced by Taylor Tools and Supplies has a 36 in. by 36 in. table which is usually fitted with three electro-magnetic chucks, although other work-holding arrangements can be provided if required. Using an abrasive paper belt which can be quickly changed when necessary, the machine enables large flat surfaces on metal, plastics, and wood to be finished rapidly. A substantial bridge member set at right angles to the bed, carries driving and idler pulleys for the abrasive belt. It is also fitted with a contact roller or pad which is reciprocated for the full width of the table at steplessly-variable speeds by an air-hydraulic system. The table feed is applied automatically and the contact pressure can be varied to suit the materials being processed and the finish required.

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A Hungarian Mobile Diesel Compressor in India

IN India-as well as in other countries of Asia—road, bridge and railway building form an essential part of the economic plans of the states. The economic development, the industrialization and the rise of living standards necessitate an increased speed in the developing and extension of these branches of industry.

Modern building, bridge building, road building and mining industry require an increased pace of work which brings about the frequent change of site. To meet this requirement, mobile Diesel engine driven air compressors are employed for operating the pneumatic tools necessary for such works.

Such mobile Diesel compressors attached to a tractor can be readily and easily trailed from one work site to the other, and are especially suitable for operating in countries and working places where power supply is not sufficient.

Within Hungary's significant heavy industry the manufacture of compressors has a past of nearly 50 years. The compressors required for the Hungarian industry and for foreign trade purposes are manufactured by the MAVAG Works of Budapest, one of the largest Hungarian factories, founded in 1868 and employing more than 10,000 workers. This factory has great experiences, and its engineers engaged in designing compressors keep in view the achievements attained in this field by the industry of foreign countries and by the Hungarian industry, as well as the experiences gained during the utilization of the machines both abroad and in Hungary.

The CYCLONE mobile Diesel air compressor is one of the best products of the Mavag Works in the past few years. Constructed in conformity with the most up-to-date standards, this compressor has appeared on the world market as fully competitive with similar Western makes.

At present Cyclone compressors are being exported in one category only, with an air consumption of 223 CFM/6,34 m3/min/ and an effective air delivery of 177 CFM /5 m3/min/ at a final discharge pressure of 100 PSI /7 atu/. The unit consists of an air-cooled, 3-cylinder compressor type KL 300/32 driven by a water-cooled, 4-cylinder Diesel engine type CSEPEL-DT built in a housing which can be completely closed and is mounted on two pneumatic-tyred wheels.

The air sucked into the two low pressure cylinders of the compressor is compressed to 33 PSI /2,1 - 2,3 atu/ pressure, while in the high pressure cylinders this pre-compressed air is compressed to 100 PSI /7 atu/. Between the two stages efficient cooling is obtained by the use of an intercooler cooled by an amply dimensioned fan. Perfect cooling is secured also by the fact that within the cylinder heads the suction part is completely separated from the delivery part, so that the temperature of the compressed air does not warm the sucked-in air. These constructional solutions have been adapted by the engineers of the factory with an eye to the possibility of using the compressor in areas of tropical climate, where perfect cooling is of utmost importance.

Suction and discharge takes place through circular plate valves which are easy to disassemble. Both high pressure and low pressure cylinders are provided with safety valves.

The compressor is provided with fully automatic pressure and speed controlling device. The Diesel engine and the compressor respectively are changed over by this automatic device to idle running when the desired service pressure is attained in the air receiver ; and the set will be again automatically changed over to full running and full load when the air in the air receiver proves to be insufficient for operating the pneumatic tools. This device ensures the economic

(Continued from page 70)

Optical measuring tools has recently introduced tilting rotary tables with working surfaces of 12 in. and 16 in. diameter. These new tables have built-in optical micrometers of the wedge-prism type, which enable settings to be made in both the plane of the working surface and in the vertical plane to an accuracy of 1 sec. of arc.

The patented auto-trip guard for power presses, recently added to the range made by the firm of Press Guards, incorporates a pivoted screen which is opened and closed by an air cylinder. The valve for controlling the cylinder is operated by an adjustable cam, driven by a variable speed geared motor, housed in a separate portable unit.

utilization of the machine and makes it possible to economize a considerable quantity of fuel.

The cylinders have forced lubrication by means of a gear type pump.

Long durability is secured by the relatively low speed – 960 RPM - of the compressor.

The Diesel engine is of water-cooled, 4-cylinder, 4-stroke, vertical design, started by means of two 12 V accumulators, through a 4 HP 24 V self-starter. Output: max. 64 HP at a speed of 1750 RPM. Piston displacement: 324.83 cu. in. The Diesel engine has a power reserve of 20% compared to the power requirement of the compressor.

The instrument panel of the compressor plant shows not only the final pressure of air, but also the pressure of the intermediate stage, temperature of motor-cooling water, oil pressure of the compressor and the Diesel engine, etc. thus ensuring easy control of the operation of the whole plant.

The air receiver of 270 litres capacity is on the front part of the compressor housing. It is provided with four air cocks of 3/4" for the 4 pneumatic tools of medium size which can be operated by- the compressor.

Compressor and Diesel engine are built into the compressor housing in such a way that all important parts of the machine should be easily accessible and, if needed, disassembly can be performed simply and quickly.

The large-sized pneumatic tyred wheels /8,25 x 20/ ensure easy transportability even on the most uneven ground.

The Cyclone compressor has a robust, stable design. Its chassis is particularly reinforced and the entire structure of the machine shows the endeavour of the designers to place at the disposal of the users such a machine which perfectly meets all requirements.

It is worth mentioning that /in case the purchaser, domiciliated in a country far from the factory, requires it/ the machine is supplied together with a large set of spare parts comprising spares both for the engine and the compressor. The supply of this spare part set has the advantage of securing the trouble-free operation of the unit for about three years.

To-day the Cyclone compressors are supplied to many parts of the world, e.g. Argentina, Brazil, China, Egypt, Yugoslavia, Turkey, etc. giving highly satisfactory operation with indoor and outdoor works. In outdoor service they proved to be excellently suitable for roadbuilding and road repair works, building of railway lines, bridge and tunnel construction, building and repair of gas pipe lines and sewage systems, trench digging as well as the erection of prefabricated steel constructions and for any work where pneumatic drills, riveters and other tools are used.

One of the great importing private companies of India has placed an order with the competent Hungarian foreign trade enterprise for a larger quantity of Cyclone compressors which will presumably arrive in India in the middle of this year.

IRON ORE CONCRETE AGAINST RADIATION

Iron ore concrete—concrete mixed with iron ore instead of stone in order to increase the volume weight and thereby the protection against radiation—has been used to a large extent in Sweden's new atomic research station at Studsvik, south of Stockholm. The station is now in its second building stage.

Concrete of this type has been used for the 35 inch thick basement flooring in the hall housing the R 2 research reactor and for the 70 inch thick walls of the reactor pool, which is 354.5 feet high.

The reactor building proper, which is 945.6 feet high, has a framework of prestressed concrete pillars and girders. The walls between the pillars, 7 inch thick, have been sliding-form moulded, the exterior insulation being 3 inch mineral wool mats and the cladding corrugated light-metal sheets.

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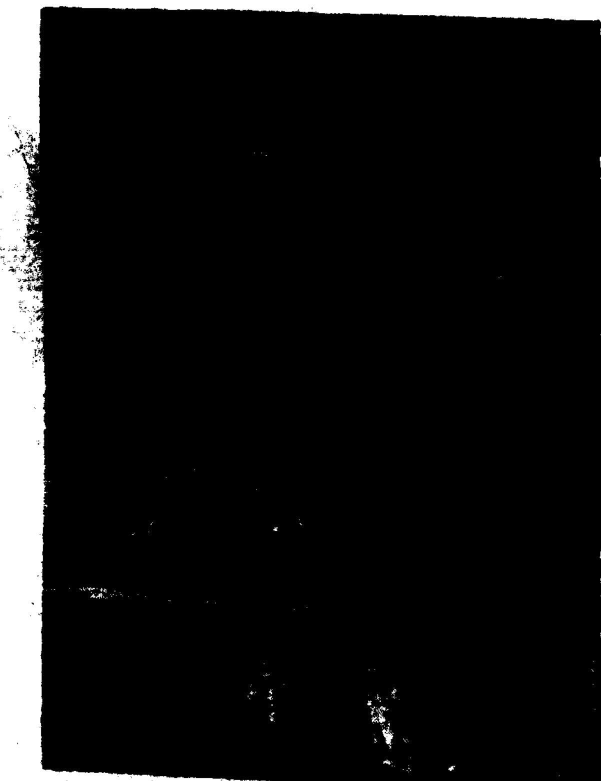
PAINT WARNS OF DANGEROUS HEAT

A new paint developed by an American company gives a visual warning or alarm when objects painted with it get too hot. The paint is brushed or sprayed on metal pipes and boilers and will change its colour from blue to white when the temperature reaches 585 degrees Fahrenheit. The manufacturer of the paint is the Humble Oil and Refining Company of Houston, Texas.

during the two years, during which they have been introduced. They have created for themselves a high reputation for efficiency and reliability.

Another new development of the Consolidated Pneumatic Tool Company's range of horizontal slow speed compressor is the F. E. Class Compressor, a unit of balanced opposed type piston design which has been specially introduced to give the least amount of vibration to the foundations, in addition to being economical in space requirements.



A Baby Boyer superior chipper on locomotive repair.

A beginning has been made to manufacture certain of the ranges of air Compressors in India and negotiations are far advanced with a reputable Indian firm to undertake this work in a factory specially designed for manufacturing Air Compressor plants. The day is, therefore, not far that the Consolidated Pneumatic Tool Co.'s Indian manufactured compressors in no way inferior to those manufactured in their parent factory at Fraserburgh will be introduced to Indian buyers.

Apart from the Railways, compressed air is in great demand at many river valley schemes for the construction of many major and minor dams. The tremendous amount of excavation required at dam sites together with the raming of very large quantities of reinforced concrete is done by the use of Pneumatic tools and compressed air.

Portable Compressors of the Consolidated Pneumatic Tool Co. are used in India by the Public Works Departments and Municipalities in large numbers, for road constructions and repairs and by the various mines in combination with pneumatic excavating tools for the excavation of coal and other mineral ores like manganese, limestone, copper etc.

PNEUMATIC TOOLS (Locomotive Shops)

The growing use made of Pneumatic tools by the Railways in their various departments indicates their great utility in disposing of repair work most expeditiously. In the boiler shops where the largest number of Pneumatic tools are used, such operations as chipping, caulking, rivet cutting, rivetting, drilling, tube expanding are performed with the use of pneumatic tools. The tools have also been designed to meet the requirement of each type of work done.

BOILER SHOP

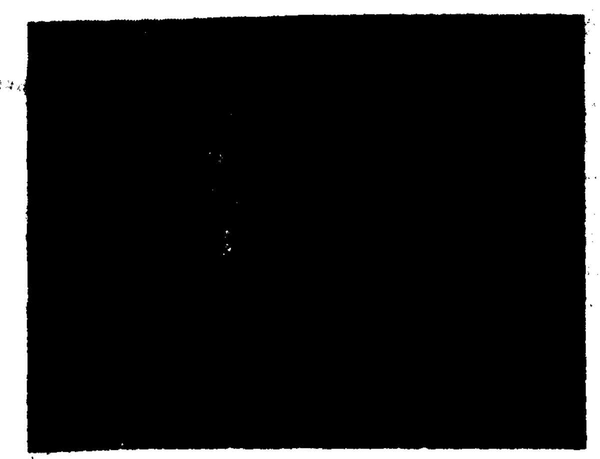
The first work of a Locomotive Boiler Shop dealing with the repair of boilers is inspection and for this purpose after removal of tube the plates have to be descaled, so that all rivets may be tested for soundness. For this operation the CP. 5 Pneumatic Scaler is eminently suited and is used in clearing scale round rivet heads. If rivets are found defective they have to be cut out and for this the 11X Rivet Cutter with a cutting capacity upto 1" dia. is used. Boyer Superior Gun is also used for cutting larger rivet heads with one

A Consolidated Pneumatic type 327 reamer used on boiler work.

or two heavy blows. Other work of the Boiler shop consists in cutting and trimming plates in situ, for which the Boyer Superior and the Simplate Chippers are used. Once the cutting and trimming is done then the surfaces have to be ground finished to take the plates which have to be welded as patches. For these operations, various types and sizes of Pneumatic Grinders are used which finish the work in minutes which would have taken hours if hand filing had been resorted to. For removal of stay bolts by drilling, for drilling new holes in plates, for reamering holes to size of rivet and in drilling in difficult positions various sizes of pneumatic straight, close quarters and corner drills are utilised. After removing rivets and stays it is necessary to replace them and for this purpose rivetting hammers of various sizes and patterns are employed such as the No. 40 and 90 open handle, the No. 60 closed handle, the No. 2 Boyer Superior and No. 3 each designed to suit the work to be done.

FITTING SHOP

One of the most difficult jobs in the locomotive fitting shop is the unscrewing of the large 6" piston rod nut which keeps the piston head fixed to the piston rod. The nuts originally run in with graphite grease due to extreme temperatures during a period of about two years of service get practically bonded to the threads and five or six men with long handled spanners find it difficult to shift these nuts. It has been found that the power vane Wrench is able to do the work in minutes in an effortless manner, and for lighter nuts which appear to be fixed permanently to back plates or ashpan plates the light CP. 337 RAN is able to losen them without much exertion.



Running staybolts with a power vane impact wrench.

PNEUMATIC TOOLS (Carriage & Wagon Shops).

In the carriage and wagon shops the wagon repair shop and the carriage under frame and bogie shops make the greatest use of pneumatic tools and they are of the same kind as mentioned above for chipping, grinding, drilling, reamering and rivetting operations. In addition on the carriage side there are various polishing operations which are done with light pneumatic tools like the polishing of journals, the polishing of light and fan fittings, stainless steel wash basins etc.

HICYCLE TOOLS

For drilling holes in the panel plates and members of carriage for floor and body side and end and roof Hicycle Electric Drills have found to be most useful. As these wooden members are joined together in addition to standard wood joints by large and heavy coach screw the hicycle screw drivers are found to be both efficient and quick. The great advantage of these type of high-frequency tools is their high power-weight ratio and their high efficiency in power consumption.

The hicycle tools operate from a 200 cycle supply, which necessitates the use of a frequency changer but their specific advantage is that they work without a wound armature and brush gear, the induction motors used incorporating solid or copper bar rotors. The power savings from these type of tools is substantial and is a recommendation for their greater use.

CONSOLIDATED PNEUMATIC TOOL CO. (INDIA) LTD.

With the Consolidated Pneumatic Tool Co.'s new Indian factory going up in Mulund, Bombay, and coming into production in the near future, India will be self-sufficient in pneumatic tools and equipment and will be able to supply their customers with machines and tools in every way equivalent to their imported stock. This factory will be well equipped with every type of machine tool and heat treatment equipment required to produce pneumatic tools and equipment of a high order. It will be manned by experienced staff from England and Indian engineers specially trained at the parent factory abroad and will employ only high skilled machine operators. The standard of inspection will be very high so that the product put on the Indian market will be in no way inferior to the imported product.

Thos. Smith & Sons (Rodley) Ltd.

A company which, throughout its long history, has had a particularly close association with industrial development in general and with railway development in particular, is Thomas Smith and Sons (Rodley) Ltd. Rodley is a small town on the outskirts of the busy and prosperous Yorkshire city of Leeds, which is itself notable for its heavy industries and for its close connection with the earliest British railways.

The first heavy machinery produced by this company nearly 140 years ago, was stone-cutting equipment for the local stone quarries and from this it was probably a natural development to go on to the manufacture of winches, with which to facilitate the removal and handling of the quarried stone. From winches it was but a step to cranes.

There can be little doubt that the inauguration of the first public railway in Britain, which was also the first public railway in the world, must have been of great interest to Smiths, as it was to other Yorkshire industrial concerns. This great new step forward in the history of transport was taking place in their very midst and they would indeed have been poor business men not to recognise the opportunities which might come their way. Thus, whilst the advent of rail travel undoubtedly stimulated industry throughout Yorkshire and the North-East of England, it is also true to say that had it not been for the existence of these local industries, railway expansion might not have proceeded so quickly.

The comparatively simple manual appliances of 100 years ago are puny in comparison with the massive power-operated appliances of today but they served their purpose. As long ago as 1860, however, steam cranes began to replace the hand-operated guy and derrick cranes which had formed the bulk of the company's production up to that time. Smiths were the first firm in Yorkshire to build a steam locomotive crane and, during the sixties, they widened their range by the introduction of overhead travelling cranes. After these came hydraulic lifting gear and, in 1894, the first electric crane. The availability of electricity as a motive power led to the building of gantry cranes and of level luffing cranes for use at docks and harbours, and these have carried the name of Smith all over the world, paving the way for the great international trade in all types of cranes and excavators for which the firm of Smiths is now famous. These mechanical excavators have very largely been developed during the present century but their construction now forms as large a part of the Smith factory's production as does that of the cranes.

In India, as in nearly every other country, Smith products have played a great part in railway development and on the Calcutta electrification scheme they have given particularly valued service. Appreciation of the worth of Smith products was shown recently in the confirming of yet another order for cranes for the Indian railways, valued about 4,000,000 rupees.

The overseas organisation handling Smith products now spreads to more than fifty countries. Smith representatives travel frequently throughout the world and are often visiting India to keep themselves fully acquainted with present-day requirements and problems. Their representatives in India are Marshall, Sons & Co. (India) Ltd., 33/1, Netaji Subhas Road, Calcutta 1.

Today, the Smith range of universal excavators consists of four models, ranging from 8 to 21 cubic feet capacity. Each of these machines is capable of conversion for no fewer than seven different purposes. Certain of them are equipped with a new Smith development known as Power-lowering, which permits extremely delicate and gentle handling and positioning of loads. It is, for example, now possible, when a Smith excavator is being used on crane duties, to position exactly and without risk of damage, a complete pre-fabricated concrete roof-truss for a building, saving much time, expense and labour.

Amongst the wide range of cranes produced at Rodley are two recently-introduced lorry-mounted cranes, known as the M. E. I. and M. E. II. The first of these has a lifting capacity of 22 tons and the second has an 8-ton capacity. The larger model can be fitted with a 100 ft. boom, which makes it a tremendously useful machine, particularly on construction work where a really mobile unit of this type can produce enormous savings in labour and in other forms of equipment. The M. E. I. has been introduced to supplement the range of mobile units. The M. E. II is an entirely new machine which was only recently exhibited to the public for the first time at the British Mechanical Handling Exhibition and which has had an excellent reception

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Modern Used Machine Tools at half to-days cost

IT is not generally realised in India that "Used Machine Tools" does not necessarily mean old machine tools. So many production engineers today, either think only in terms of new machine tools which are becoming more and more expensive each year, and tend to dismiss the possibility of acquiring used machinery for the job in the belief that such machine of a sufficiently modern type would not be available. It is true that much rubbish in the way of old machinery has in the past been imported into India and Pakistan, and to protect the users against this, the Indian Government has introduced Legislation covering the import of used machinery which stringently, perhaps too stringently, controls the importation.

It is not generally appreciated that, there is today, a tremendous and world wide trade in modern used machine tools of latest type, modern construction and in thoroughly good serviceable working condition, large stocks of such machines are held for immediate sale. Intending importers should not, however, fall into the trap of always trying to buy the cheapest as it often turns out to be the most expensive in the long run. A modern turret lathe for example, (1949 to 1945) has all the advantages of the latest type machine, speeds, strength, and long life etc. and can be obtained at about half to a third of the new price, with immediate delivery. They may too of course, be obtained cheaper, but then so may many other things too: cheaper and older and worse. Everything has its proper value, and cheapest machinery is nearly always not only false economy but a waste of money. After all, the world wide trade and demand governs the proper market price that can be asked and obtained, and most reputable dealers can only ask what they can reasonably hope to get for their machinery.

With most modern tools, the new price and delivery affects and to a certain extent controls the second hand value of a similar machine, so long as it is a similar machine. So many works engineers and directors of companies, have mistaken ideas on this too. It is by no means uncommon for a cheap, light-weight, badly designed and untried and unknown make of machine, to be priced at less than it is possible to buy, a used machine of top British or American manufacture. The new cost explains this, so will the performance.

After all, a new cheap car can usually be bought less than a second hand Rolls Royce or Cadillac, but which is the best? Which will last the longest? Which will retain more of its value for eventual resale? The answer is the quality article every time.

There are several other points of interest in this examination of the uses of used tools.

Firstly, equipment: Most new machine tools are bare of equipment which is all "extra's" and when cost of the tooling, and sometimes the motor and switch

(Continued from page 78)

In India, Smiths are best known for the types of crane which they have supplied to the Indian Railways but one of their chief claims to fame lies in the number of dockside cranes which they have supplied to many of the world's great ports. Ocean travellers are well accustomed to seeing the name of Smith on cranes at quayside everywhere. These cranes are of many types and in a wide range of capacities and behind the construction of each of them lies a wealth of knowledge and experience gathered during more than 100 years. But apart from locomotive, dockside and lorry-mounted cranes, there are still many other types of crane built at Rodley, including mobile cranes with crawler tracks and rubber-tyred mobile cranes. Various kinds of power are utilised, including diesel, electric and steam-operated units but, here again, so wide and varied is the experience available at the Rodley factory, that these various forms of power present no problems to the skilled engineers whose work it is to produce the famous Smith range.

Indian railway engineers who find themselves in Britain would be well advised to contact Smiths of Rodley as they are known, to arrange a personal visit to the factory. Here every single process of manufacture and construction can be seen, right through to the final rigorous testing of the finished product before delivery. That delivery, it is interesting to reflect, may literally be anywhere in the world. Visitors are always welcomed and will find much to interest them. It is advisable to make an appointment in advance however, for Rodley is a busy place, far different from the modest early home of this justly famous firm.

... tried and proven and it has a useful second hand value ...

... turers factory, are used, and have been ...

cannot be much wrong with them if they make new ...

Today, factories change their tools often and they ...

Reputable merchants can today be relied upon to ...

used machine offered th... in price, it is advisable to secure it at once if the ...

ment overseas. Most engineering concerns in Australia, South Africa, New Zealand etc. place all their European purchases through such an organisation. The services rendered by these shippers and the trouble they save is well worth paying for. The integrity of London Shippers is such that they will not pass shoddy goods and will maintain delivery dates and guarantee proper payment to the supplier at the right time.

Against this of course, they will require payment in advance against the order placed with them, by cheque or irrevocable letter of credit.

Many shippers would also probably issue the certificates of worthiness called for by the Indian Import licencing Authorities, without charge, which would avoid the tiresome and expensive business of appointing independent consulting engineers to make these inspections. Again some are qualified to advise as to the most suitable machinery for certain work, or can call on their contacts in the engineering world for such advice. What is the most usual and up to date method of doing a new job is always of interest to the production engineers, and if he can get expert advice along with his buying order free of charge, it is an attractive proposition. Enquiries of this nature should however always include the important relevant details to enable an intelligent appraisal of the work to be made. The kind of metal to be machined, accuracy required, quantities estimated are all basic information, together with the type of machine in mind. It is usually possible to do a job half a dozen different ways and the type of machine, not always the cost, determines the speed of production and accuracy.

Generally speaking, with used machine tools, buyers get what they pay for and a good machine tool will command a good price whether it is sold in India or the U. S. A. in England or Hong Kong. It is wise to reflect upon the words of John Ruskin nineteenth century scholar whose words are as true today as when they were written.

"There is hardly anything in the world that some man cannot make a little worse and sell a little cheaper, and the people who consider price only are this man's lawful prey."

The wise buyer today will therefore choose modern used machine tools at average prices; we will then have the satisfaction of knowing that his workshop is equipped to manufacture economically at modern speeds, and at the same time, show a very considerable saving, often half to two thirds of the cost of an equivalent new machine of similar performance.

AUTOMATIC COACH WASHING MACHINE AT TRACTION CAR SHED, BOMBAY CENTRAL

An Automatic Coach Washing Machine, the first of its kind on Indian Railways, designed by the Western Railways Engineers and constructed by the staff of the Car-shed, utilising all indigenous materials was formally inaugurated on 14th April 1958 by Shri M. Ganapati, General Manager, Western Railway, at the Car-shed, Bombay Central.

This washing machine has been installed so that more number of rakes can be washed within the limited period during which coaches are available in the Car-shed in the afternoons between peak periods of suburban traffic in the morning and evening. Compared to the two rakes which are being washed externally every day using manual labour so far, with the help of the machine the output is expected to be increased to four rakes being washed every working day. This will result in the suburban trains being cleaner and more attractive to the general public.

After the introductory speech by Shri R. N. Chaudharie, Divisional Superintendent, Bombay Central, Shri S. C. B. Mazumdar, Chief Electrical Engineer, addressed the guests and the staff and explained the technical aspects of the washing machine and the advantages of machine washing of coaches as against the present practice of manual washing. He also pointed out that the cost of the machine, as constructed and installed locally, was very much cheaper than the cost of a similar machine of foreign manufacture and also as a result of the saving in recurring expenditure, the cost of the machine would be made good in less than two years of operation.

Shri Ganapati, General Manager, addressing the gathering expressed his appreciation of the machine having been designed and built by railway staff at a very economical cost and also urged them to give their best always keeping in view the aim of more amenities and better services for the travelling public.

The General Manager then pressed a button and formally inaugurated the newly installed washing machine. One coach was then washed by the machine and was inspected by the General Manager and other guests present.

HERBERT LATHE DESIGN

Some features of Herbert Capstan and Turret Lathe design which contribute to high-quality, accuracy, durability and trouble-free operation

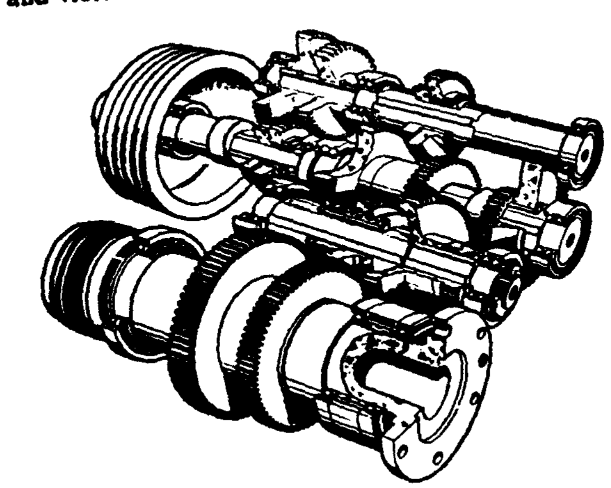
The line drawing below shows the headstock gearing of the Herbert No. 9C/30 Combination Turret Lathe, which has a maximum swing of 30".

Wall thickness and bore diameter of the spindle are 1¾" and 4½" respectively, proportions which, with the general design, provide for maximum rigidity and eliminate chatter when machining heavy work at high speeds.

Quiet running, dependent on minimum shaft deflection under load, is ensured by large diameter shafts and the minimum distance between bearings. Where this distance is excessive relative to the shaft diameter, intermediate bearings are fitted. Shafts are also kept as stiff as possible, the method, where applicable, of clamping the keyed gears and bearings against a shoulder by means of retaining split rings or circlips being conducive to this design.

All high-stress gearing on Herbert Lathes is profile ground, an operation which, when producing cluster gears, necessitates the gears being ground separately and then clamped together.

One method of holding the cluster-type sliding gears together is with a hooked key. This positive method is preferred to the radial grub screw which tends to be thrown out of its seating by the centrifugal and vibrational forces developed by high speed shafts of this kind. The hooked-key method also permits the use of hardened and ground shafts.



Two other features of design in this Headstock are the use of sliding gears on splined shafts, in preference to using sliding keys and all shafts are mounted on ball bearings. The main spindle is mounted on ball and roller bearings; front bearings are of the angular-contact, double-purpose type to take thrust in both directions.

The power-operated Preoptive Headstock is exclusive to Herbert Lathe design and is now fitted to two sizes of each of the ranges of Capstan, Combination Turret and Hexagon Turret Lathes. This headstock with either a two-speed motor or a single-speed motor with double clutch drive, provides sixteen speeds and transmits ample power throughout the range. This headstock eliminates idle time due to speed changing and provides simplicity of operation, long life, quiet running, freedom from vibration and transmission of maximum power to the main spindle flange.

The accompanying illustration of the shaft and gearing arrangement of the Preoptive Headstock on a Herbert No. 5 Senior Capstan Lathe, shows that the high efficiency originates from a multi-vee rope drive. The efficiency is maintained through shafts and gears made from alloy steel and mounted on ball bearings. The hardened and ground gears are mounted close to the bearings to minimise shaft deflection.

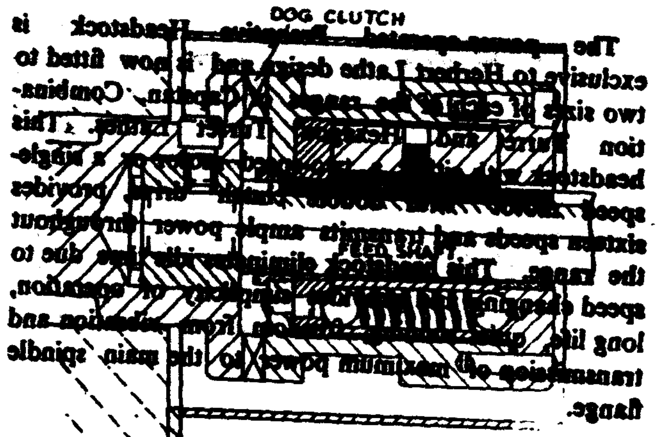
The final drive is to a main spindle which is mounted on a roller bearing at the rear end and two large opposed angular contact ball bearings, which take thrust in both directions, at the front end. These bearings are specially made to precision tolerances and supplied in sets. Each bearing is guaranteed to be within .0001" in the bore and outside diameter relative to each other.

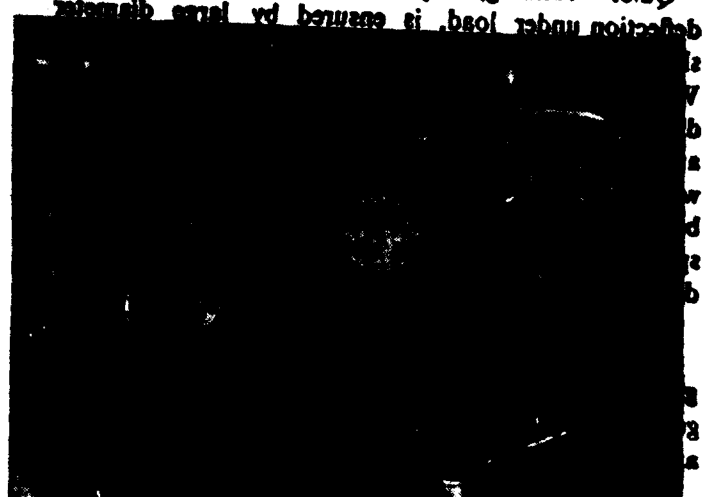
Instantaneous change of speed, under cut if desired, is made possible by the elimination of sliding gears, the actual change being made by the power operation of highly-efficient multi-disc friction clutches which are of Herbert design and manufacture.

These Herbert clutches have been specially developed to deal with high-load conditions in restricted spaces. The clutch diameters have been kept small to permit adjacent shafts to be spaced closely together so reducing gear peripheral speeds and consequently gear noise.

Very high speeds are possible with these clutches as they are in perfect balance and not affected by centrifugal force.

Light pressure is sufficient to operate them, therefore very little end thrust is placed on the clutch [illegible]





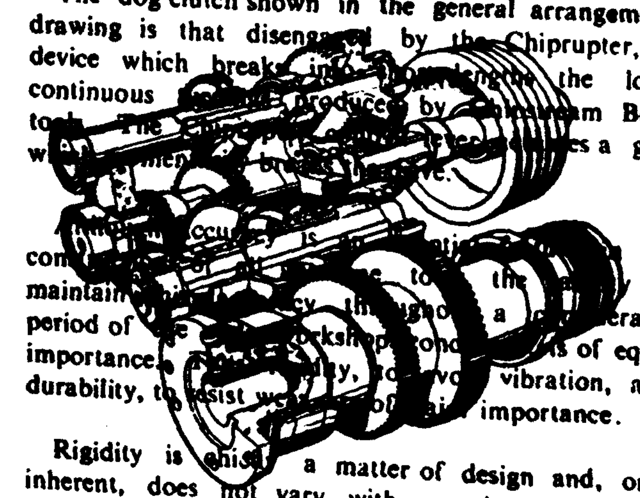
[illegible] shaft during engagement. Driving pressure is self-contained within the clutch and does not put any end load on the shaft.

Maintenance and adjustment is simple.

A constant-torque ball slipping clutch is fitted to the feed drive shafts on all the larger Herbert Lathes. This clutch limits, to a predetermined load, the torque transmitted and so protects the machine in the event of the operator permitting the saddle to run into an obstruction.

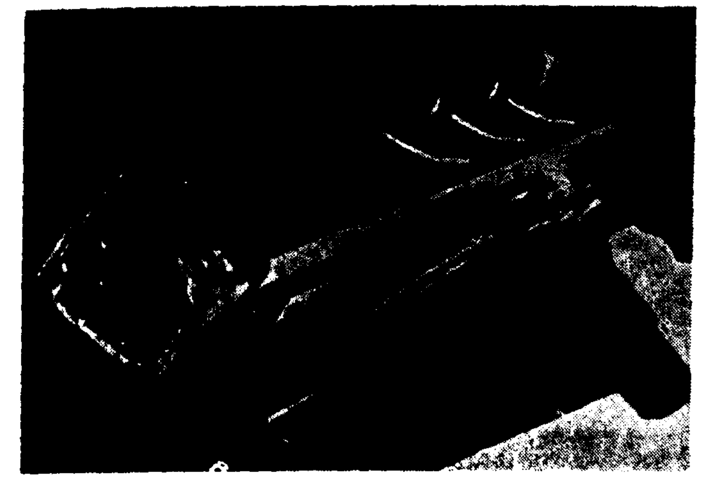
The testing of the predetermined load is shown above. A hydraulic gauge is mounted in the turret and the feed is engaged to bring the gauge into contact with the steel block gripped in the chuck. The clutch, in this test on a Herbert No. 4 Senior Preoptive Lathe, slips at 11 tons. On a Herbert [illegible] Combination Turret Lathe the load is [illegible]

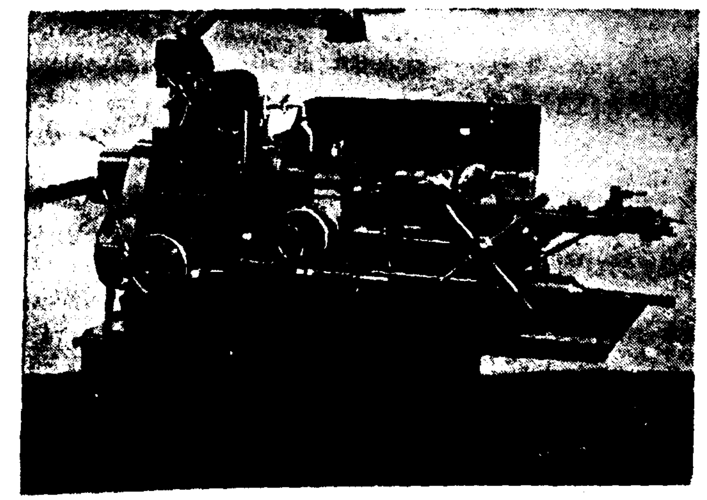
The dog clutch shown in the general arrangement drawing is that disengaged by the Chiprupter, a device which breaks [illegible] the long continuous [illegible] produced by [illegible] Box-tools. [illegible] a glut [illegible]



[illegible] accuracy is [illegible] the [illegible] to the [illegible] to maintain [illegible] a [illegible]rable importance. [illegible] of equal durability, to resist wear [illegible] vibration, and [illegible] importance.

Rigidity is [illegible] a matter of design and, once inherent, does not vary with varying conditions.





HERBERT No. 2D CAPSTAN LATHE

This is a 1½" bar or 9" swing capacity lathe, ideal for batch production methods requiring frequent changes of set-up. Sixteen speeds, 50 to 2,550 r. p. m.; eight speeds, forward or reverse, obtained instantly without stopping the spindle.

This lathe is easy to set and simple to operate. It is capable of precision production on materials ranging from non-ferrous metals to stainless steel and its general design permits close limits to be held and maintained throughout a production run.

The machine illustrated has a long bed which increases the distance from the spindle to capstan from 18¾" (standard machine) to 26¾" and is fitted with an automatic traversing saddle. Accurate control of the transverse movement of the cross slide is provided by a large micrometer dial. This control is provided on the standard machine but an alternative fitting is the patent duo-rate cross slide which provides a fast approach and fine machining feeds.

foundations on the larger machines being considered as an integral part of the machine structure. Durability, however, is never absolute because wear

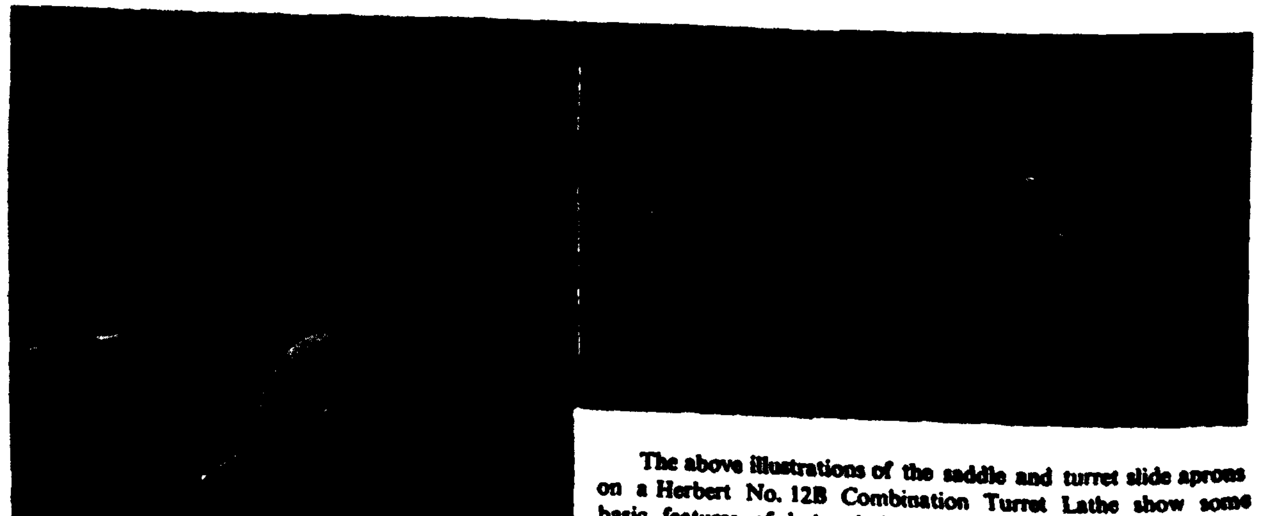
is always present where sliding members are involved and is progressive. Thus the machine-tool maker must combat wear by means of hardened and protected surfaces and efficient lubrication systems.

The quality of wear resistance or durability of sliding surfaces is assisted in Herbert Lathes by the Flamard process which considerably increases the wear-resisting qualities of cast-iron, without detracting from its other excellent properties. This hardening process is applied to bedways and other slides, to the mating surfaces of the turret and top slide and to spindle flanges. Wear has been practically eliminated by this process, for a check-up on a Herbert Lathe with "Flamard" bed after fourteen years continual use, confirmed that the alignments were still within the original limits.

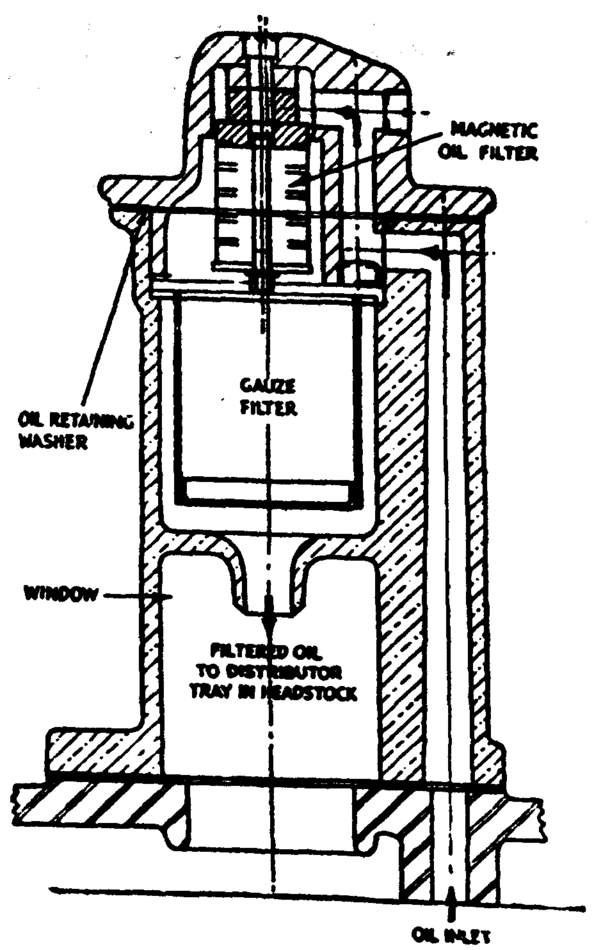
The above illustrations show the bed for the Herbert No. 7 Preoptive Combination Turret Lathe, the protection of the asymmetric bedways by a cover attached to, and moving with, the saddle at the headstock end and the depth of hardness on the bearing surfaces of the bedways.

Haphazard methods and sole dependence on the machine operator for proper and adequate lubrication have been replaced by automatic continuous lubrication to important mechanisms. The operator is now responsible only for either topping-up oil reservoirs or operating an oil pump once every four hours.

An important unit in the automatic lubrication system to the headstocks of Herbert Capstan, Turret and Auto-Lathes is the indicator, which serves the dual purpose of filtering the oil, through gauze and magnetic filters and providing a visual indication that the pump is working. In this system an oil pump forces the oil to the indicator and so to a distribution tray from which it cascades over the gears, clutches and bearings. Oil is also fed through the shafts and ejected through various orifices by centrifugal force to ensure further distribution of oil to the different moving parts.



The above illustrations of the saddle and turret slide aprons on a Herbert No. 12B Combination Turret Lathe show some basic features of lathe design common, where applicable and necessary, to most types and sizes of Herbert Lathes.



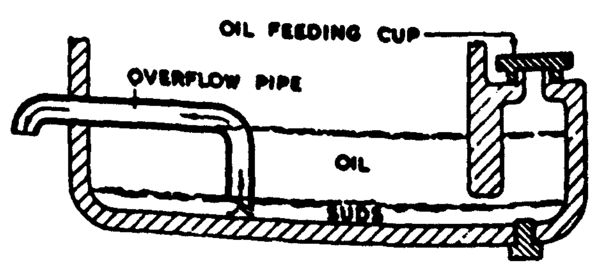
These features include:—

(*a*) Adequate protection of sliding surfaces such as the cross slide and mating slides of the saddle and turret slide with the bedways, to prevent ingress of fine chips between the mating surfaces.

(*b*) Wipers are fitted at the right-hand side of the saddle and both sides of the turret slide mating with the bedways. Bed covers are attached to the left-hand side of the saddle. The bottom slide on the saddle has been extended on the No. 12B (see left-hand illustration) to ensure full support to the cross slide at its extreme rear position and to avoid the wiper J extending beyond the end of the bottom slide.

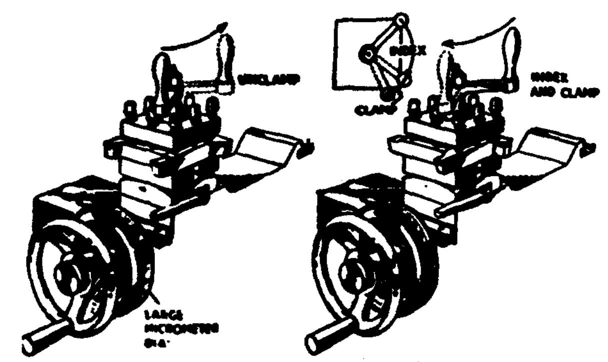
(*c*) Each apron has an oil reservoir for splash lubrication of the apron mechanisms. The overflow pipe for each reservoir also assists in draining any soluble-oil coolant which may penetrate into the aprons. The coolant, after a period of idle time, will separate from the oil and sink to the bottom of the sumps; the overflow is arranged so that when new oil is poured into the reservoir the coolant is forced out through the overflow pipe (*see below*).

(*d*) Longitudinal feeds of saddle and capstan or turret slide are accurately controlled by



"barrel-type" trip or dead stops. The fitting of barrel stops on the capstan slide has numerous advantages. They are more precise (being in-line with the thrust of the tools), contact with the trip stops is totally enclosed (chips cannot be trapped between the contact faces, neither can the operator's fingers) and are easy to set.

(*e*) The turret slide clamp lever locks the slide to the bed. Under extremely severe cutting conditions such as using a revolving centre in the turret, the clamping of the pilot-wheel shaft to its supporting boss, is advisable due to the high ratio of gearing in the turret slide apron.



The average machine-tool is occupied in cutting for a surprisingly short period of a working shift consequently anything which reduces non-cutting times increases the productive capacity of the machine. Herbert designs ensure that controls are readily to hand and are instinctive, operation is easy and precise, without mental or muscular fatigue. It is surprising how the shape of a knob will affect production on a fast-cycle, manually-operated machine.

A standard feature of Herbert Lathes is the quick-acting square turret, illustrated above. One forward and reverse movement unclamps, indexes and clamps the turret. Cross-slides are fitted with a large micrometer dial. The dial has widely spaced, easily-read .001" graduations on a surface of satin finish chrome plating. The graduated ring is adjustable on the periphery of the dial disc so that it can be set to zero at any position of the cross slide.

Accurate indicators are fitted to this dial, also to the capstan slide pilot wheel to assist in repetition machining to close limits. The indicators on the dial avoid dependence on the operator's memory whilst those on the pilot wheel eliminate independent measuring of lengths machined in the work. The dial and indicators also simplify setting the machine trip and dead stops.

The tool clamp screws on the cross-slide tool posts have ground threads. After years of continual use, little damage is caused to screw threads and tapped holes in the toolposts. Their replacement is necessitated only by burred heads (caused by using incorrect spanners) and stepped contact clamping faces (caused by clamping on the edges or steps of tools).

All cross slides on Herbert Lathes (except the Nos. 0 and 1 Capstan Lathes, which are of cast-iron) are machined from forgings, approximately 212 Brinell, to ensure maximum strength and rigidity. One forging from each batch is laboratory-tested, a procedure followed with all deliveries of raw materials to our works.

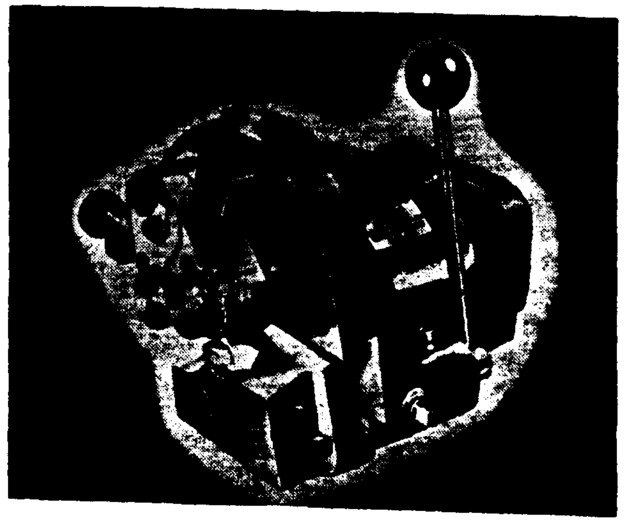
Efficient production is as much dependent on the tooling as on the machine—Herbert tooling is designed to ensure the maximum productivity.

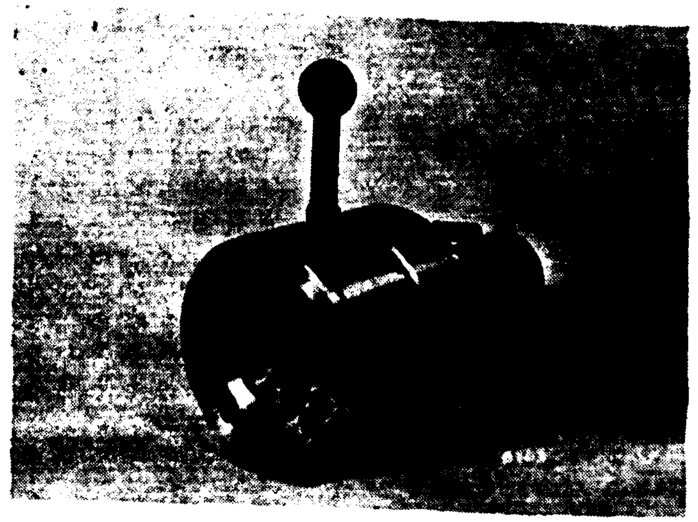
Tools can be set, clamped and used to take full advantage of the power available at the spindle.

Standard outfits of tools for barwork or chuckwork are available for each size of machine and will deal efficiently with all normal work. Coventry Dieheads and genuine Coventry Dies will cut good threads at high rates of production in any material which can be threaded. Ardoloy, Chipsteam and Microbore tools are highly developed to meet modern production requirements.

Many other features contribute towards general durability of Herbert Lathes; for example:—

(*a*) Where desirable, knee and combination toolholders are made of light metal, as





strong as, but 60% lighter than similar sizes of cast-iron holders. Thus in addition to reducing operational fatigue, wear on the capstan indexing and locating mechanism is minimised due to the reduction in weight, inertia and momentum.

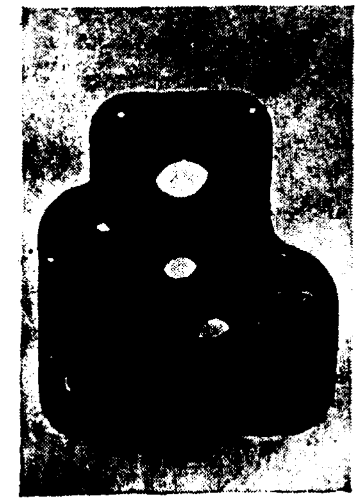
(b) Interlocks prevent the simultaneous engagement of two speeds or feeds, or prevent gear changing until the clutch drive is disengaged.

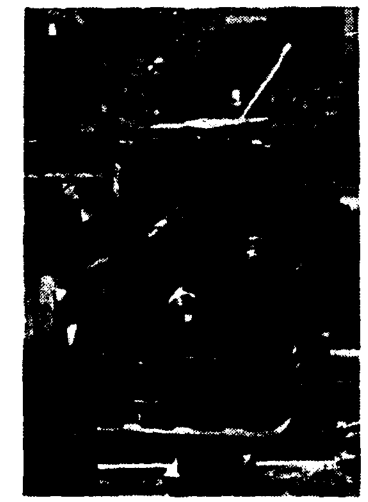
(c) Combination Turret Lathes are fitted with a frictionless rotating turret which can be easily rotated by hand in either direction, irrespective of the weight or unbalanced mounting of the tools. (On unclamping the turret, a thrust race is held firmly against the underface of the turret.)

A single oil pump on the saddle and turret slide aprons on a Herbert 12B Combination Turret Lathe, lubricates the slides and gib strips mating with the bedways. Oil grooves zig-zagged to the full length and width of the slides and gib strips ensure distribution over the full contact area. Other moving parts such as the front and rear cross slide stop-bar bearings, rotating barrel stops and cross slide handwheel (saddle), turret locking, stop bar indexing and turret slide clamping mechanisms (turret) are also lubricated by these systems.

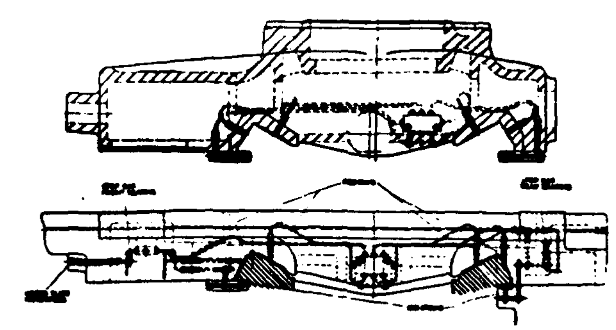
One stroke of the oil pump every four hours is sufficient.

This efficient single-shot lubrication system is also standard on the Herbert No. 5 Senior Preoptive Capstan Lathe and is a feature of design which has achieved a greater significance by the evolution of new machining techniques which today subject the machines to far more exacting conditions than those previously experienced. This method of pressure lubrication has been developed on most Herbert





This illustration shows the front cover removed from the Capstan Slide apron on a Herbert No. 4 Senior Capstan Lathe. Automatic feed is engaged by moving a small lever 45°, to rotate the detent pin "g" which, when the cover is fitted, is in the centre of the glut G to lift the worm box and thus mesh the worm and wormwheel. The drive is mechanically held by the retaining latch B, as shown at "b". Another lever on the saddle apron, through the pin "d", moves the cluster gear carrier D longitudinally along the splined feed shaft to bring either the fine or coarse feed spur gears into mesh. (Coarse feed is obtained when gears E and F are meshed.



Lathes to an ultimate which, with the Herbert system of Headstock lubrication, is conducive to prolonged life of the machine and accuracy of its products.

The power feed to the capstan slide is from the feed shaft through the spur gearing, worm and wormwheel and through gearing to the top pinion shaft which meshes with the rack bolted to the under-side of the capstan slide. After the completion of the forward stroke of the capstan slide, the feed is automatically tripped by an adjustable stop in the rotating barrel at the end of the top slide, which contacts a trip lever which rotates shaft A to press the plunger "a". The downward movement of this plunger rotates the trip plate under the retaining latch B to permit the worm box to drop and thus bring the worm out of mesh with the wormwheel. Rapid disengagement of the drive is ensured by the spring S.

This simple and very effective method of tripping feeds, generally known as the drop-out worm, is extensively used, not only in the Capstan Slide apron, but in saddle and turret slide aprons on Herbert Capstan and Combination Turret Lathes fitted with power feed. In these aprons the worm boxes are mounted on ball bearings and the worm shaft in the worm box is provided with ball thrust bearings.

Ball-bearing mounts considerably reduce loads and, consequently, the rate of wear and power losses, but the extreme importance in fitting them to apron worm boxes is that they minimise friction, a desirable factor to ensure an efficient, rapid automatic reverse feed disengagement. Immediately a forward power feed is tripped, the drive tends to throw out the worm whereas on a reverse feed, the frictional tendency is for the worm to remain in engagement with the wormwheel.

On Herbert Lathes fitted with quick-power traverse an interlock is incorporated into the turret slide drive mechanism to disengage the pilot wheel automatically when either the power feed or quick-power traverse is selected. This is a safety precaution primarily to safeguard against injury due to a rapidly rotating pilot wheel when the quick-power traverse is operative. An oil dashpot is also fitted into the quick-power traverse selection mechanism to ensure that the pilot wheel clutch remains disengaged until the turret slide is stationary.

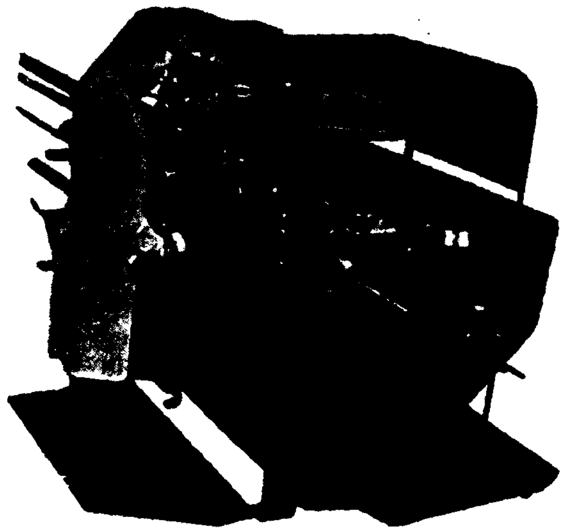
All essential features are incorporated to safeguard the operator against lack of vigilance or the unforseen. Particular attention is drawn to :—

(a) Complete enclosure of tools and work during operation. The front guard is provided with a window to give full view of the work when in position.

(b) Protection of rotating shafts slides and covered bedways.

(c) Chip deflectors on Chipstream Boxtools, a safety precaution which, with the Chiprupter, avoids injury from the long coiled turnings produced.

Notice also the compactness of design and that



all operating controls are within easy reach of the operator.

The Herbert No. 5 Senior Preoptive, shown above, is a masterpiece of Capstan Lathe design. It incorporates all the basic and proved features of Herbert designs and numerous new developments to meet specific requirements of users. These include:—

(a) Automatic sliding and surfacing saddle with or without chasing and taper-turning attachments. The taper-turning attachment is supplied complete with a special square turret and is mounted on the cross slide in place of the standard turret, a development which simplifies setting and operation.

(b) Cross and longitudinal feeds to the saddle are independently reversible to the longitudinal feed of the capstan slide. Thus either of the cross slide tools can feed transversely towards the work at the same time as the capstan tools feed towards the headstock.

(c) Automatic trip to chasing mechanism, when fitted.

(d) Automatic clamping of hollow turret. The hollow construction permits bars to be passed through, when required.

(e) Leader control to capstan slide if required. Of extreme advantage in precision cutting of threads requiring a number of cuts, when using a diehead or collapsing tap.

Equally important and well-known Herbert features are a diagonally-braced bed, large chip clearance, transverse adjustment of square turret and longitudinal adjustment to rear toolpost.

FURTHER DEVELOPMENT IN LD STEEL-MAKING PROCESS

A delegation of British specialists of the metallurgical sector has arrived in Austria to conduct negotiations on the granting of a licence for the industrial use in Britain of the Austrian LD steel-making process. The Austrian partners in these negotiations are the Austrian Alpine Montan Steel Corporation and the United Austrian Iron and Steel Works (VOEST).

Particular consideration in respect of British requirements will be given to a licensing of the recent further development of the LD-process, permitting the utilization of high-phosphorous-content pig iron for the production of top-grade steel. Other negotiations of the granting of foreign licences on the LD-process are under way with Portugal, Rumania, Hungary and Rhodesia.

* * *

QUICK METHOD OF EVALUATING ORES

The U. S. Bureau of Mines has developed a simple and accurate method for using X-ray equipment to analyse certain earth ores, metals, and compounds which are of growing military and industrial importance. The new technique makes it possible to analyse 40 samples in a single day. By contrast only about a dozen samples could be analysed in a week by methods formerly used.

The basis of the new technique, known as X-ray emission spectroscopy, is that every element has a characteristic, simple X-ray line spectrum. High energy X-rays cause the atoms of the sample to become excited and re-emit fluorescent X-rays, which are characteristic of the elements in the sample.

In the Bureau's method, these rays strike a special crystal, which reflects the characteristic line spectra of the various elements at different angles as its race is rotated Use of instruments of automation in the method virtually eliminates the chance of human error, and so within limits provides an accurate method for determining the purity and for making quantitative analyses of rare earth preparations. One of its advantages is the ease with which technicians can be trained to prepare samples and operate the X-ray machine.

MACHINE TOOLS

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

THE Machine Tool is the basis of modern civilisation. It is the Keystone of the arch for it brings into being the means of supporting human life under any but the most primitive of conditions. Without it every branch of the complex system of our present-day life would soon cease to function and the race will die.

Man must have agricultural machinery to grow his food and machinery to prepare it; textile machinery to clothe him; the printing machine for his intellectual pursuits and the dissemination of news. The amazing advances that he has made in transportation by land and sea, his achievements in the conquest of the air and the annihilation of space for communications are all attributable to machine tools.

MASTER TOOLS OF INDUSTRY

Alone amongst all the modern mechanical marvels the machine tool can produce machinery and can even reproduce itself. So is justified the claim that machine tools are the master tools of Industry. They have removed drudgery from metal working operations, multiplying man's efforts manyfold.

Machine tools are as basic as metal, coal, oil, water or electricity. The lathe, drill press, planer, milling machine and grinding machine, in many types, styles and sizes, are basic commodities to be reckoned with before industry can start production. Furthermore, the ability of industry to expand or to produce new or improved products is dependent on the machine tool industry to first furnish the necessary tools.

CLASSIFICATION OF MACHINE TOOLS

In simple terms, a machine tool is a mechanical device designed to perform some tooling operation, and so far as the engineer is concerned this usually consists of the cutting or shaping of metal.

Machine tools, which are in use to-day, can broadly be divided into three main groups depending on different tooling operations.

(1) Machine tools for metal-cutting shaping:

(a) Lathes, Turret and Capstan lathes, and Automatic lathes.
(b) Shaping
(c) Planing
(d) Milling and combined Boring and Milling machines.
(e) Drilling, Boring and Tapping machines.
(f) Sawing, Filing and cutting-off machines.
(g) Grinding, Lapping and Polishing machines.
(h) Slotting and Broaching machines.
(i) Gear Cutting machines.
(j) Screw cutting machines, etc.

(2) Machine tools for non-cutting shaping:

(a) Presses
(b) Drawing machines
(c) Power hammers, Drop stamps, etc.
(d) Rivetting Machines
(e) Sheet metal working machines like can making
(f) Wire working, wire converting machines and wire and strip forming machines.
(g) Bolt forging and heading machines.
(h) Special machinery for the manufacture and subsequent treatment of tubes etc.

(3) Special purpose machine tools:

(a) Railway wheels and axle lathes.
(b) Tyre Boring Mills.
(c) Vertical spindle surfacing machine for use in the manufacture of grinding wheels.
(d) Diesel-engine crankshaft-forging Gashing machines

Special purpose Machine Tool — Railway Axle Burnishing Lathe made By Maschinenfabrik Deutschland, Dortmund (Germany)

(e) Locomotive Frame plate combined slotting and Milling machine.

(f) Double-headed Turbine Rotor and slot milling machines, etc.

The chief of the fundamental machine tools are the lathe, the shaper, the planer, the drilling machines, the slotting machine, the grinding machine and the milling machine. An engineering workshop equipped with no more than these can perform a very great number of operations which are generally encountered in such a place.

The lathe is the most generally useful of the machine tools and is alone capable of performing a very large number of operations. It is also considered as the parent of all machine tools and from it have been derived the drilling, milling, screwing, sawing and grinding machines in addition to the boring machine.

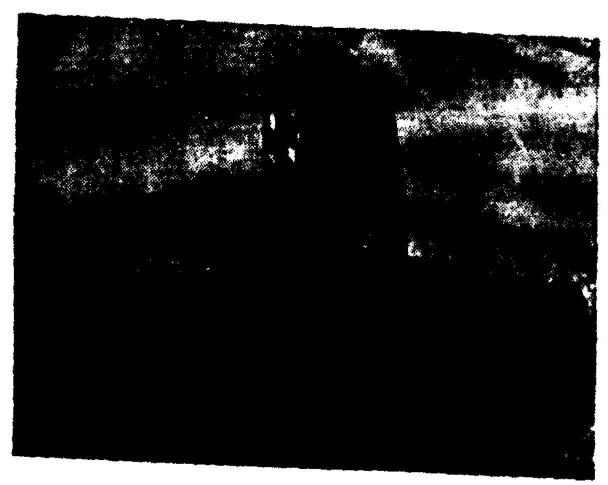
The need for producing flat surfaces - which prior to the early 19th Century had to be laboriously chipped and filed—gave birth to the family of reciprocating machines, the shaper, planer and slotter. In the shaping machine the cutting tool move in a straight-line backward and forward motion and cuts on the forward stroke only, the return stroke being idle. The planing machine is similar to the shaping machine in so far that it has a straight-line back and forward motion; but whereas in the shaping machine the tool moves over the work, in the planing machine the work moves under the tool. In the slotting machine the work is fixed and is machined in a vertical and downward direction by means of a vertically moving tool. This machine is not used to the same extent as the planer or shaper, but is employed mainly for working on heavy parts or those which cannot be conveniently tooled on any other type of machine.

The milling machine resembles the planing machine in that the table carrying the work moves under the tool, but in its case the tool takes the form of a revolving cutter mounted on a rigid mandrel or arbor supported by the framework of the machine.

Drilling machines had made in a large variety of sizes and types, from the small sensitive drill running at high speed for light work, to the large radial machines for heavy work. The majority have a single spindle and drill only one hole at a time, but some have a large number of spindles, so that a dozen or more holes can be drilled simultaneously in their correct relative positions in the same piece of metal.

PROCESS OF EVOLUTION

The process of evolution of the machine tool from its crude beginnings has been governed by a multiplicity of factors. The first was of course the economic factor. With the universal spread of mechanisation and the multiplication of competitive factories, need was greatly felt for cheaper and more rapid production. To meet this demand, new and improved types of machine tools where evolved, in which the aim was always for saving labour costs, either in the form of speedier output per machine, or by so simplifying the machine that a lower grade of labour could be employed to operate it or that two or more machines could be managed by one man.



Modern Planing Machine designed by Reichle & Knodler.

Progress in machine tool design has been punctuated by the appearance of high-speed tool steels in 1901 and the introduction of synthetic cutting alloys, e. g. the tungsten-carbide class in the late twenties. Evolution of electric motor driving and the perfection of ball and roller journals, now almost universally used in machine tools for all but the slowest running spindles, have brought about further revolutionery changes in machine design.

In regard to methods of feed, whilst the rack or screw still remains very popular, the hydraulic method is being used in certain cases. The rate of feed is controlled by means of a throttle valve in the oil-pipe line between the pump and cylinder. The use of self-engaging and cam feeds and the control of feeds by limit electric switches are the other directions in which the development of machine tool design has proceeded.

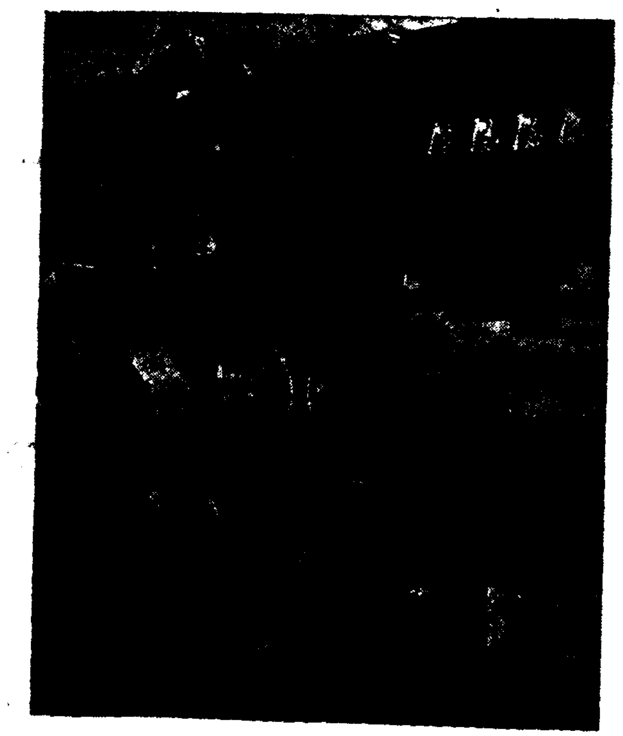
Considerable attention has been paid to obtain increased accuracy and fine finish, together with

reduced maintenance cost. The weight of a machine tool in relation to its capacity has also been given an equal importance. The importance of solidity, rigidity and freedom from vibration, particularly in large heavy-duty machine tools is considered indispensable if the best results are to be obtained.

Variable-speed motors, with Ward-Leonard or other control systems to give a wide motor speed range, have been used in many instances to give improved stepless ranges and independent electrical feeds have simplified mechanical design and improved selectivity.

Amongst the other improvements that have been taken place are the numerous applications of electronic methods of control and measurement, and many automatic copying and profiling devices fitted to lathes, milling machines, boring and turning mills, etc., and rapid power adjustment for reducing setting-up times.

Improved lubrication system incorporating pressure supply of filtered oil to the principal rotating and sliding parts for maintaining them in a proper state of lubrication, has been developed along with safety signal lights.



Wickman Chucking Bar Automatic — Six Spindle Version — showing the Tooling Area. The Machine is designed for Fast, Accurate, and Economical Machining of Castings, Forgings, Billets and Pressings.

Machine tools have become progressively complicated during the course of development. To-day cross-planing, vertical planing, auxiliary milling, grinding and slotting heads, are standard fitments of large Planing Machines; screw-cutting, coning, milling, grinding, contouring and auxiliary central boring spindles, constant cutting-speed control are all available on Vertical Boring and Turning Mills; and electrical cross-slide locking with all machine motions actuated by independent motors, interlocked and push-button controlled feed, quick traverse and adjustment mechanism, etc., etc., are all now normal practice.

In addition to the mechanical efficiency of the machine itself, safety and comfort of operation have received careful attention, as it has long been accepted that such working conditions for operators are not merely humane, but also help in obtaining increased production.

Another factor which has largely influenced the machine tool design is the mass demand for such products as motor car, resulting in the automatic and semi-automatic machine specially designed for mass production. As each new engineering field has developed, the machine tool maker has kept pace with or anticipated machining requirements.

In concluding this paragraph, it may be stated that throughout the process of development, a technical perfection with considerable improvements in the design features, has already been achieved although the designers are still working all over the world to make them better and better. For achieving high efficiency, the aim has been to develop the machine on the following three main lines:

(a) More powerful and rigid design to keep pace with the development of tools.

(b) Adopting semi-automatic and automatic working methods to make the machines fool proof and absolutely independent of skilled labour.

(c) Designing the Machine Tool as a special or single purpose machine to achieve the largest possible output.

FUTURE TRENDS IN DESIGN

Predicting about the future trends of design, it may be said that a stage has now been reached whence further development may proceed in two divergent directions.

(Continued on page 96)

The Manufacture of Parkson Plain and Universal Millers, Sunderland Gear Planers, Dividing-Heads, Gear Testers and Vises

[I]

IT is undisputed that numerous businesses today enjoying a world-wide reputation for their products began in a quite humble way and owe their present success largely to the enterprise, originality and character of their founders. This is particularly true of the British machine tool industry in which many well-known firms started modestly with little more than enthusiasm and an unlimited capacity for hard work, and have since steadily progressed under the personal direction of several generations of their founders' families.

Such a business is that of J. Parkinson & Son (Shipley) Ltd., founded by Joseph Parkinson in 1867, and some brief account of its earlier years should be recorded before lengthening memories of living personalities blur the details of an interesting story.

Strangely enough the firm at its inception had no real connection with the manufacture of machine tools, for Joseph Parkinson then acted as agent for Singer domestic sewing machins, for which he developed a thriving sale in and around Bradford. As sales and demand increased, repairs to the machines were also undertaken with the aid of two mechanics.

The next step saw the business engaged in the actual manufacture of domestic sewing machines, which led ultimately to the construction of industrial

(Continued from page 95)

On the one hand people are becoming more and more "automatic minded" and as such a trend towards automatic operation, maximum utilisation of horse-power, the ultimate in speeds and feeds, and all other features which contribute to the highest possible productivity in mass production operations, is generally expected.

The possibility of calling for simplification so as to produce simple but effective range of machine tools, cannot also be ruled out altogether.

In features worthy of further investigations are included the provision of automatic operating facilities, reduction of setting time as also of loading and unloading, gauging and checking, etc., and the ease of chip removal.

The Germans seem intrigued with full automatic operation and have given a considerable attention to what they call "programming" machines and establishment of a push button factory since, based on electronics, these machines are activated by a series of push-buttons to perform a multiplicity of pre-selected operations automatically.

MOTHER OF INTERCHANGEABILITY

The machine tool is the mother of interchangeability. Its accuracy and productivity make possible mass production. The progress in precision achieved from dimensional limits of ·040" in 1770, when James Watt built his steam engine, to the present day limits of ·000025", is by no means less spectacular.

To-day machine tools do their work so accurately that no hand fitting is required during assembly; therefore by reducing time and expense during manufacture, more goods are brought to market to millions of people who could not have afforded them if it were not for the accuracy of the machine tool in making interchangeable parts a reality.

Without the machine tool the engineer would be stripped of his power and opportunities. Every tools, machine, and material used by the engineer to accomplish his purpose stems directly from Machine tools or was evolved from machines which themselves were produced by machine tools.

From the machine tool flows every object of our industrialized world. More than anybody thinks, our machine tools are influencing our time, our culture and civilisation. Without them our mechanised society would slowly grind to a halt.

models for the quilting of coat linings and bed covers. These large sewing machines carried from 80 to 120 needles each. But a change in the world of fashion, principally the decline of the once popular Victorian crinoline, brought disaster to that venture with the consequent end of the sewing machine chapter.

THE FIRST MILLING MACHINE

This period, however, laid the foundations of the machine tool business which is carried on today, since it was from the necessity for performing milling operations on sewing machine components that there emerged one of the first milling machines ever to be designed and made in England. Originally the operations were done on improvised appliances set up on centre lathes; but it later became apparent that a milling machine would be more suitable for the purpose.

At that time Joseph Parkinson had as a foreman a man who constantly pressed for the purchase of a milling machine, but the requisite money could not be spared. Ultimately it was decided to build one on the premises and this foreman made practically all the drawings and patterns for it himself. Having obtained the necessary castings from an outside source, he and Joseph Parkinson themselves undertook almost all the machining and fitting.

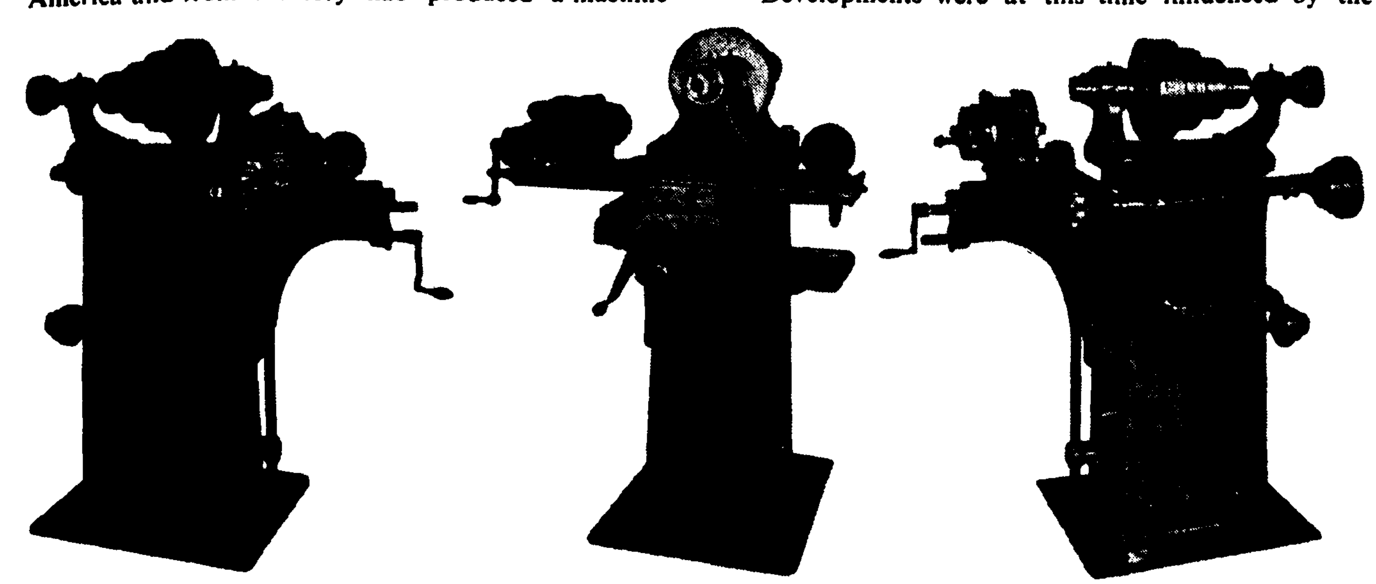
Not until some time afterwards did it transpire that the foreman, Bill Allen, had previously worked in America and from memory had produced a machine similar indeed to an early type universal miller originating from the Brown & Sharpe Company. This first machine, now an honoured historical exhibit at the Shipley works, is illustrated below and it is interesting to note here that the firm have made both plain and universal milling machines uninterruptedly since 1875.

In about the year 1884 a cone-driven back-geared universal miller, complete with dividing head, sold for £ 92 12s. 6d., packed and delivered f. o. b. London. While fundamental features of the machine today remain the same, how changed the design has since become and what a difference there is in price!

After the disastrous ending of the sewing machine venture Joseph Parkinson turned his attention to various textile machinery requirements such as "temples" "dobbies" and other accessories for the spinning and weaving trade.

Approaching these problems with little knowledge of the difficulties to be overcome his inventive genius had full play and he succeeded where many men of much greater experience had failed. For instance he evolved a temple (a tensioning device used in the making of velvet) which left no mark on the material and this proved an immediate success, bringing him much business. This particular incident is commemorated in the Parkinson telegraphic address which remains TEMPLES to this day.

Developments were at this time influenced by the

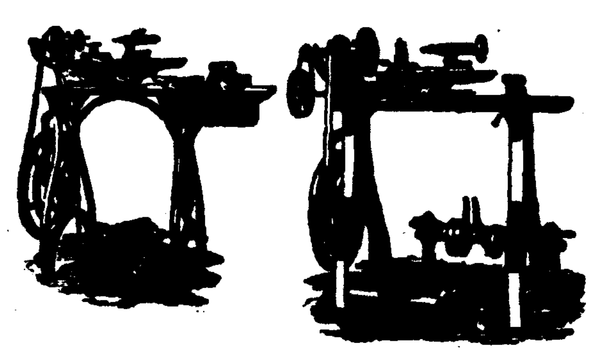


A "museum piece" still to be seen at the Shipley works is this original Parkson machine, one of the first millers ever to be designed and made in England.

era of the amateur mechanic and the vogue was for ornamental turning in ebony, ivory and metals with the consequent creation of a market for small treadle lathes for that purpose.

The design of the Handy lathe, the first of a series made by the firm to meet that demand, very obviously had been influenced by the earlier association with sewing machines. The Handy incorporated a number of unorthodox features in lathe construction and offered in a compact form advantages not secured by other makes, principally in an improved arrangement for 'gaps'. The bed was secured to the main casting by means of one bolt and made to slide on its ways to the right, extending its length to take 16 in. between centres with a gap 10 in. wide. When the gap was not required, or short work was to be done, the bed could be moved back and fixed by the bolt in much less time than was necessary to take out and replace ordinary gap pieces.

Greater and more uniform differences in speed were obtained by the movement of the foot, when the machine was used as a foot lathe, than with the usual construction. Moreover, as the cone and the driving wheel were on the outside of the stand, the belt could be more readily changed than when mounted inside, as was the more common practice. Another illustration of one of these early lathes with sliding saddle is given below.



(left) This Handy lathe, made by Joseph Parkinson in the 1880s, reflects in its design the influence of the treadle-driven domestic sewing machine. (right) A slightly later Parkinson lathe designed with sliding bed to give 16 in. between centres. The vise, thoughtfully provided at the right as a mechanic's accessory, was the forerunner of hundreds of thousands of vises since made by the company.

QUICK-ACTION VISES

In these illustrations it will be noted that the machines carry a table or wooden board and that towards the right-hand end of the table is a small parallel vise. This vise proved to be a happy inspiration that led to unforeseen and unexpected development. The table was made a little longer than the lathe so that the extra length served as a bench to take a vise: but as no suitable vise could be purchased, Joseph Parkinson designed and made one of the Handy type now so familiar in tool dealers' stores. An illustration of one of the larger models having a plain screw action is shown below.

(left) The simple Handy bench vise, having plain screw action has long been in demand because of its robust simplicity. (centre) The urge to save time even in hand operations at the bench was catered for by the introduction of the patented Perfect vise which speeded up clamping and unclamping of work by the aid of a withdrawable half-nut. (right) A version of the Perfect vise, having quick-action, large-area jaws and "under bench" construction, suitable for wood workers and sheet-metal workers.

Although at that time there was no idea of making and selling vises independently of the lathes, the idea developed when a commercial traveller from Sheffield called one day and said, "That's a nice little vise, What's your price for a gross ?". The manufacture of such a quantity had never been envisaged, but in due course a price was quoted and the order received, with the understanding that if the vises proved satisfactory further orders would follow. With somewhat limited reserves that the order naturally took a little time to fulfil. No complaint regarding the vises was subsequently received; but neither was a repeat order, nor even a reply, in spite of several letters written on the matter.

One day Joseph Parkinson, while in Sheffield seeking further business and waiting for an interview, saw a dray-load of vises, identical to those he had supplied, arriving at this firm's works. In due course at the interview he forcibly expressed his opinions of their conduct (the firm have since been out of existence for many years) ending with the statement "I'm going back home and will make a better vise, and this time I'll patent it so that it cannot be copied."

At that period, in the year 1884, when he lived at Shipley Glen a noted beauty spot about 5 miles out of Bradford, his only son, Ernest, was serving as an apprentice with Messrs. Darling and Sellers at Keighley. When Ernest arrived home that night from evening classes he found his father using the drawing board on the kitchen table, having just completed a drawing of a Quick-Action vise which incorporated a square thread and withdrawable half-nut. Joseph invited his son's comments and the conversation ran on these lines:

"Come and have a look at this lad."

"It looks very simple father. Are you sure no one else has thought of it before?"

"Well I don't know, but I have never seen one," said his father.

An inspiration then came to young Ernest, who often, in telling the story in later years, added that if he had not been learning about screw-threads at night school for several weeks and in particular that very evening had not been drawing the buttress thread, he would probably never have made the suggestion he did.

"Why not a buttress thread father; the strongest form of thread for resisting pressure in one direction ?"

Joseph thumped the table with his fist—

"You've hit it lad and we'll undercut a few degrees so that the greater the pressure the more the screw and nut are drawn into mesh." An application for patent was filed as soon as possible and in due course granted.

Plain screw vises without quick action are still made in a range of sizes under the original name 'Handy', while the Quick-Action vise, combining continuous screw and quick action is known in many countries as the 'Perfect' vise.

The Perfect vise combines continuous screw with quick action, a combination which has survived the test of time. Its leading feature is the undercut buttress thread screw and half-nut.

After early struggles, the Perfect vise began to sell and, as repeat orders came in, the inventor wrongly anticipated that within a comparatively small number of years he would have made all the vises the world required. Contrary to his expectations, there are probably more vises made today than ever before, but there are few tools of this type more badly abused. How often does one see a vise which has not had the elementary essential attention of a few drops of oil per week and how often is too small a vise used for the job in hand.

Bench vises for metalworkers and woodworkers and various types of machine vises—are also among the Company's specialities. Although vises are not machine tools and consequently have been dealt with only briefly here, this story of Parkinson activities would be incomplete without reference to their vise products.

The steady growth of the business made it necessary to seek better accommodation and in 1893 a move was made to Shipley where premises, though not ideal for the purpose, were made to serve immediate requirements, gradual additions and subsequent adaptations resulting in compact and conveniently arranged workshops and foundry.

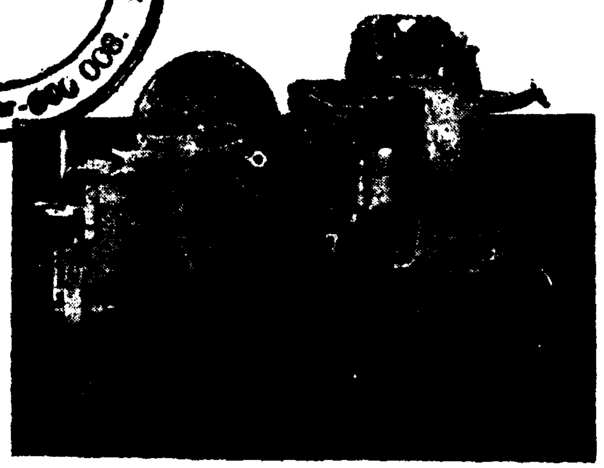
Concurrently with the manufacture and sale of vises, the young firm developed steadily as machine tool makers, undertaking to design and build almost any of the usual standard types for which they had facilities. In this way lathes, milling machines, shapers, slotters, horizontal borers and drilling machines brought in orders and provided employment to tide them over severe periodical trade depressions.

The advent of the bicycle boom and the consequent demand for machines needed to equip the cycle factories, advances in machine tool design following the introduction of high-speed steel, and the development of the internal combustion engine increased the demand for machine tools, and the worst of the lean years were past.

SUNDERLAND GEAR PLANERS

In the yearly years of this century a trade gear cutter, Sam Sunderland of Keighley, was pre-occupied with the idea of building a gear-generating machine that could use a cutter designed virtually as a section of a straight rack. He proved to be the first to succeed in this and actually made several machines to operate on this now well-known principle, for use in his gear-cutting business.

Now Sunderland happened to be a great personal



Although made nearly 50 years ago, this early Sunderland gear planer which is preserved at Shipley, can still produce spur gears of first class quality.

friend of Charles Henry Smith who for many years was the Parkinson chief draftsman; so it was not surprising that Joseph Parkinson and his son Ernest both became interested in the new gear-cutting machines. The method was then regarded as completely revolutionary—so much so that in the first year or two machines proved very nearly unsaleable in England.

Sunderland had no desire to make machines for sale, but Joseph Parkinson and his son had such complete faith in this principle of gear generation that they entered into an arrangement to make machines for sale in Great Britain and a number of other countries.

An illustration of the first Sunderland gear planer built at Shipley in 1909 is shown above. Although not now in use, the machine can be seen today at the works in complete running order and it is still capable of cutting a good gear.

The combination of the rack-shaped cutter with the planing method of gear generation undoubtedly had some effect on design. for it enabled more compact cluster gears to be made in one piece than was possible when the gears had to be cut by any type of rotary cutter. There were also other aspects of design generally that were affected.

The faith of the inventor and his manufacturing colleagues in this system has been amply justified by results, for it is true to say that there is no other single type of gear-cutting machine more widely known throughout the engineering world.

Reasons for the popularity and success of Sunderland gear planers are not hard to seek, some of the principle advantages being (a) comparatively simple low-cost cutters, (b) ease of setting up, (c) simplicity of cutter sharpening and (d) long life of cutters.

One cutter cuts all numbers of teeth of the same pitch, both spur and spiral, so that a small outlay in cutters covers a large range of work. Machines are easily set up for pitch, number of teeth, face width etc., and quickly changed from one job to another—a feature appealing specially to the trade gear cutter or jobber.

Highly skilled labour is not necessary and one man may easily look after two or more machines. A high rate of productivity is obtained at low maintenance, cutter and operating costs.

Sunderland gear planers were the first machines to cut successfully double-helical gears having continuous teeth, thus enabling the same efficiency to be obtained with a narrower face width of gear. Today they are made for spur gears only, spur and spiral gears, double-helical gears only, or any combination in sizes ranging from 12 in. dia. × 4 in. face × 5 d.p. to 15 ft. dia. × 30 in. face × 5 in. pitch for spur gears and 3 in. pitch for double-helical gears.

Joseph Parkinson did not live to see more than the first few Sunderland gear planers built, for he died in 1910 at the age of 66. In spite of failing health he took an active part in the affairst of the firm until shortly before his death.

Some time earlier he had taken his son Ernest into partnership and re-styled the business as J. Parkinson & Son. Ernest Parkinson like his father, had an inventive and practical mind, perseverance in gaining knowledge, ability to grasp the essentials of a problem and sound judgment in dealing with men.

Under his guidance up to the 1914-18 war, widely diverse types of machines were made and during the war period the greatest output was in shell turning lathes of different kinds. At this time he was chairman of the board of management of the Bradford Munitions Factory, being later awarded the O. B. E. for his work there.

(To be Continued)

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