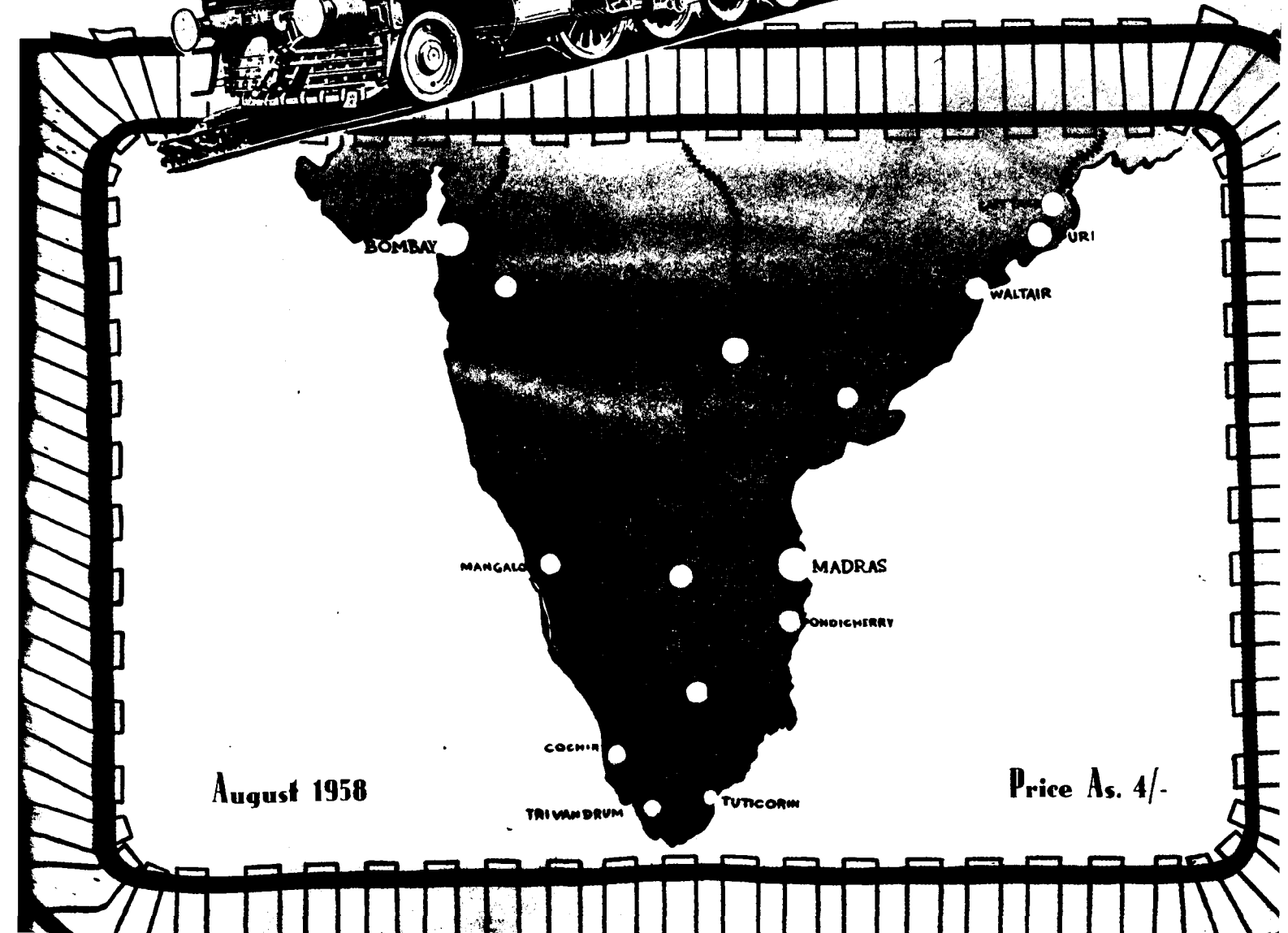
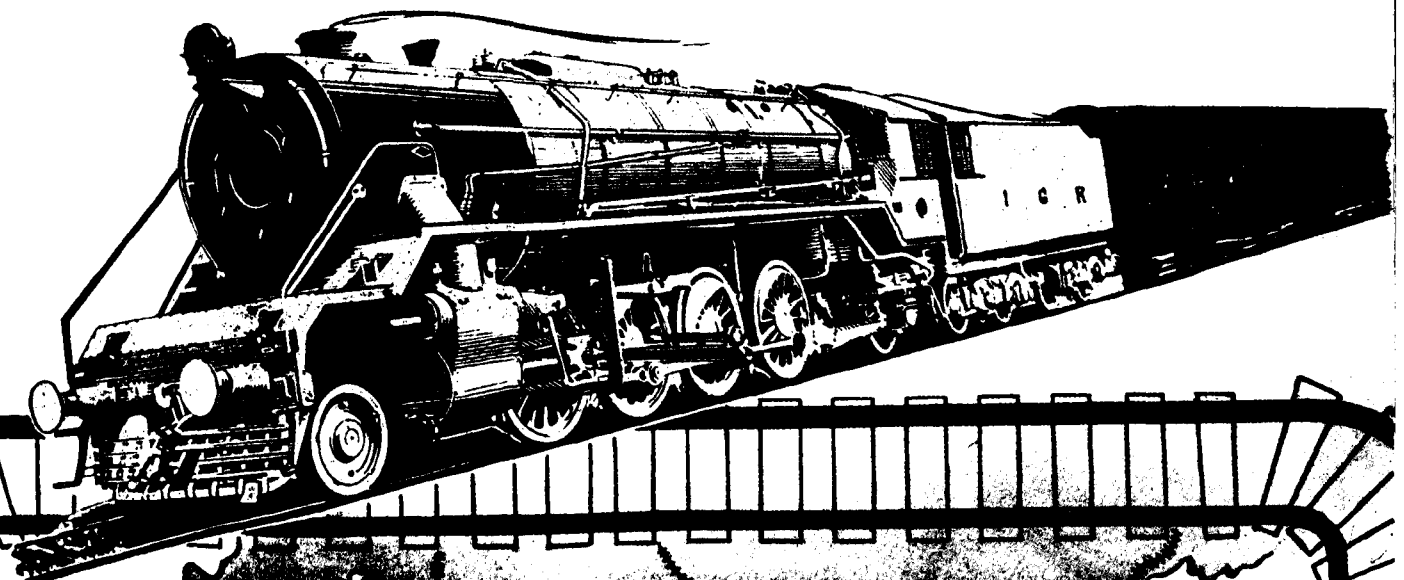


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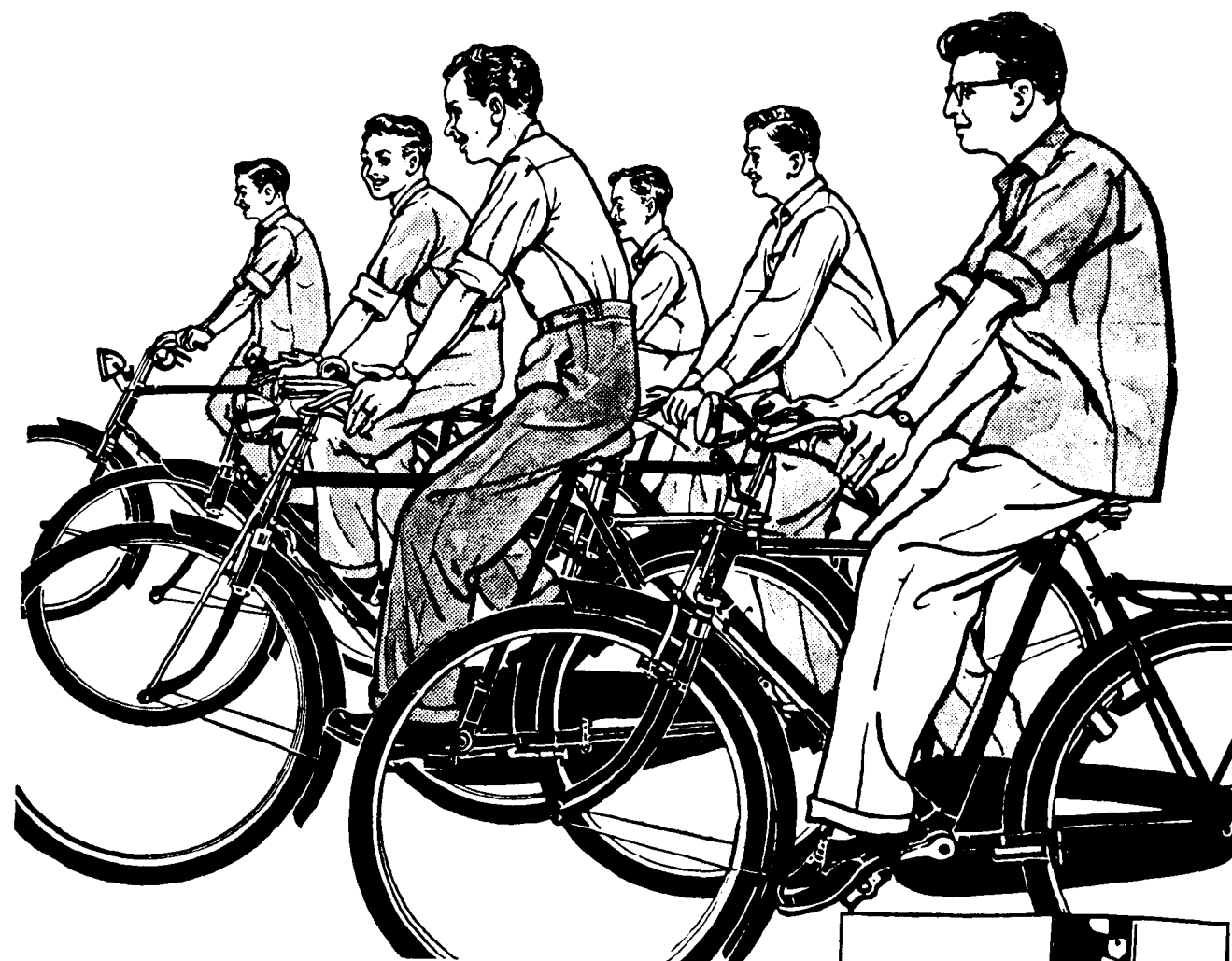
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Magazine



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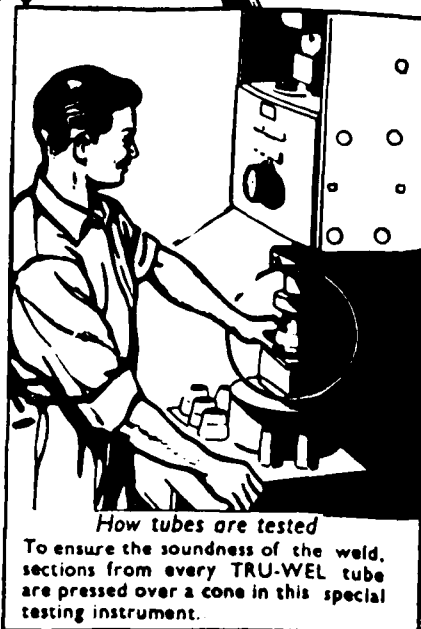
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INTEGRAL COACH FACTORY SUPPLEMENT

Vol. X No. 2 AUGUST 1958 Price 25 NP.

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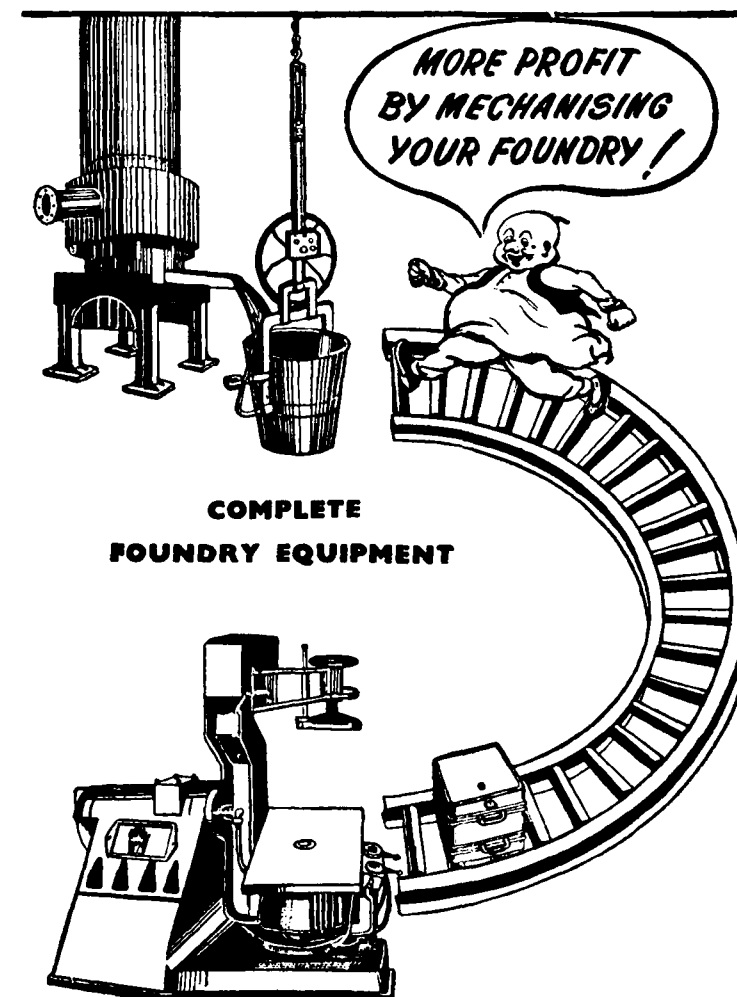
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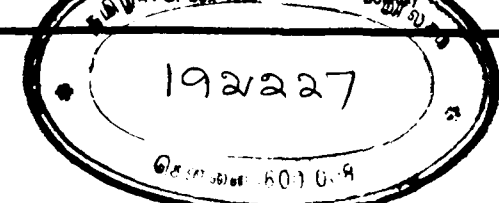
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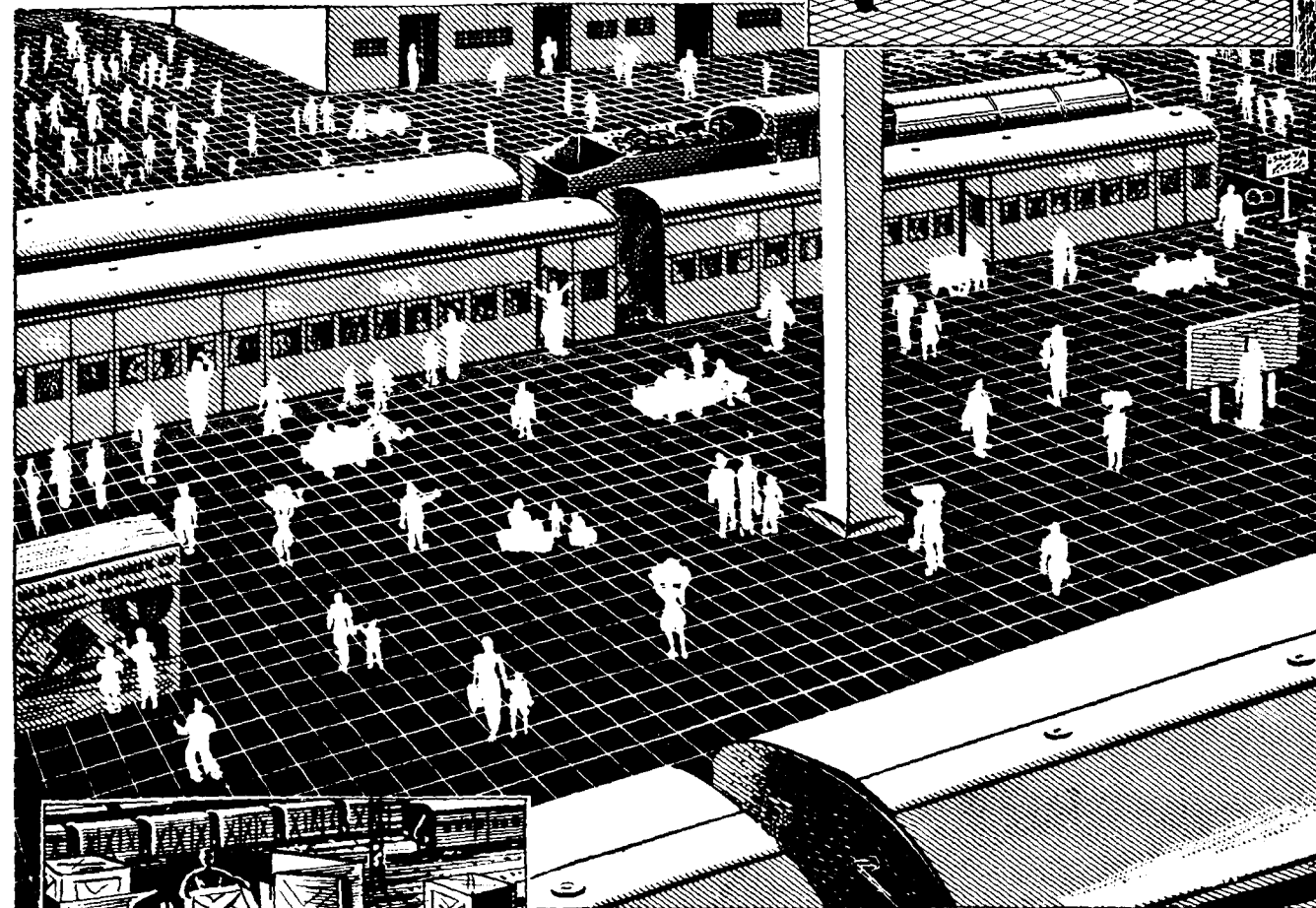
We have great pleasure in informing all our readers and advertisers that a Special edition entitled "MACHINE SHOP SUPPLEMENT" will be released for circulation along with our October 1958 edition sometime by the middle of November this year.

We need not over-emphasize that our Second Five-Year Plan — a gigantic task — that the nation has set itself to, calls not only for an all out effort from everyone but also calls for caution at every step. The enormous human material so also the economic potentials in the country are sought to be harnessed in the interest of evolving a prosperous socialistic welfare state and it is our duty to stand by and assist the government without demur in reaching that goal.

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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

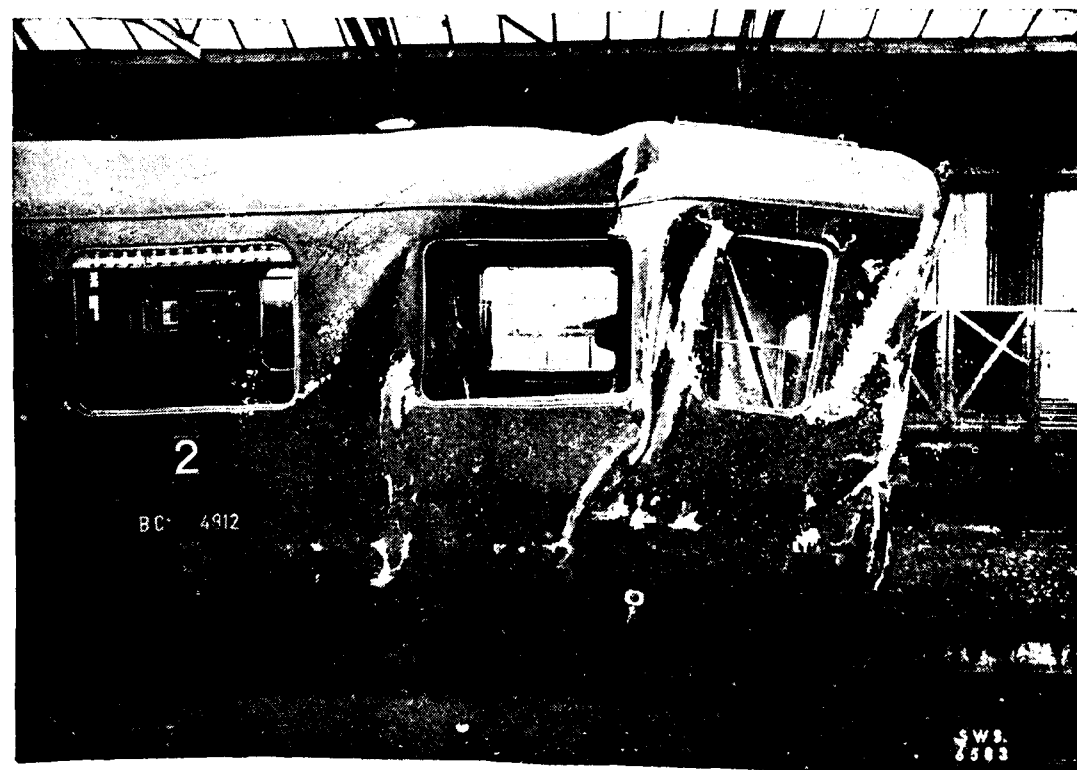


Fig. 1



Fig. 2

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.

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

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,

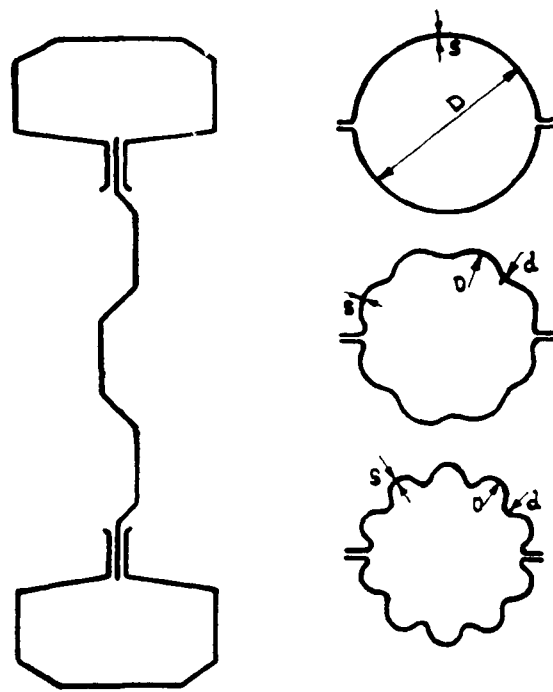


Fig. 3

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 dust-bins.*
- ★ *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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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.

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 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 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.

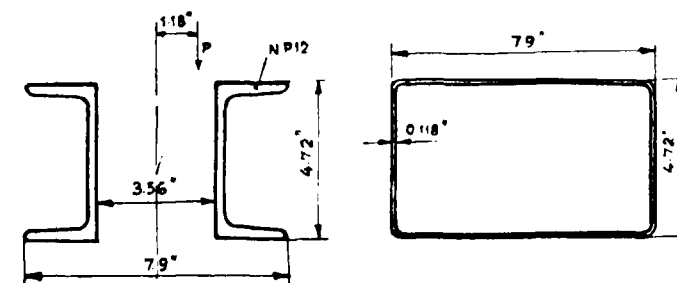


Fig. 4

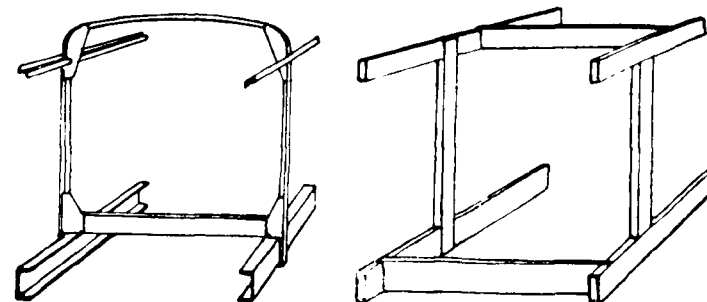


Fig. 5

Fig. 6

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,

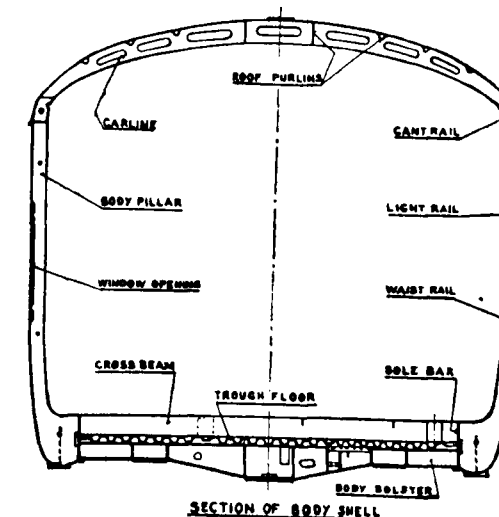


Fig. 7

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' 5 1/2"
Buffer height from Rail level	3' 7 1/2"
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

SPECIFIED LOADS

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

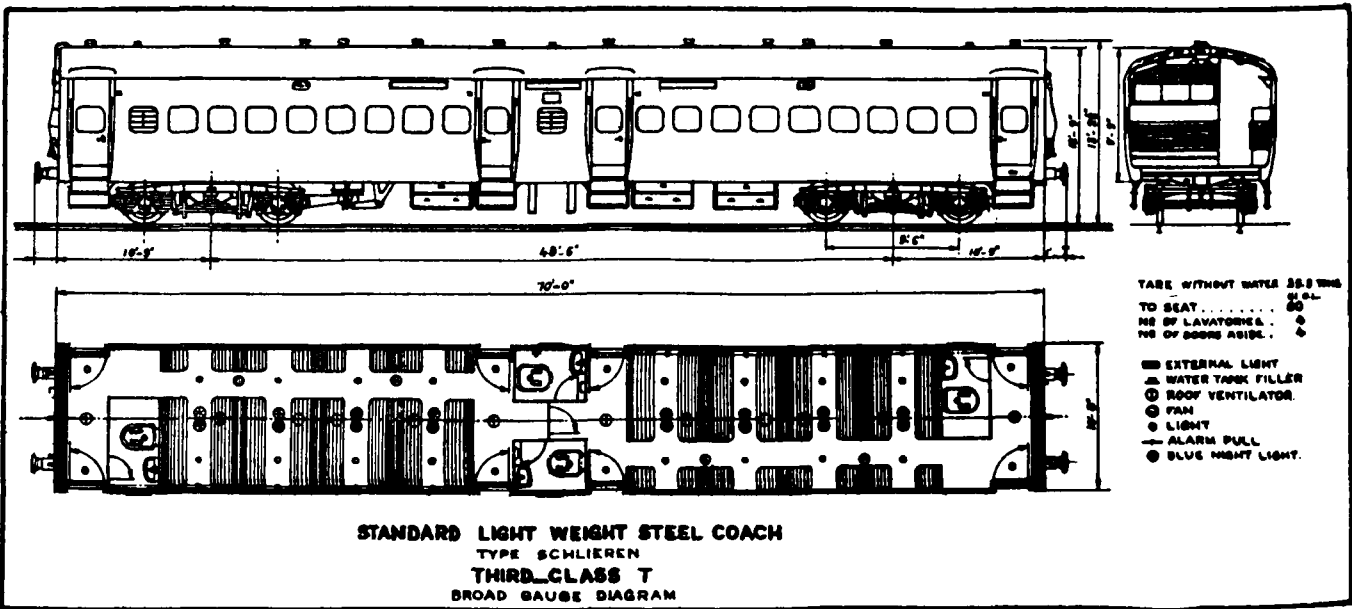


Fig. 8

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 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

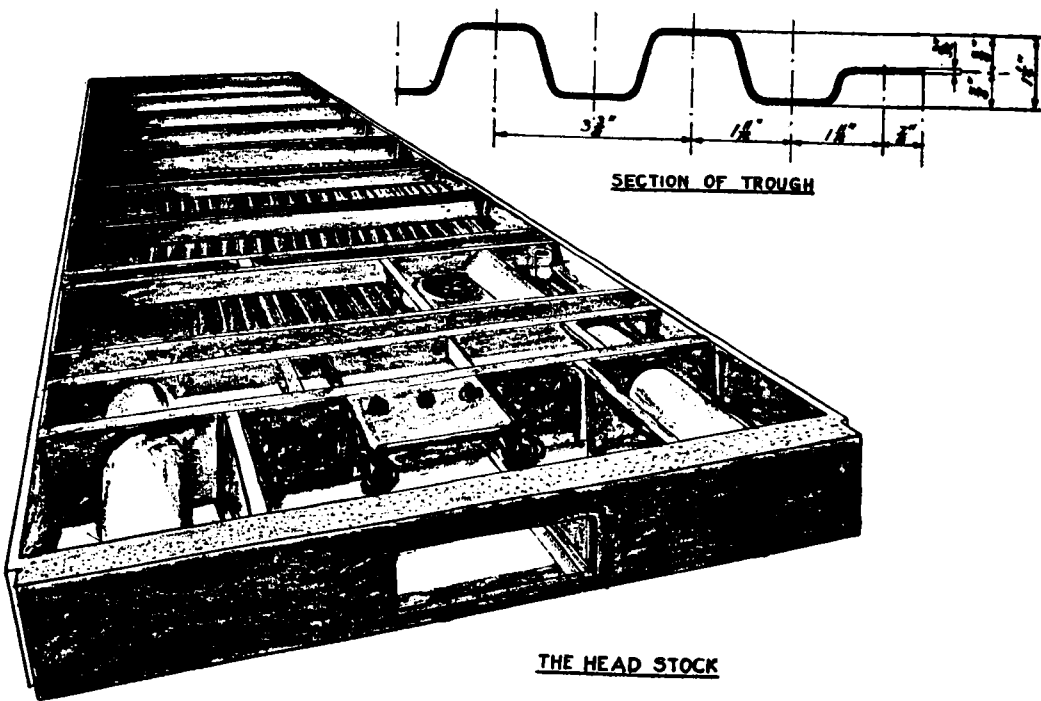


Fig. 9

Gross weight of the coach
+ 20% shock 45.0

CASE (I)—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.
$$= \frac{200}{6.128 + 14.38}$$
$$= 9.75 \text{ tons per sq. inch.}$$
Where 3.064 sq. inches is the area of cross-section of each sole bar

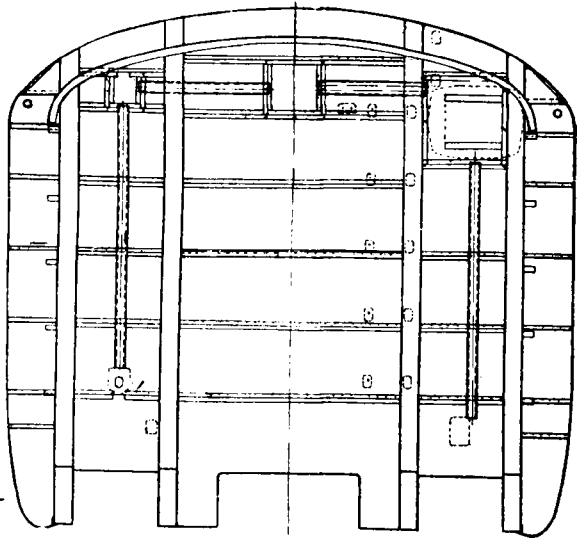


Fig. 10

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—

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

Critical stress for buckling in side longitudinal

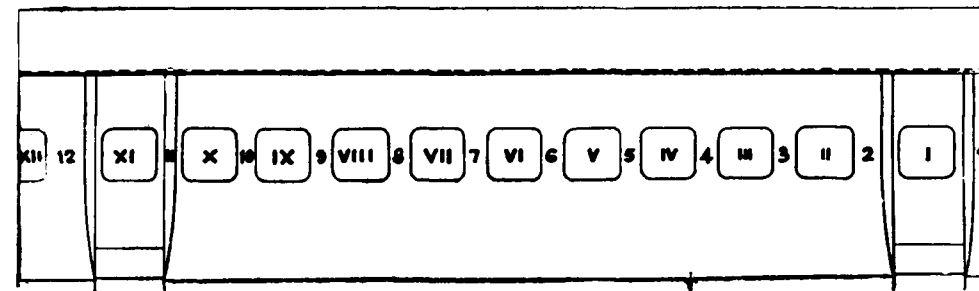


Fig. 11

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

∴ Factor of safety against buckling in side

$$\text{longitudinals} = \frac{19.2}{9.75} = 1.97$$

and Factor of safety against buckling in trough

$$\text{floor} = \frac{15.32}{9.75} = 1.57$$

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

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.

$$= \frac{1 \times 100.63}{10} \\ = 10.063 \text{ inch tons.}$$

Maximum bending stress

$$= \frac{10.063}{1.33} \\ = 7.56 \text{ tons/sq. in.}$$

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

Also maximum shear stress

$$= \frac{0.5}{0.907} \\ = 0.55 \text{ tons/sq. in.}$$

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

B.M. & S.F. DIAGRAMS.

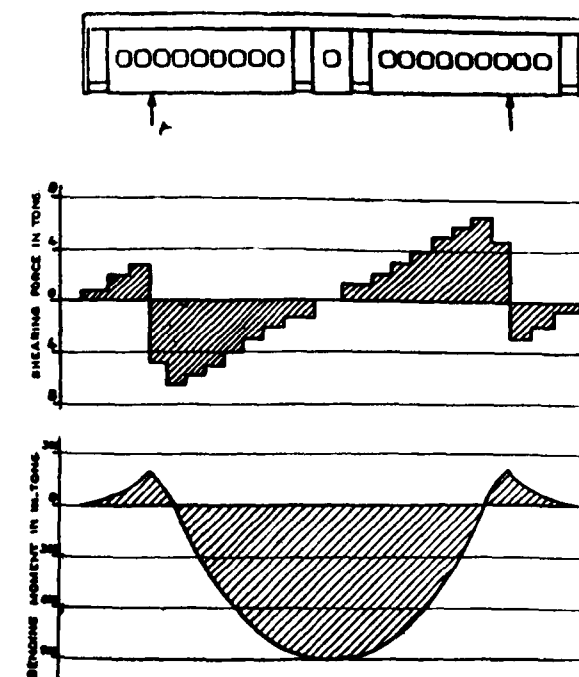


Fig. 11(a)

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

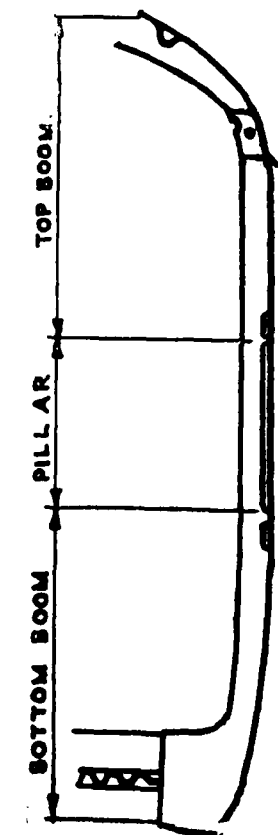


Fig. 12

	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 Schapitz

$$= K \cdot \frac{E}{12} \left[\frac{S}{b} \right]^2 \text{ tons/sq. in.}$$

Where E = Modulus of Elasticity

Where 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

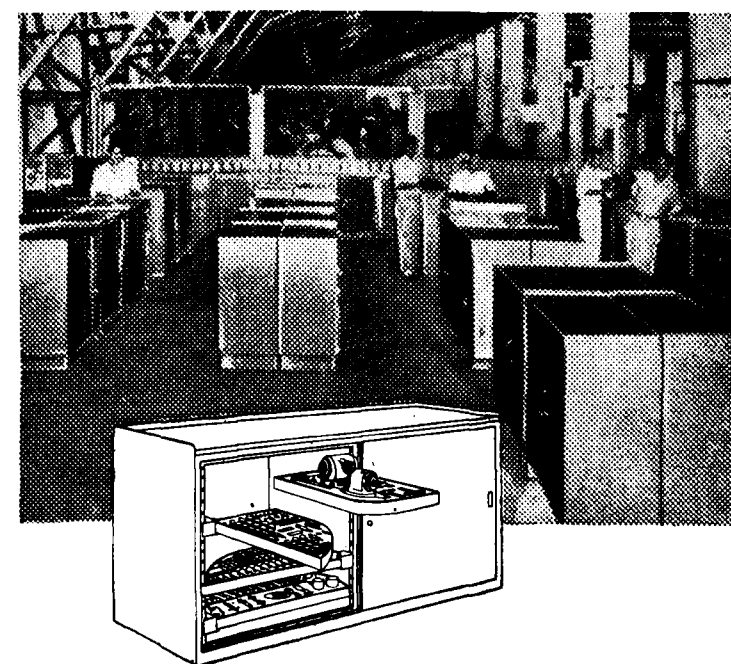
In all the above calculations the roof members are not taken into consideration though due to the Monotype of construction a certain amount of load is shared by members of this structure. Actual tests, however, justify neglecting these members for purposes of calculation since the stresses measured were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

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A PEEP INTO THE INTEGRAL COACH FACTORY

By Our Special Correspondent

THE Integral Coach Factory has made good progress in recent years. The Chief Administrative Officer and his able team are leaving no stone unturned to see that the Factory becomes a model one for others to follow. The Factory has very successfully completed a year of production in January, 1957 and against the target of 20 coaches set by the Government, they had not only completed 40, as revised by the Government, but have even exceeded that figure and completed 43 coaches. During the second year they have a still heavier and more ambitious programme to fulfil and there is no doubt the Integral Coach Factory will rise to the occasion.

It was to meet the twin problem of replacing a large number of over-aged stock and, at the same time, adding substantially to the present holding of the passenger coaches that the Government of India decided to establish a separate railway coach building factory. After a comprehensive survey of several alternative sites for locating the factory, the vacant railway land to the west of the Locomotive Repair Shop of the Southern Railway at Perambur, in the suburbs of Madras, was chosen in June 1951. By September 1952, the Engineers had completed the survey and had come into full swing in the field for construction of the factory buildings. The factory was completed, ready for inaugurating production in October 1955, in a record period of 3 years—a record which even the industrially advanced countries of the West with unlimited resources of men and material will find difficulty in accomplishing. The factory costs Rs. 7.35 crores and spreads over an area of 51.5 acres.

The integral coach to be manufactured is the most modern type of coach design in Europe and combines three major factors ensuring comfort and safety to the travelling public, viz. smooth running, light weight and strength. The design incorporates the all-welded trough floor system integral with the body and permits the forces sustained by the coach to be borne by the entire body including the skin. It is this feature which gives it the name 'Integral

Coach'. Another advantage of the coach is that it incorporates anti-telescopic construction and this feature reduces the possibility of the coaches telescoping in the event of an accident. The tare weight of the equipped third class coach is 35 tons against 42 tons of the conventional coach and the carriage has seating capacity of 80 passengers in third class.

Production of 350 body shells a year at the rate of one body shell per six working hours, is the target of the Integral Coach Factory and this would represent perhaps the largest output of any single coach building Factory in the world. According to the Technical aid Agreement entered into with Messrs. Swiss Car and Elevator Manufacturing Corporation Ltd., Schlieren-Zurich, Switzerland, this was to be achieved in progressive stages in 5 years as indicated below :—

First year	20 coaches
Second year	100 "
Third year	200 "
Fourth year	300 "
Fifth year	350 "

From the production experience gained since October last, it has become possible to double the target of out-turn in the first year, from 20 to 43. It has also been possible to rearrange the whole Production Plan with a view to attaining the maximum production target of 350 coaches a year, one year ahead of schedule, that is, in the 4th year of production, instead of fifth year.

In the matter of establishing indigenous manufacture of parts, components and subassemblies, it has been possible to achieve very considerable progress in this direction. The coach body shell consists of 1169 items of which 1120 components are either manufactured in the Integral Coach Factory or purchased indigenously. The remaining 49 finished components are at present being imported from abroad but it is proposed to develop the indigenous capacity to manufacture 47 of these components also in the country

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leaving a balance of two components to be still imported. These two items which present difficulty for manufacturing indigenously are the Axle Box Roller Bearings, demands for which will not interest any manufacturer in producing these bearings in the country at present.

A completely indigenous coach shell from the details, sub-assemblies and assemblies manufactured in the I.C.F. was turned out from the Main Assembly Shop by the President on the 14th of August, 1956 and since then seven more have been turned out.

Sufficient machinery and plant numbering 608, for the production of 250 body shells have already been installed and, based on the experience gained, 417 extra machines inclusive of 220 portable welding sets have been ordered to step up the outturn from 250 body shells to 350 body shells a year. To obtain economical processing and interchangeability and easy assembly, almost all the details and sub-assemblies are manufactured on jigs and fixtures. 750 jigs and fixtures have had to be specially designed for the manufacture of these components.

Handling and storage have also been given careful attention in order to save on unnecessary handling costs and economise on the floor space. Most of this shop equipment has been manufactured in this Factory itself.

The Factory will employ 4000 men when in full production. It was foreseen to train these men well in advance of the production and the Technical Training School for training the technicians to the required skill was started as early as March, 1954. This school has already produced 4 batches of Apprentices numbering 665 men and the 7th batch of 190 boys is now undergoing training in the Basic Training Workshops attached to the school.

A Hostel to accommodate 250 boys has already been completed and the boys have moved into the hostel from the 1st of August, 1956.

A proper Theoretical Training School has been completed subsequently and is functioning since November last.

A Colony of 400 quarters has been provided to accommodate the essential staff. All the modern amenities are included in this Colony, which has a Primary School, a Children's Park, a Recreation Club and a Co-operative Stores.

It has been the aim of the Administration to provide good working conditions for workmen in the Factory. Lighting and ventilation of the shops have been given special attention. Staff canteens run on a co-operative basis have been provided near the Main Entrance as well as in the Office. Water coolers to supply cooled drinking water have been installed in the shops. Bathing places and lavatories have been provided at convenient places.

Now let us see the expansion programme of the Integral Coach Factory. The integral shells manufactured in the Integral Coach Factory were originally planned to be furnished in Railway Workshops. On account of the Second Five Year Plan requirements and large expansions necessary on the Railways, the capacity in Railway Workshops is now required for timber coach building and for their increased needs for repairs and maintenance. Further, it was logically most economical to have the factory furnishing on mass production methods and produce the complete units, viz., a coach ready for use. Hence, a furnishing unit has been sanctioned by the Government of India at a cost of Rs. 3.69 crores. This unit will be located close to the factory—South of the New Avadi Road, where about 240 acres are being acquired for the factory including some land for future additional quarters.

The proposed Furnishing Factory will have a covered area of 5.5 lakhs sq. ft. The factory buildings will be of modern design similar to the Integral Coach Factory with ample lighting and ventilation and will cost Rs. 102 lakhs. There will be about 260 machines to enable a target production of 350 coaches of all types per year. To obtain economical and speedy work, jigs and fixtures will be used extensively for details and sub-assemblies.

A number of details and fittings will be obtained from the trade. Adequate storage has been provided for and the entire design of storage and lay out has been made to suit an economic handling of material.

It is estimated that the factory will employ about 2400 men when in full production. The training of the men required is also being planned by suitable expansion of the Technical Training School of the Factory at a cost about Rs. 4 lakhs.

A Colony of 200 quarters is being provided to accommodate the essential staff. This Colony will be located adjacent to the present colony of the Integral Coach Factory. Future requirement of additional

quarters has also been envisaged and a provision of land adjacent to the Factory has been made. The standards of amenities for good working conditions, cooled drinking water, bathing places and lavatories and also canteens and co-operatives will be planned on similar scales to those already planned for the Integral Coach Factory.

In order to expedite bringing into full production of the furnishing unit and also to find additional coach building capacity so badly needed for the expansion requirements of the Second Five Year Plan, arrangements have been made to commence furnishing work immediately. Development of technique and staff will be done gradually during this furnishing work. It has been started in a small free space available in the Integral Coach Factory. Temporary sheds have been sanctioned and are under construction in which further furnishing work will be undertaken. A small amount of machinery and plant costing about Rs. 6 lakhs will be obtained for the interim work which will all be subsequently utilised by the Unit. The interim furnishing programme has been so made that the workshops of the furnishing unit will be

utilised immediately they are completed and the staff of the furnishing switched over to the Unit. Thus, the unit will be brought into full production as soon as it is complete.

In accordance with these plans, the first coach has been furnished in the Integral Coach Factory and has been launched into service by His Excellency the Governor of Madras on 21st February, of last year.

This coach has been furnished for 3rd class. It has 4 lavatories, 2 in the middle and one at each end. The coach is divided into two halves by the middle lavatories and the seats are arranged as one row of single seats along one side, a passage by the side of these single seats and transverse long seats on the other side. Each of these long seats takes 4 passengers. Two fans are provided for each pair of seats facing each other seating 8 persons in the long seats and 2 persons on the single seats. Two night lights have been provided on each half of the coach. There are two shutters on each window, one of Aluminium venetians and the other of glass in an aluminium frame. The lavatories have been provided

(Continued on page 22)

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The 'SCHLIEREN' Bogie for the new Integral Coaches for the Indian Railways, manufactured by the Integral Coach Factory

By W. J. Bræm

ONE hundred years ago, the first Railway link between Bombay and Thana was inaugurated. Since then many changes have taken place in Railway services being the public utility service, have to march with the times and cannot stand back. Considering the big enterprise the Railways generally form in a country, and specially where Railways are Government-owned and they should even take a leading part and should, therefore, try not only to go with the times but to go ahead of time. The Indian Railways, with their new schemes, are just about to reach this stage.

"In the initial stages all-wooden coaches similar

to horse-driven carriages of that age were used. Then in the second stage also all-wooden coaches, but better adapted to Railway purposes, were in service. In the third stage, and this is about the beginning of the 20th century, wooden bodies were built up on steel underframes, and in the fourth stage, round about 1920 and the later years all-steel coaches of a rather very heavy design were adopted. During this period, opinion was held that only a heavy type of coach would give good riding qualities and would be rigid enough to give ample security to passengers in case of Accidents. This was specially influenced by the American Railways Engineering Practice at that time.

(Continued from page 21)

with mirrors and wash hand sinks. The commode is of Indian style and made of stainless steel. The flooring of the compartment and the lavatories is of oxy-Chloride Cement which gives a pleasing red smooth surface and lasting hygienic qualities. The coach body doors as well as lavatory doors are provided with chromium plated handles and spring loaded catches, while additional locking has also been incorporated. The interior has been finished in light biscuit and buff colours relieved by aluminium mouldings giving a bright clean appearance.

The Integral Coach Factory produces new type of coaches which is new to the Indian Railways. So a one week training course was held during the first week of February 1957, for the Mechanical Officers deputed by the various Railways for providing them with information regarding the design and manufacture of the Integral coaches and the maintenance problems they may have to tackle in such coaches in use on their Railways. The new coach design is something new to the Indian Railway Engineers as the whole construction is on new lines.

With reference to the welding process at the Integral Coach Factory it has been stated that it would be a matter for careful consideration to reduce the maximum demand of the Factory as much as

possible and build up a good Load Factor in the interest of reducing the electricity bills and that proper staggering heavy equipment like furnaces and other plants including the heavy welders would prove a great advantage in that line.

Inspection and testing of welded bogie bolsters and underframes is very important for which a non-destructive method of testing is invaluable, it is stated. Radiographic inspection i. e., by adopting X-Rays, is proposed and the necessary equipment is being processed through, besides magnetic crack detectors.

With the latest equipments they have in the Factory and the technical skill being developed locally in the Integral Coach Factory Basic Training School, there is ample scope, it is stated, for more perfection and advancement in not only the technological aspects of welding but also its allied electrical and other problems.

There are 1,169 components for the coach manufactured at the factory, out of which 1,120 components are either manufactured in the Integral Coach Factory itself or purchased indigenously. The remaining 49 components are at present being imported from abroad. The Government of India are exploring ways and means of manufacturing these 49 components also indigenously.

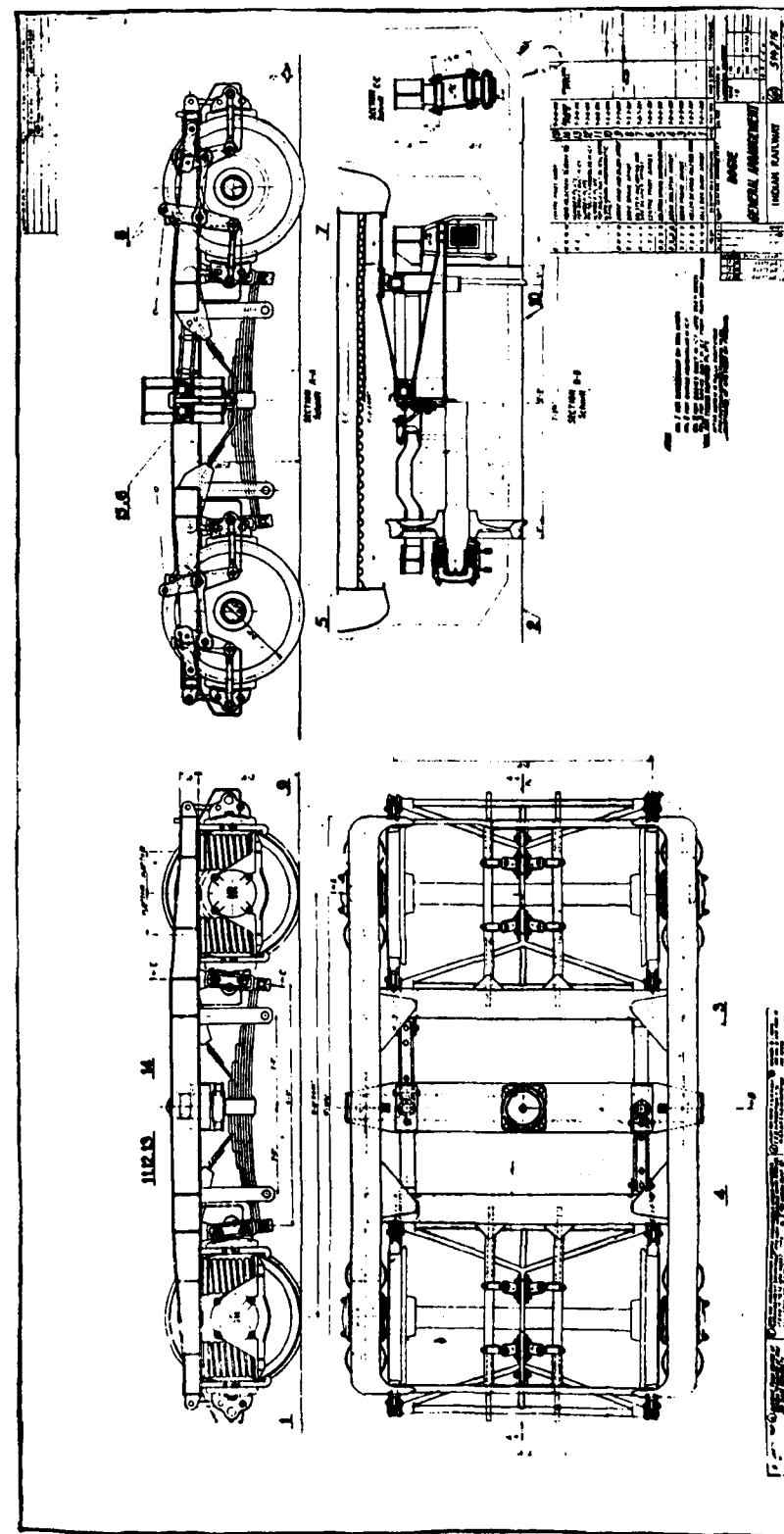
Now in the fifth stage since 1937, light-weight rolling stock designs have been evolved in mild steel, stainless steel or even aluminium alloys incorporating the features of improved riding facilities and security to passengers. However, keen pioneer work was needed to make such a design possible. It also needed some enterprising and broad-minded Railway Administration which were prepared to accept coaches of such an entirely new design in order to try them out and prove their advantages compared to the preceding rolling stock of heavier construction. It is only in this fifth stage that Railway coach building has been started on a somewhat scientific basis.

"The light-weight steel coach for the Indian Railways, which will be manufactured in the I.C.F. in future, incorporates many new features and inventions as compared to the Railway Coaches built previously.

"It is needless to point out that the bogies are the exceptionally important parts of a Railway coach. The riding comfort depends nearly exclusively on a good bogie construction. The bogie is the part which is most liable to wear and tear. Its behaviour in actual service contributes towards the efficiency factor of a coach. Therefore, it has to be so constructed that it can withstand long, uninterrupted and maintenance-free service.

"In designing and constructing the Schlieren bogie, attempts have been made to incorporate all these requirements. It has been possible by taking advantage of new processing methods, welding techniques etc., to develop a new standard type of bogie which became a pioneer in this field. Preliminary studies for this new design and already started more than 20 years ago.

"The set aims at that time for



bogie construction were, increased riding qualities, lesser weight, and a greater dependability, i. e., less maintenance, and it can be said that all these aims have been achieved by now.

"The following are some of the important constructional details of the Schlieren bogie :—

"In the first instance, the saving in weight per bogie which amounts to about 23% in comparison with the IRS bogie in use till now on the Indian Railways. This has been achieved specially by restoring to a reliable welded construction throughout the bogie frame and the bogie bolster. Wheel sets come next in contributing to the weight-saving, as the special aim was also to reduce the unsprung weights as far as possible. The bogie of the new light-weight steel coach of the Indian Railways has wheel sets according to the European standard of 3 feet wheel diameter only, against 3' 7" of the conventional IRS wheels. It may be noted that as the total weight of the Schlieren coach is approximately 7 tons lighter than the conventional one, the axle load is reduced by nearly 2 tons and therefore a

somewhat smaller wheel diameter can be adopted without any disadvantages.

"Great care is being given nowadays to the reduction of unsprung weights to the greatest possible extent. This results in less wear and tear of the permanent-way wheels and other parts of the coach in general. Shocks from rail joints transferred to the coach body, which cannot be absolutely eliminated, can be reduced appreciably.

"Modern Railways prefer already for their new coaching stock, wheel sets of a special light design, with double corrugated wheel discs pressed in dies and equipped with hollow axles.

"The Swiss Federal Railways have come to know from experience that the higher costs of these light wheel sets are largely compensated by the reduction in cost on account of the lesser wear and tear on the wheels and the permanent way and, further by the better riding comfort achieved. The additional saving in weight with such light-weight wheel sets of 3' diameter is half a ton per wheel. When compared

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with the IRS wheel sets with 3' 7" wheel diameter, the unsprung weight would be reduced by nearly 40%. The first two prototype coaches, which were delivered by Schlieren (Switzerland) to the Indian Railways in 1951, have been fitted with such special light-weight wheel sets to enable the Indian Railways also to gain experience. For the I. C. F. production, however, no such special light-weight wheel sets are going to be used at the moment as the manufacture of such wheel sets has not yet developed in India.

AXLE BOXES AND AXLE BOX GUIDES

"As a result of the Good experience with axle boxes fitted with roller bearings, these new bogies have also been equipped with roller bearings. For the axle box guides, a special patent construction, which has been developed in Schlieren (Switzerland) and which has proved very successful in service since many years on various Railways, has been adopted. With this axle box guide the play between the axle box and the guide has been eliminated and this ensures a better riding quality of the coach. These axle box guides are working in an oil bath sealed against dust and water, thereby resulting practically in no wear and tear. They are further so constructed that they also act as shock absorbers for the axle box helical springs controlling the deflection of the spring similar to the shock absorber arrangement in an automobile.

"The experience with such axle box guides has shown that the maintenance is minimised requiring only periodical checking and topping up of the shock absorber oil.

SPRINGING

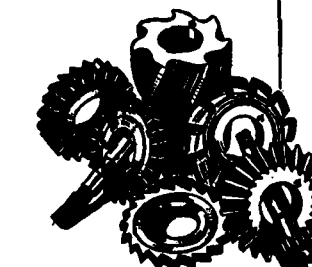
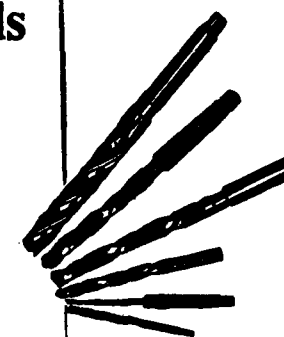
"Besides the axle box springs which are arranged on each side of the axle box, the bogie has also two bolster laminated springs arranged longitudinally, on which the bogie bolster is directly supported. By arranging the laminated springs longitudinally on the bogie, long springs could be applied which results in softer action of the spring. Further, Schlieren have used for the longitudinal spring, leaves having channel profile.

"This special channel profile provides the spring with a cavity throughout the whole length of the blades after they have been assembled. These cavities provide an ideal means of permanent lubrication as they are capable of storing a considerable amount of a lubricant. This ensures an improvement of the spring in its shock absorbing capacity enabling a

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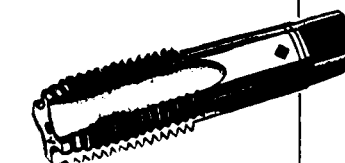


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softer cushioning of the coach—so important for comfortable travelling. Further more, it has to be noted that the spring leaves, before being assembled, are passed through the so-called “over-straining process” which makes it possible to load such a spring to such an extent without its showing any permanent deformation that the stresses, calculated in accordance with the usually known bending formula, will be much higher than the yield point or even the tensile strength of the steel.

BOLSTER SPRING SUSPENSION

“The bolster springs are suspended by swivelling hangers to the bogie frame and these take up the lateral shocks as well as the side swinging of the running gear. These movements will therefore not be transferred to the coach body.

“These swivelling hangers are suspended on the longitudinal members of the bogie frame in opposite angles in relation to the vertical. By this arrangement the bogie bolster and, consequently the coach body, are being centred in to the longitudinal centre line of the bogie frame. The lateral swinging, transmitted from the running gear to the coach body when the coach runs over joints, crossings, etc., is being reduced or even eliminated as a result of the developed restoring force. Experience has shown, that an angle of inclination, about 7° for the hangers, gives the best results.

“The bogie bolster is connected by means of two anchor links in the longitudinal direction to the bogie frame. These anchor links communicate the pull and braking forces resulting from accelerating or braking from the coach body to the bogie frame. The bolster springs are therefore being completely freed from such additional forces which again count and are very important for the soft action of the spring.

“A further feature is that the centre line of the anchor links coincides with the centre line of the centre pivot. Due to this feature the pull and braking forces transmitted through the centre pivot to the bogie frame do not result in a bending moment requiring a bigger centre pivot.

“These anchor links are also an improvement over the up-till-now-known sliding plate guides located between the cross-member of the bogie frame and the bogie bolster. The new anchor links are also

much less susceptible to wear and tear and have the great advantage that an absolute-play-free-connection between the body bolster and bogie frame could be achieved which eliminates additional jerking while the coach is running.

The bogie frame is of a completely welded construction, welded together of mild steel flats and plates, some of which are pressed by means of the press brakes to the required profiles. The design of the bogie is adapted to the special requirements of modern welding technique. Further, the design has been evolved after very accurate stress calculations and eliminates all pockets and corners, thus reducing the possibility of corrosion and ensuring accessibility for proper inspection.

“Special attention has been given to the design of the connections between the longitudinal and the cross members of the bogie frame, so that there is uniform stress distribution to the greatest possible extent.

BRAKE GEAR

“With the usually known brake system in which the brake cylinder is fixed to the underframe, the braking force coming from the brake cylinder acts directly on the bogie frame, thereby subjecting the centre pivot to an additional stress. The braking arrangement on the Schlieren bogie, however is designed in such a way that this additional stress does not act at the centre pivot. This has been achieved by fixing respective reaction points for the brake rigging on the underframe. This results in a remarkable relief of force on the centre pivot, taking into consideration that the pull on the brake rod amounts to about 4.54 tons. The centre pivot is therefore subjected to less wear and tear and the free play of the bogie is unaffected during the braking period.

“The brake block is designed in two parts consisting of the brake shoe and the brake shoeholder. Therefore, when worn out, the relatively cheap ‘wearing part’ (brake shoe) is replaced instead of the whole brake block.

CONCLUSIONS

“The outstanding features of the new bogie of the Indian Railways light-weight steel coaches can be summarised as follows:

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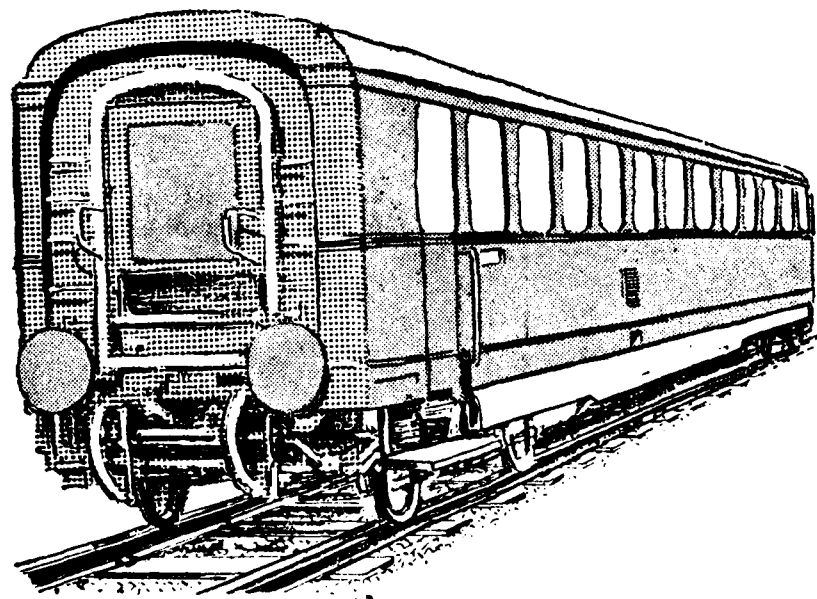
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August 1958

SOUTHERN RAILWAYS MAGAZINE

29

- (1) The total weight of the bogie has been reduced by 23% against the old IRS bogies.
- (2) The unsprung weight has been reduced by 20% as compared to the conventional IRS bogies resulting in much lesser wear and tear of the track and coaching stock.
- (3) The wear and tear of the axle box guides has been completely eliminated.

- (4) The movements of the axle box helical springs are being controlled by built-in shock absorbers.
- (5) The centre pivot is completely released of any additional reaction stresses from the brake gear.
- (6) The conventional rubbing blocks for the bogie bolsters have been replaced by the anchor link arrangements which eliminates the jerky movements of the bolster."

Three Mills Modernize as India Seeks Increases in Annual Steel Production

A twentieth century industrial revolution is under-way in India.

That country, until recently depending largely on her agricultural economy, is now faced with the problem of supplying steel to factories and plants springing up in every region.

At present, India contributes a little more than one per cent of all the world's steel and must import several hundred million dollars worth annually to meet her needs—a situation the Indians are out to correct in order to build a more favourable trade balance.

Two new steel mills are being constructed and three existing mills are modernizing to meet the competition. Just one of the new mills, officials estimate, will be able to produce in its first year half as much as India's total production for 1955, which was 1,900,365 net tons. Eventually output of the mill is expected to reach 2.5 million net tons annually.

To facilitate this expansion, three of the Indian mills—one now in construction and two already in existence—have ordered more than \$2,000,000 worth of General Electric (U. S. A.) Industrial haulage locomotives. The orders were received from the Indian Iron and Steel Co., the Hindustan Steel Co., and the Tata Iron and Steel Co.

Indian Iron and Steel, a privately-owned concern, has purchased six diesel-electric locomotives, three rated at 80 metric tons, one at 72 metric tons and two at 31 metric tons, for its plant at Burnpur, (West Bengal).

Hindustan Steel, state-owned, ordered 24 G-E diesel-electric locomotives for a new plant it will put into operation at Rourkela, (Orissa).

Tata, another privately-owned mill modernizing to meet the competition, purchased seven diesel-electric locomotives. Two of them, rated at 115 tons and 720 horse-power, are the largest size industrial locomotives built by GE. Four are 80-ton diesel-electrics and one is a 25-ton diesel-electric.

Locomotives for the three mills are broad (66-inch) gauge and all have special equipment allowing them to operate in the extreme dust, heat and humidity encountered in the blast furnace area of the mills.

An industrial locomotive is a vital part of a steel mill's operation. It is used in every phase of the steel-making operation.

Ore is hauled into the plant by these tough little machines, as well as coke and other ingredients that go into the making of steel.

Molten metal is taken from the blast furnace to molds in cars pulled by the industrial locomotive and waste slag is taken to dumping areas.

Finally, the finished steel is transported from the mill to shipping depot on flat cars pulled by the locomotive.

Steel is the biggest industrial user of these haulage locomotives and the purchase of modern motive power by India's mills is the necessary first step in her planned industrialization.

ROLE OF STORES INSPECTIONS

By *Heeralall Khaitan,*

Member, Regional Rly. Equipment Advisory Committee, Calcutta.

UNDER the present day conditions of mass production of stores with emphasis on their conforming to rigid standards and specifications, Inspection and their approval of stores have assumed a prominent place. This would mean checking up right from the raw material to the finished product stage to ascertain the stores suitability. Needless to say that inspection cannot guarantee cent per cent quality but it goes a long way towards the attainment of the desired goal by approval of fabrication methods, and all the steps taken in the industrial unit to ensure the manufacture at all times of uniform products to specifications stipulated by the purchaser. Careful account should also be taken of the tolerances and clearances allowed and these are naturally based on vibrations, load speed etc. of the production machinery.

The necessary equipment required for Inspection are numerous and with the marching of Science numerous gadgets are coming to the fore for the detection of flaws. Except perhaps in very few big industrial units, no medium scale unit can afford to own all the facilities for inspection. Raw material suppliers usually provide test certificates for tensile and compression tests and also chemical composition. The determination of these would need a costly metallurgical laboratory which can only function efficiently at a cost far beyond the range of medium units.

The next stage in inspection would be the physical check and approval of machined dimensions in various operations. Many types of gauges are in use and it is well to remember that the gauges themselves should be periodically checked against parent gauges. This will apply to such products where micrometric accuracy is desired. Many industrial units nowadays provide their own hardness testers like Brinell Hardness Tester and

Rockwell Hardness tester to assist spot inspection. In the inspection of both basic raw material and castings, the Crack Detector is also employed.

About the question of clearances and tolerances allowed, there is much to learn both for the purpose of satisfying inspection and also to avoid wasteful production and consequent rejections.

Inspections may be broadly divided into three different heads. (a) Inspection in the factory by foremen in the course of production. (b) Final inspection in the works by one deputed and qualified for it. (c) Inspection on behalf of the consumer. It is to the interest of the industrial unit to evolve suitable checks in the inspection of stores at the various stages of production and thus avoid production of defectives involving loss of time and material. Coming to the last stage of consumer Inspection it is necessary that the efforts put forward by the previous two inspections meet the critical and approving eye of the consumer whose representative is the Inspection, whose responsibility can well be appreciated.

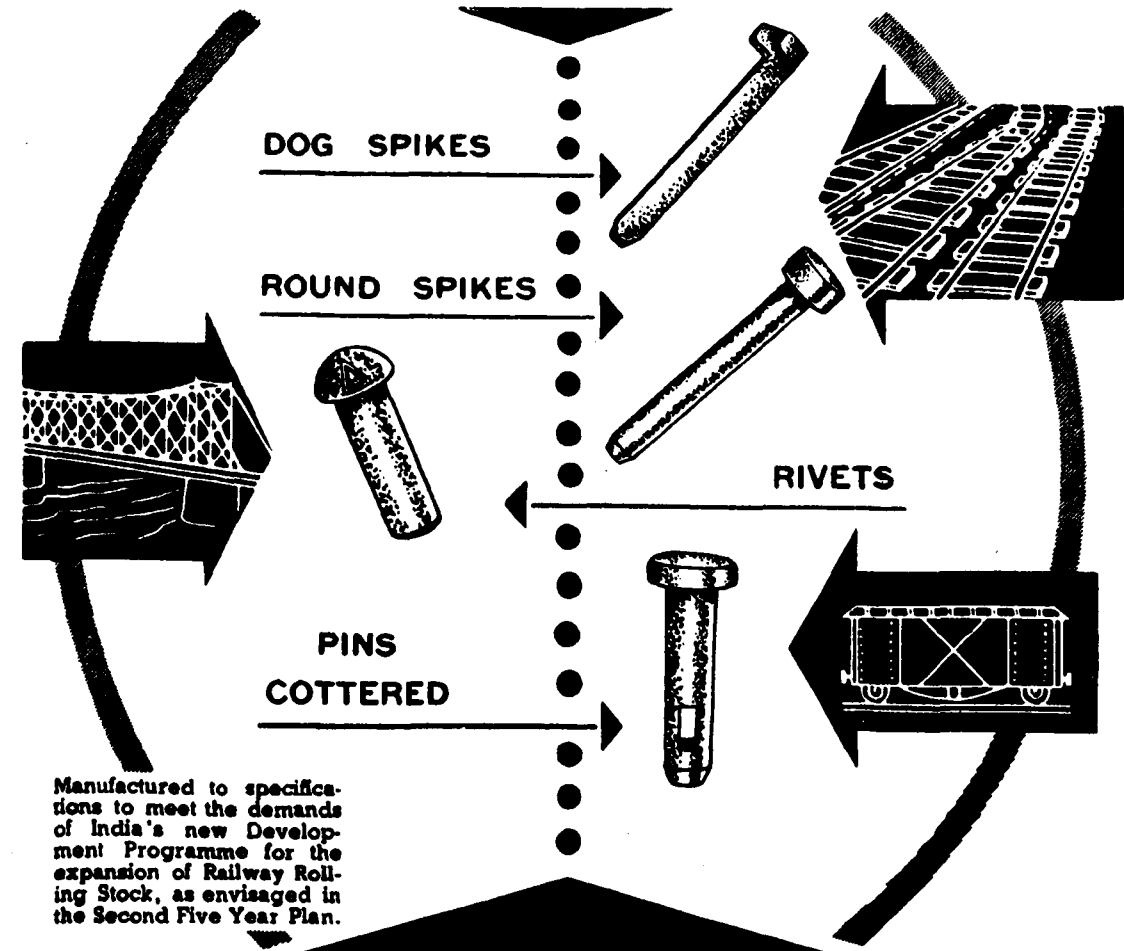
With so much benefits accruing by the role played by Inspection, it is not understood how public purchasing departments can think of placing orders on firms without independent inspection. It is to be impressed on purchasers the necessity for inspections to avoid non-standard stores being supplied and also to protect better firms from unfair competition from those who cannot supply stores to specified standards. Price considerations should not be allowed to stand in the way as approved goods are always cheaper in the long run. Further, the potentiality, equipment and performance of the supplying firms should be carefully scrutinised prior to commitments.

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THE INTEGRAL COACH FACTORY, PERAMBUR

By H. Bänziger

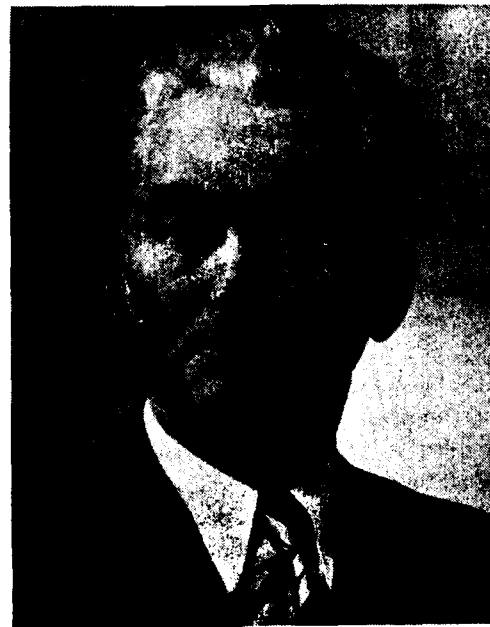
THE biggest coach building unit in Asia is located in Madras, the Integral Coach Factory, Perambur, manufacturing all steel light weight coaches for the Indian Railways. The I. C. F., as it is called in short, reached its first stage of development on October 2, 1955, with the inauguration of production by Prime Minister Jawaharlal Nehru. With this, the start was initiated for a set target of 350 all metal light weight coaches per year, to be reached in 1960, when every 6 hours an all metal light weight coach will leave this factory. By the combined efforts of the Swiss and Indian engineers, the output in the second production year has already reached the manufacture of one coach every 12 hours, in this way proving the success of this collaboration.

The Indian Government and with it the Indian Railways were compelled, soon after reaching independency in 1947, to compensate for the big deficiency of rolling stock. The lack of rolling stock resulted from over age, since there was no replacement during the war, and the traffic increased tremendously ever since 1939. The Indian Railways were therefore forced to renovate their complete rolling stock which, as an immediate remedy, could be accomplished by imports only.

Due to the growing industrialisation of India it was obvious to also take into consideration the construction of a coach building factory. The decision for the construction of a coach Factory for the manufacturing of broad gauge coaches was taken in 1948 by the former Railway Minister, Mr. N. G. Ayengar.

Enquiries were then started in order to find out which coach design should be adopted as the future standard design for the Indian Railways. For this reason, a delegation of Indian Railway engineers visited all the important coach factories in Europe as well as in the U. S. A.

After a through investigation, decision was reached that the all metal light weight coach built by the Swiss Car and Elevator Manufacturing Corporation Ltd., Schlieren, Zurich, should be accepted, it being the most suitable coach design for India.



Mr. H. Bänziger

"INTEGRAL DESIGN"

In the last two decades, the construction of railway passenger coaches has undergone a revolutionary change. It was not only a question of seeking means for greater economy in railway rolling stock operation but in particular also of providing for greater riding comfort of the passengers so that railway travel may be more agreeable and be actually an attraction for the travelling public.

New developments in manufacturing processes, availability of the correct raw materials produced to specifications drawn up to meet the various requirements and above all, the introduction of the electric arc and spot welding technique which, in Europe, dates back from 1930, opened new vistas in the coach building industry. As a result of these advancements, the old customary principles of construction were completely abandoned and new methods adopted.

Under this influence, in Europe, a specific new development of an all-steel coach design became

popular which distinguished itself particularly by virtue of its considerably lighter weight when compared to the coaches of earlier manufacture, at the same time improving the running qualities of the coach and also ensuring greater safety of the passenger by the so-called "integrated design".

Birth in Switzerland: This new method of construction had its birth in Switzerland, the first execution of which dates back to 1933, when Messrs. Swiss Car and Elevator Manufacturing Corporation Ltd., Schlieren, Zurich, in co-operation with the Swiss Federal Railways, built an experimental coach of the "integrated design". The final tests and the concluding trial runs were so promising that, with this new coach, the foundation stone for a new epoch in railway coach building industry was laid.

With the good practical experience gained in the meantime, this new type was declared as the standard type by the Swiss Federal Railways as far back as 1937. Today, this mode of construction has already been adopted by most of the European railway administrations as an ideal design of modern coach building.

Special feature: The apparent characteristic feature of this new construction lies in the unique constructional design of the coach shell. According to the old principle, the walls with the roof were built as a superstructure on the underframe which, by itself, only had to serve as a carrying unit or a supporting bridge resting on the running gears or bogies at both ends. The superstructure served only as a protecting hood to offer passengers, the seating and other comforts and protection from the elements and did not subscribe to the strength of the coach.

In the new construction, this "protecting hood" is so designed as to form part of the supporting construction itself. The under-carriage, the side and end walls and roof together constitute an integrated structural body which can, in a certain sense, be compared to a quadrilateral girder construction; consequently, the entire coach shell which, for simplicity, can also be imagined as a large hollow tube, constitutes a carrying unit thus serving a dual purpose.

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electrical welding technique, it was also possible to include the relatively thin side wall and roof covering plates of steel sheets of 1/16" to 3/32" thickness as the so called "skin stressed members" in the computations for the carrying capacity. By this, a further reduction in weight has been made possible without, in any way, decreasing the carrying capacity or the stability of the coach body. This type of coach has, therefore, been rightly termed as an "all welded light weight steel coach".

Seven tons savings per coach: With this type of construction, savings in weight upto 30 per cent can be achieved. In the case of the new light weight passenger stock designed for the Indian Railways, seven tons of steel will be saved for every individual coach, the new third class coaches weighing 35 tons only against 42 tons for coaches of the old design. For the entire coach body "low carbon mild steel sheets" with commercially specified standard values for tensile strength and other physical properties will be exclusively employed.

Since the entire construction is based on electrical

spot and seam welding, it is absolutely necessary that the steel employed, has all the properties for sound "weldability". When the new Government steel plants start functioning, India will be able to supply the raw materials of the required quality for these coaches from the country's own resources.

The under-carriage incorporates a steel plate corrugated welded floor, running throughout the entire length and so designed as to absorb in particular, the various tractional forces and the buffing shocks. The end constructions are heavily reinforced so as to resist every kind of telescopic action in the event of a collision.

The Louvre and glass windows have light metal frames manufactured from extrusions and for ensuring better sealing against dust, light metal guides with felt linings are provided. The entrance doors have special hinges with ball bearing arrangement and are further provided with protective guides so that any possibility of injury to the passengers by jamming of fingers or having parts of their dress caught, etc. are positively eliminated.

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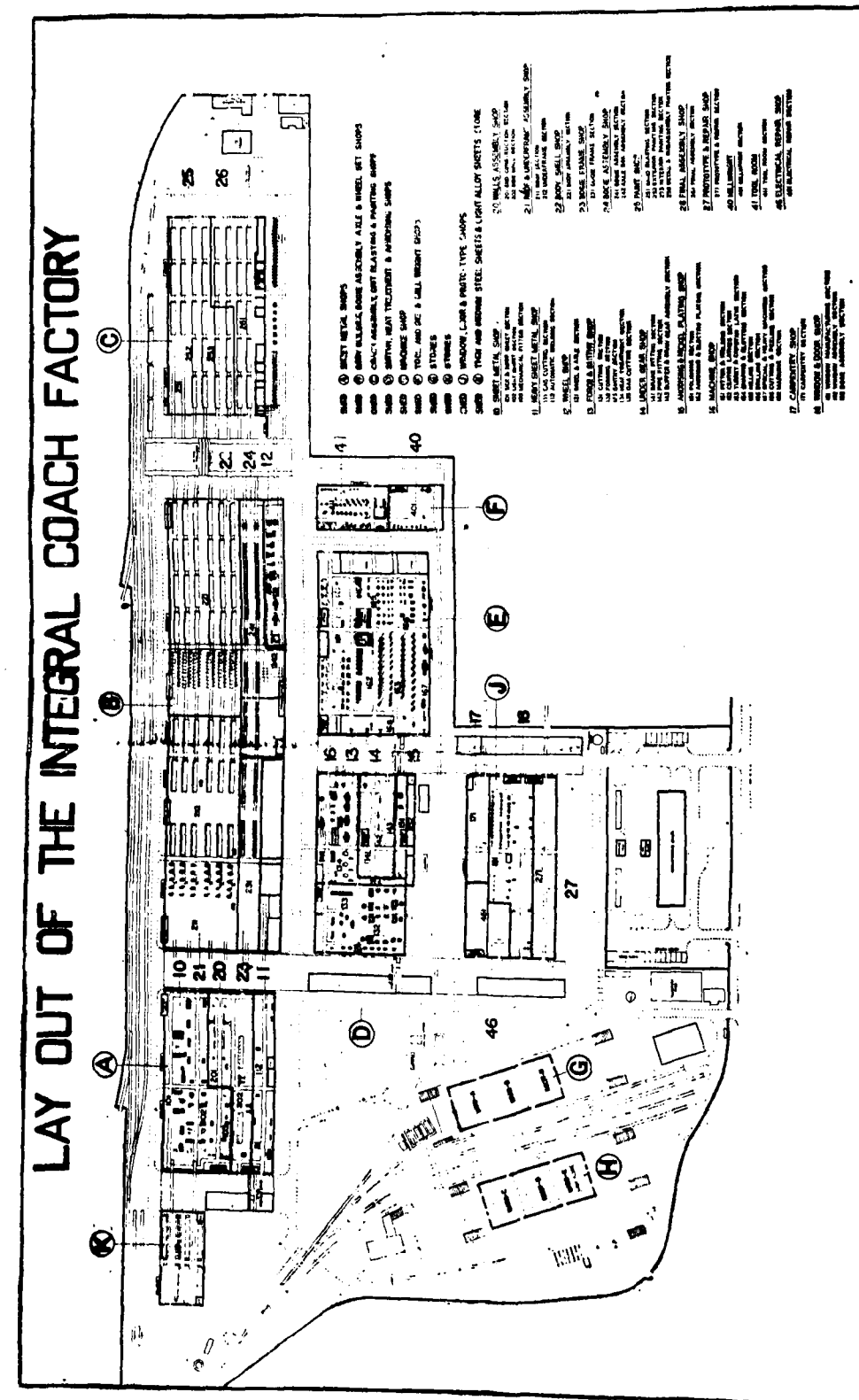
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As a protection against the danger of rusting of the sheet steel body shell, the complete interior receives a 3-fold coating of special bituminous paint. Further,

the walls and the roof are also inlaid with an asbestos insulation layer as protection against the conduction of heat into the coach interior and also as an

anti-reverberating medium.

The design of the coach enables the entire construction to be processed continuously; commencing from the manufacturing of details, sub-assemblies, right up to the finished stages, ensuring smooth flow of work on the various assembly lines.

Riding Quality: In developing this new integral all-welded light weight steel coach design, attempts have been made to improve on the previous design of running gears also. It would be superfluous to emphasise that the bogies are the most vital parts of a railway coach. The riding quality depends almost exclusively on a good bogie design. The bogie is the part which is most liable to wear and tear. Its behaviour in actual service contributes towards the efficiency factor of a coach. Therefore, it has to be so constructed that it can withstand the heavy wear and tear and thus ensure long, uninterrupted, maintenance-free service.

The "Schlieren" bogie that has been adapted by the Indian Railways, incorporates several new features.

Taking advantages of the new processing methods, welding techniques etc., it had been possible to reduce its weight by 23 per cent as against the other I. R. bogies in use. As explained elsewhere, this reduction in weight had been achieved by resorting to a reliable welded construction throughout the bogie frame and bogie bolster.

Cushioning effect in riding: The axle boxes which play an important role, are fitted with spherical roller bearings. The old jerky axlebox guides have been eliminated and are replaced by an entirely new arrangement of guides working in an oil bath sealed against dust and water which in turn, ensures a smooth working with practically no wear and tear of moving parts. The axle box helical springs are controlled by shock absorbers. The laminated bolster springs arranged longitudinally have a special spring leaf design which ensures better lubrication between the leaves on the long run. This improvement of the spring provides for better shock absorbing capacity which consequently produces a softer cushioning effect in the riding of a coach. These springs are suspended by swivelling hangers to the bogie frame thus taking

up the lateral shocks as well as the side swinging of the running gear thus isolating such movements from the coach body.

An absolutely play-free connection between the body bolster and the bogie frame by means of two anchor links longitudinally arranged, diminishes additional jerking while the coach is running. The brake rigging in the bogie has an improved arrangement so that the centre pivot is entirely relieved of the heavy pulls of several tons applied through the brake rod. The brake blocks are designed as two parts, consisting of the brake shoe and the brake shoe holder, with the result that the relatively cheap brake shoe as wearing part has only to be replaced when worn and brakes have to be reset.

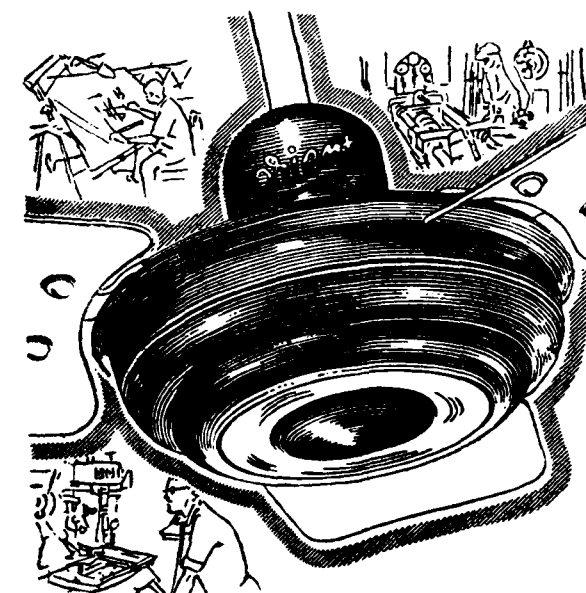
Coach seats 80 passengers: The new third class all-steel coach seats 80 passengers. It has four lavatories and four doors per side. The length of the coach body is 70 feet, while its width is ten feet eight inches. The width of the compartment is five feet seven inches, while the space between seats is one foot and nine inches.

The seats are made in wooden strips placed transversely to the length of the coach. Above the bunks are luggage racks which can be utilised as upper berths.

An agreement was concluded in May 1949 between the Indian Government and the Swiss Car and Elevator Manufacturing Corporation Ltd., Schlieren. Accordingly, Schlieren was compelled to first build two prototypes. After extensive tests in India on the Indian Railways net, orders for the supply of light weight steel coaches were placed on "Schlieren".

Furthermore, Schlieren had to supply a project study for a coach factory with a capacity of 350 unfurnished all metal light weight coach bodies and bogies per year. Based on this project study, a suitable site had to be selected. Bangalore was considered before a decision was taken in favour of Perambur, offering advantages which could not be overlooked, having the big repair shop for locomotives and carriages in its vicinity, road and rail connections in existence, and being in the proximity of Madras which meant it was not necessary to build a colony for the entire staff.

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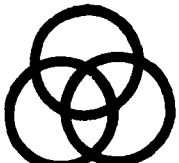
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The plant of the Integral Coach Factory consists of 10 workshops arranged for uniflow production of the all metal light weight coach. The shops of sheet construction with north light sheds are covered with corrugated, well ventilated asbestos sheets, a requirement for the South Indian climate. The production flow for the coach shell and bogie starts from the Sheet Storage building at the west, goes through the Sheet Metal Shop into the Assembly Hall and from there to the Paint Shop.

The production of parts flows on a parallel line from the heavy steel store at the west into the Smithy and then to the Machine Shop, which delivers the finished parts into the Assembly Hall.

The Door and Window manufacturing unit is housed in a separate shop and delivers the finished products directly to the Paint Shop where they are fitted to the Coach.

Adjacent to the Machine Shop is the Tool Room and the Millwright Section. For the storage of the semi-finished products, consumable goods, etc., two store buildings are provided.

Besides these production units and store buildings, provision for a 4 storey administrative building, a workers' canteen, and artizan training school and a colony with 400 staff quarters were built.

The Sheet Metal Shop is arranged for the shearing, forming and the welding of sheets and plates. Complete sidewalls, floors and end constructions are assembled in huge complex welding jigs. These prefabricated coach parts are then transported on special vehicles into the 1000 feet long Assembly Hall, one of the biggest industrial buildings in India. In this Assembly Hall, the coach shells take shape on six separate lines simultaneously in a breath-taking pace. The roof is produced in a gigantic rotating, 70 feet long welding jig, followed by the assembly stand for the underframe. In the last step these sub-assemblies, i. e. underframe, side-walls, and construction and finally the roof are welded together in the ingeniously arranged assembly jig of Schlieren design, forming the self-supporting shell. A self-supporting coach shell is lifted out of this assembly jig every 36 hours (4½ days) and lowered on to diplory rollers for its further transport over a traverser into the track of the Paint Shop where the grit blasting plant is installed.

The coach shell passing through the grit blasting Plant is cleaned and now ready to receive its first

coating. While the coach shell is pushed through the different stages in the Paint Shop, paint is applied, insulation carried out, complete doors and windows are delivered, ready for assembly, from the door and Window manufacturing Shop; these are fixed on and the finished coach shell is lowered on to its bogies. Passing through a final inspection, the coach is ready to leave the Integral Coach Factory, over a second traverser on the connecting main track.

Bogies: The bogie frames for which the parts are delivered from the Sheet Shop are welded together on two parallel lines adjacent to the coach shell assembly lines in the assembly hall.

In the first stages the frame is built and then transferred to fixtures supported on diplory rollers till the frame is completely assembled. From the opposite side axles and wheels are manufactured and assembled to wheel sets, receiving the last machining operation on a wheel lathe and delivered for the erection of the bearing. The parts for the final assembly of the bogies are delivered from the Machine Shop.

The wheels with their bearings are then transferred to the bogie assembly line which is a continuation of the bogie frame line, for their final erection. From the Assembly Hall the finished bogies are moved on their own wheels into the Paint Shop, where the coach shell is lowered on to them. This now is the final product of the Integral Coach Factory, the "all metal light weight coach".

The procurement of the machinery and plants required for manufacturing the all metal light weight coach at the Integral Coach Factory in Perambur started in 1954. On January 20, 1955, the erection of the machinery started in presence of the Railway Minister. The initial production began on October 2, 1955.

Further procurements to bring the machinery and plants in step with the production requirements and the increase of staff to its full capacity of 600 machines for the manufacturing of 350 all metal light weight coaches were made in 1956 and 1957.

Artizan Training School: For a production unit of the size of the Integral Coach Factory, steps had to be taken in good time for training the required staff of approximately 4000 men. In March, 1954, the Artizan Training School was opened by the Railway Minister for the training of the first batch of 260 apprentices, i. e., 60 as machinists, 100 as fitters and



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100 as welders, with an instruction period of 6 months' basic training, followed by one year of improvement in the shop floor.

Specific training in coach building was accorded to already skilled and specially selected men (78+4 officers) through 6 to 12 months' stage at the Swiss Car and Elevator Manufacturing Corporation Ltd., Schlieren, Zurich, Switzerland, and these men have now been placed in key positions in the manufacturing process at the Integral Coach Factory.

India has a right to be proud of the Integral Coach Factory, bringing this country a step forward in its aim towards independence.

The Integral Coach Factory in brief :

covered area in the shops	8,48,600 sq. ft.
number of sheds	10
Tonnage of steel	9,500 tons
length of rail lines	12 miles
roads inside shops	3.4 miles
roads in colony	3 miles

houses	400 miles
water supply pipes	16 miles
consumption of cement	19,500 tons
general purpose machines	540
special purpose machines	60
jigs and fixtures	750
pipe lines, cooling water, oil, compressed air	8.4 miles
compressors	8,250 cft./min.
20 ton overhead cranes	4
5 ton overhead cranes	26
75 ton traversers	2
number of workmen (to be employed)	4,000
annual output in single shift	350 unfurnished coaches
total consumption of electrical units per annum	60,00,000 units
total cost of project	Rs. 7,35,00,000

NEED FOR CONTROLLING CORROSION OF STEEL

Dr. B. N. Dey, retired Chief Engineer of Calcutta Corporation and a well-known Consulting Engineer, stated that India's planned six million ton steel production could be made to equate to a ten million ton steel production with effective corrosion-control.

In a statement, Dr. Dey said that it had been found that the higher the steel production of a country, the higher would be its corrosion. It had also been variously estimated that up to nearly half a country's steel production was used up in replacing the corroded material, so that only half of its steel production was available for new construction.

According to Dr. Dey, the cost of protecting and

prolonging the life of steel by the latest methods being within one-tenth of the cost of producing steel, it is clearly a case of big economy.

* * * * *

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.

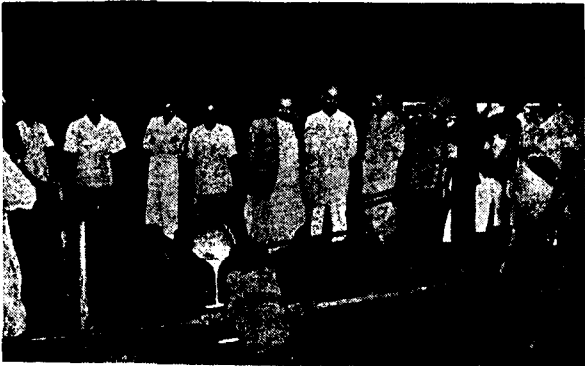
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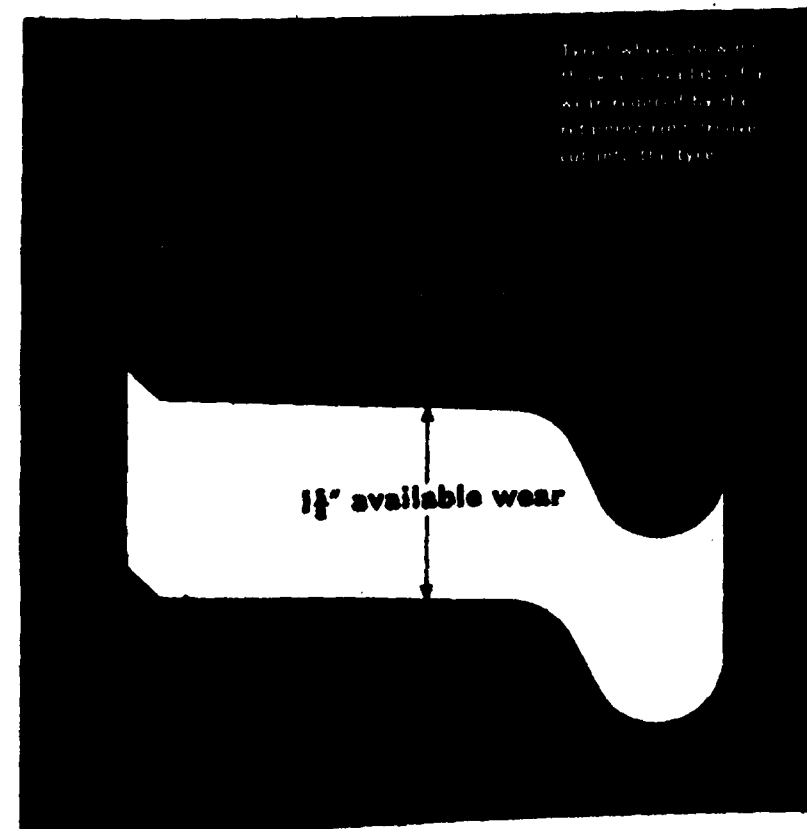
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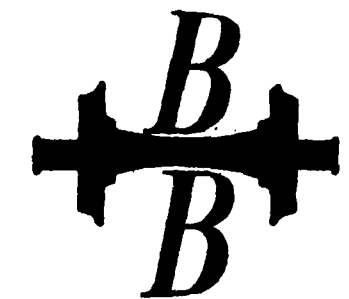


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The Integral Coach Factory— Manufacture and Furnishing of Broad Gauge Coaches

It was to meet the twin problem of replacing a large number of over-aged stock and, at the same time, adding substantially to the present holding of passenger coaches that the Government of India decided to establish a separate railway coach building factory. After a comprehensive survey of several alternative sites for locating the factory, the vacant railway land to the west of the Locomotive Repair Shop of the Southern Railway at Perambur, in the suburbs of Madras, was chosen in June 1951. By September 1952, the Engineers had completed the survey and had come into full swing in the field for construction of the factory buildings. The factory was completed, ready for inaugurating production in October 1955, in a record period of 3 years—a record which even the industrially advanced countries of the West with unlimited resources of men and material will find difficulty in accomplishing. The factory costs Rs. 7.35 crores and spreads over an area of 51.5 acres.

DESIGN AND ADVANTAGES OF THE INTEGRAL COACH

The integral coach to be manufactured is the most modern type of coach design in Europe and combines three major factors ensuring comfort and safety to the travelling public, viz., smooth running, light-weight and strength. The design incorporates the all-welded trough floor system integral with the body and permits the forces sustained by the coach to be borne by the entire body including the skin. It is this feature which gives it the name 'Integral Coach'. Another advantage of the coach is that it incorporates anti-telescopic construction and this feature reduces the possibility of the coaches telescoping in the event of an accident. The tare weight of the equipped third class coach is 35 tons against 42 tons of the conventional coach and the carriage has seating capacity of 80 passengers in third class.

PRODUCTION

Production of 350 body shells a year at the rate of one body shell per six working hours, is the target of the Integral Coach Factory and this would represent perhaps the largest output of any single

coach building Factory in the world. According to the Technical Aid Agreement entered into with Messrs. Swiss Car and Elevator Manufacturing Corporation Ltd., Schlieren-Zurich, Switzerland, this was to be achieved in progressive stages in 5 years as indicated below:—

First year	20 coaches
Second Year	100 coaches
Third Year	200 coaches
Fourth Year	300 coaches
Fifth Year	350 coaches

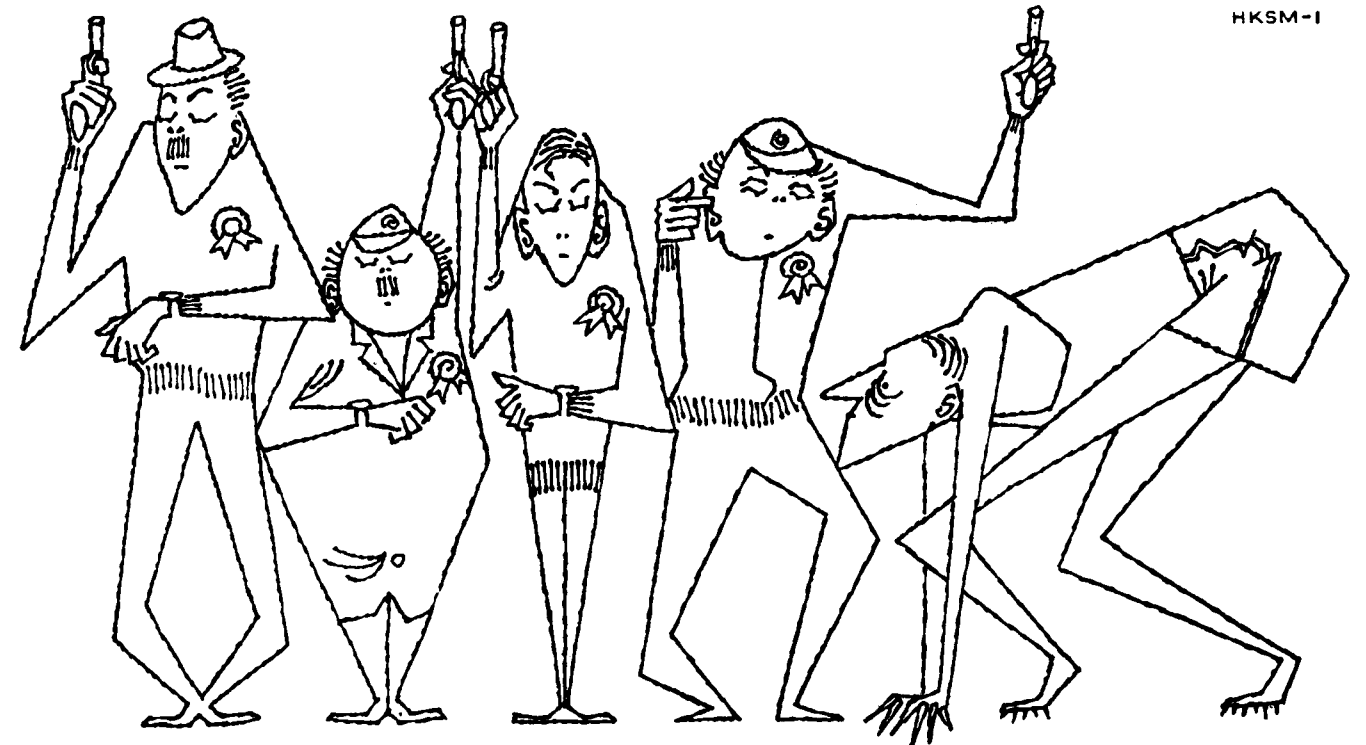
From the production experience gained since October 1955, when the factory was inaugurated by our revered Prime Minister, it has become possible to double the target of outturn in the first year, from 20 to 43. It has also been possible to rearrange the whole Production Plan with a view to attaining the maximum production target of 350 coaches a year, one year ahead of schedule, that is, in the 4th year of production, instead of in the 5th year.

In the matter of establishing indigenous manufacture of parts components sub-assemblies, it has been possible to achieve very considerable progress in this direction. The coach body shell consists of 1169 items of which 1120 components are either manufactured in the Integral Coach Factory or purchased indigenously. The remaining 49 finished components are at present being imported from abroad but it is proposed to develop indigenous capacity to manufacture 47 of these components also in the country, leaving a balance of two components to be still imported.

A completely indigenous coach shell from the details, sub-assemblies and assemblies manufactured in I. C. F. was turned out from the Main Assembly Shop by our revered President, Dr. Rajendra Prasad on the 14th of August, 1956, and since then indigenous coaches are manufactured simultaneously with the assembly of knocked down components.

MACHINERY AND PLANT

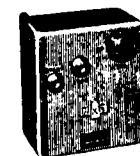
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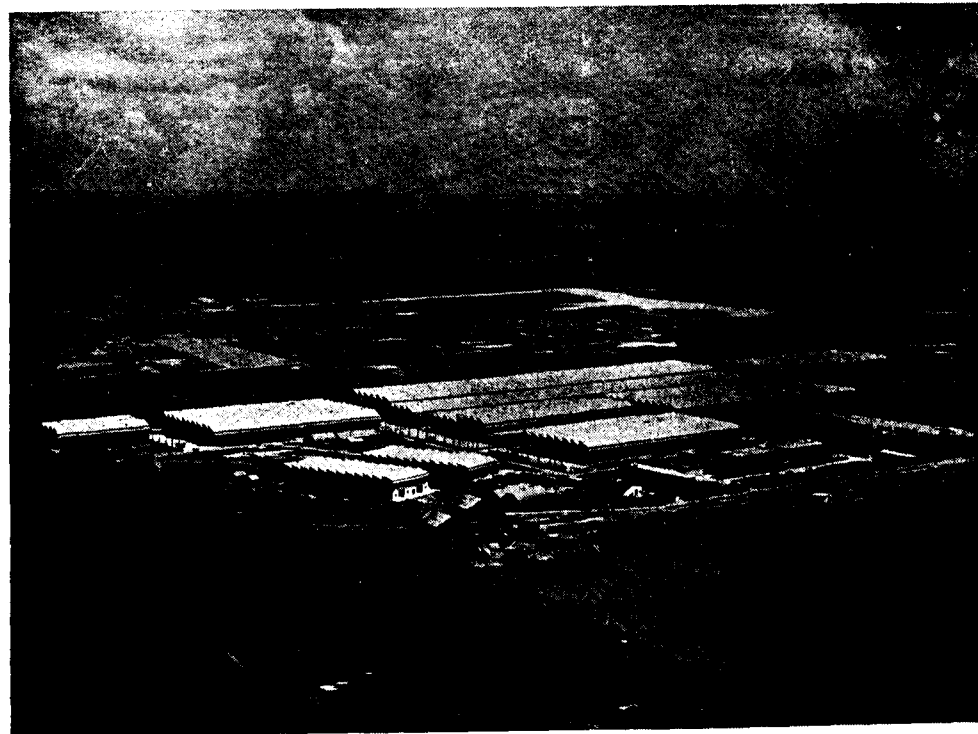
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An aerial view of the Integral Coach Factory area.



A view of the Technical Training School Apprentices Hostel.

the production of 250 body shells have already been installed and based on the experience gained, 417

Training School has been completed subsequently and is functioning since November 1956

extra machines inclusive of 220 portable welding sets have been ordered to step up the outturn from 250 body shells to 350 body shells a year. To obtain economical processing and interchangeability and easy assembly, almost all the details and sub-assemblies are manufactured on jigs and fixtures. 750 jigs and fixtures have had to be specially designed for the manufacture of these components.

Handling and storage have also been given careful attention in order to save on unnecessary handling costs and economise on the floor space. Most of this shop equipment has been manufactured in this Factory itself.

WORKERS AND THEIR TRAINING

The Factory will employ 4000 men when in full production. It was foreseen to train these men well in advance of production and the Technical Training School for training the technicians to the required skill was started as early as March, 1954. This school is producing skilled technicians in batches at a rapid pace.

A Hostel has been built to accommodate 250 boys undergoing apprenticeship at the school.

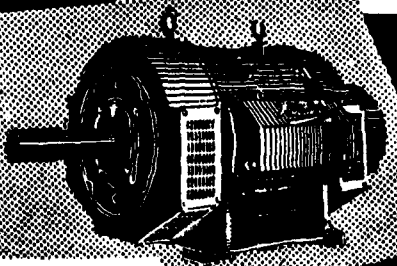
AMENITIES

A colony of 400 quarters has been provided to accommodate the essential staff. All the modern amenities are included in this Colony, which has a Primary School, a children's Park, a Recreation Club and a Co-operative Stores.

It has been the aim of this Administration to provide good working conditions for workmen in the Factory. Lighting and ventilation of the shops have been given special attention. Staff canteens run on a co-operative basis have been provided near the Main Entrance as well as in the Office. Water coolers to supply cooled drinking water have been installed in the shops. Bathing places



An inside view of the Integral Coach Factory Workers' Canteen where the workers are having their lunch. and lavatories have been provided at convenient places.

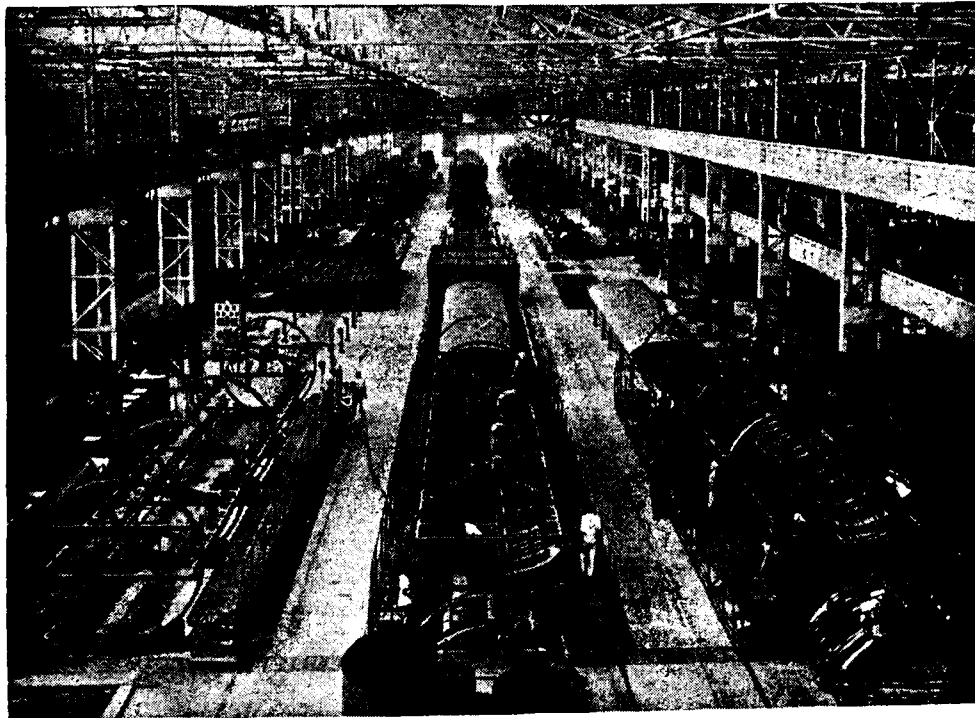



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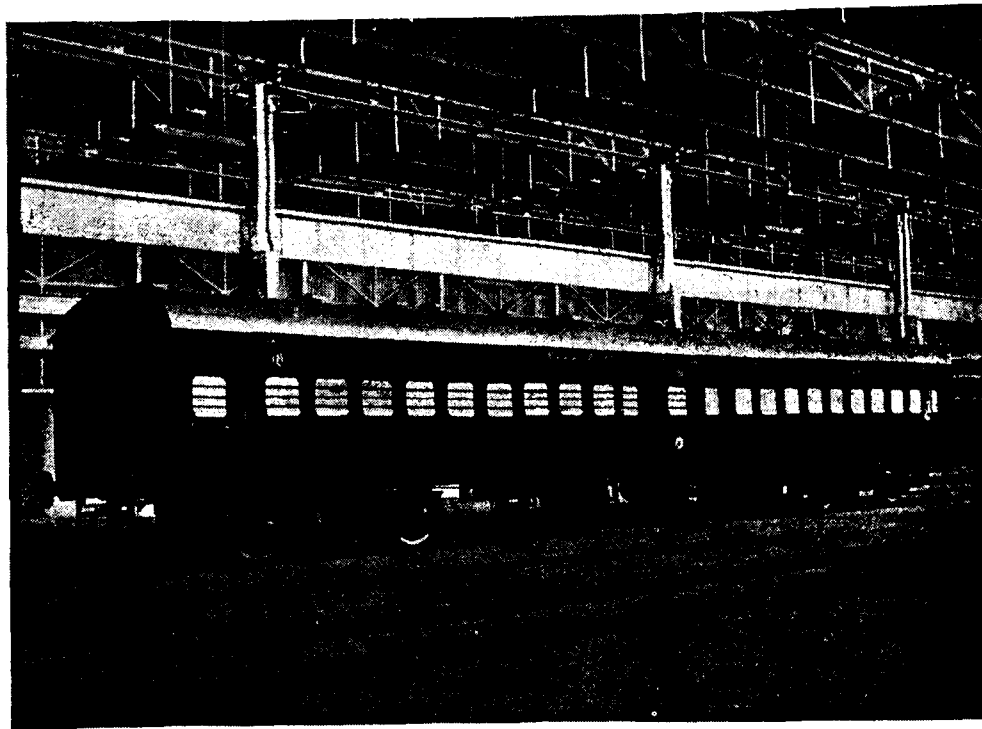
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A view of the Main Assembly Shop—1000' long—220' wide—with the three assembly jigs.



A view of the Integral Coach Manufactured in the factory.

FURNISHING PROJECT

The integral shells manufactured in the Integral Coach Factory were originally planned to be furnished

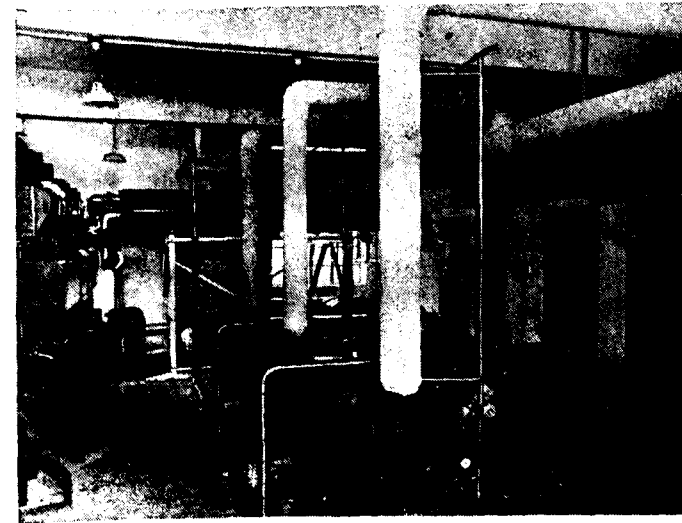
in Railway Workshops. On account of the Second Five Year Plan requirements and large expansions necessary on the Railways, the capacity in Railway Workshops is now required for timber coach building and for their increased needs for repairs and maintenance. Further, it was logically most economical to have the factory furnishing on mass production methods and produce the complete unit, viz., a coach ready for use. Hence, a furnishing unit has been sanctioned by the Government of India at a cost of Rs. 3.69 crores. This unit will be located close to the factory where about 240 acres are being acquired for the factory including some land for future additional quarters.

The proposed Furnishing Factory will have a covered area of 5.5 lakhs sq. ft. The factory buildings will be of modern design similar to the Integral Coach Factory, with ample lighting and ventilation and will cost Rs. 102 lakhs. There will be about 260 machines to enable a target production of 350 coaches of all types per year. To obtain economical and speedy work, jigs and fixtures will be used extensively for details and sub-assemblies.

A number of details and fittings will be obtained from the trade. Adequate storage has been provided

for and the entire design of storage and lay-out has been made to suit and economic handling of material.

It is estimated that the factory will employ about



The machine room showing three of the four Worthington Freon-22 Reciprocating Compressors. The main shell and Tube Condenser is shown in the rear of the machine room mounted above the condenser water circulating pumps.

2400 men when in full production. The training of the men required is also being planned by suitable

expansion of the Technical Training School of the Factory at a cost of about Rs. 4 lakhs.

A colony of 200 quarters is being provided to accommodate the essential staff. This Colony will be located adjacent to the present colony of the Integral Coach Factory. Future requirements of additional quarters have also been envisaged and a provision of land adjacent to the Factory has been made. The standards of amenities for good working conditions, cooled drinking water, bathing places and lavatories and also canteens and co-operatives will be planned on similar scales to those already planned for the Integral Coach Factory.

INTERIM FURNISHING

In order to expedite bringing into full production of the furnishing unit and also to find additional coach building capacity so badly needed for the expansion requirements of the Second Five Year Plan, arrangements have been made to commence furnishing work immediately. Development of

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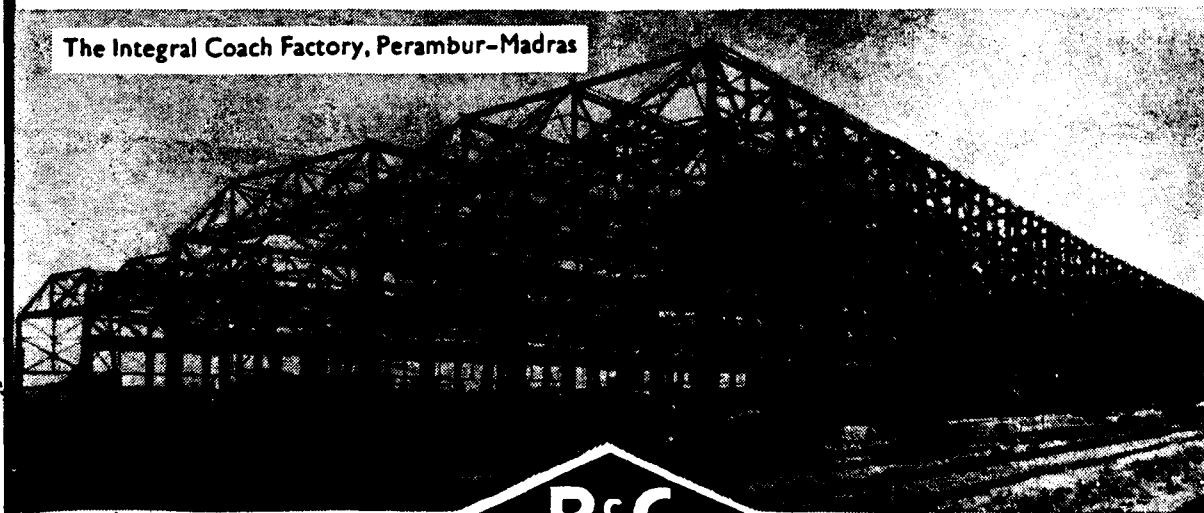
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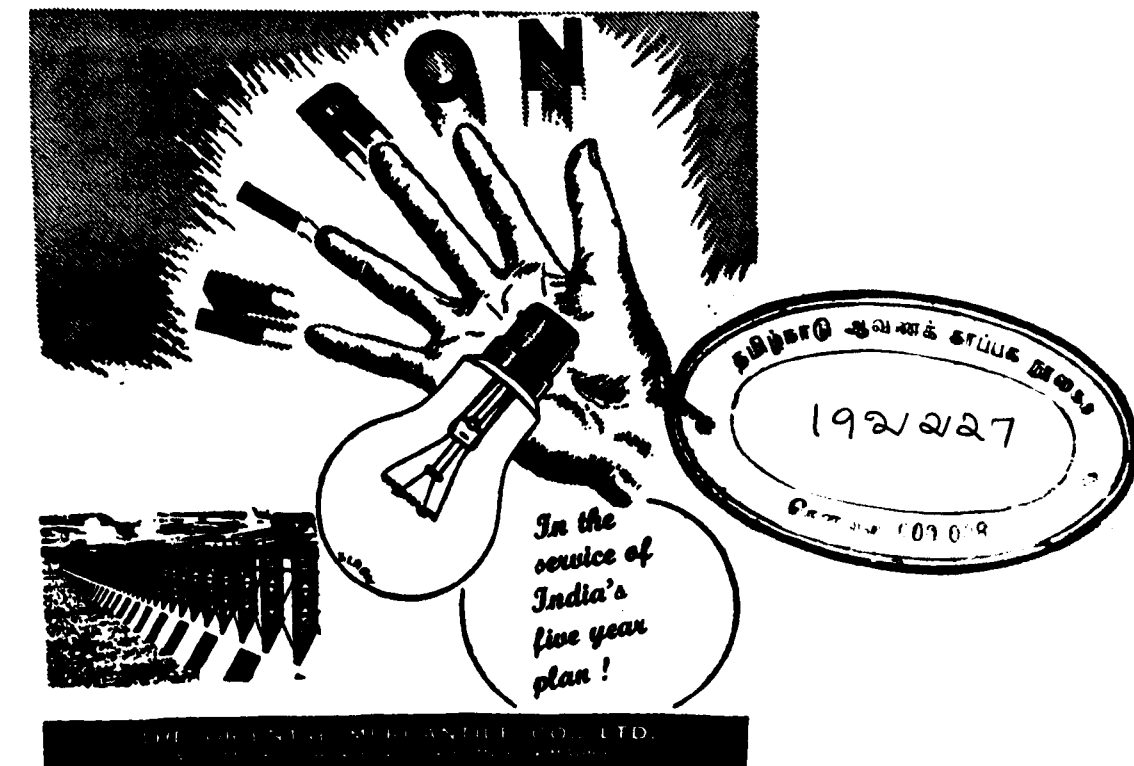
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technique and staff will be done gradually during this furnishing work. It has been started in a small free space available in the Integral Coach Factory. Temporary sheds have been sanctioned and are under construction in which further furnishing work will be undertaken. A small amount of machinery and plant costing about Rs. 6 lakhs will be obtained for the interim work which will all be subsequently utilised by the Unit. The interim furnishing programme has been so made that workshops of the furnishing unit will be utilised immediately they are completed and the staff of the furnishing switched over to the Unit. Thus, the unit will be brought into full production as soon as it is complete.

The first coach furnished in the Integral Coach Factory was launched into service by His Excellency the Governor of Madras on the 21st Feb. 1957.

This coach has been furnished for 3rd class. It has 4 lavatories, 2 in the middle and one at each end. The coach is divided into two halves by the middle

lavatories and the seats are arranged as one row of single seats along one side, a passage by the side of these single seats and transverse long seats on the other side. Each of these long seats takes 4 passengers. Two fans are provided for each pair of seats facing each other, seating 8 persons in the long seats and 2 persons on the single seats. Two night lights have been provided on each half of the coach. There are two shutters on each window, one of Aluminium venetians and the other of glass in an aluminium frame. The lavatories have been provided with mirrors and wash hand sinks. The commode is of Indian style and made of stainless steel. The flooring of the compartment and lavatories is of oxy-chloride Cement which gives a pleasing red smooth surface and lasting hygienic qualities. The coach body doors as well as lavatory doors are provided with chromium plated handles and spring-loaded catches, while additional locking has also been incorporated. The interior has been finished in light biscuit and buff colours, relieved by aluminium mouldings, giving a bright clean appearance.



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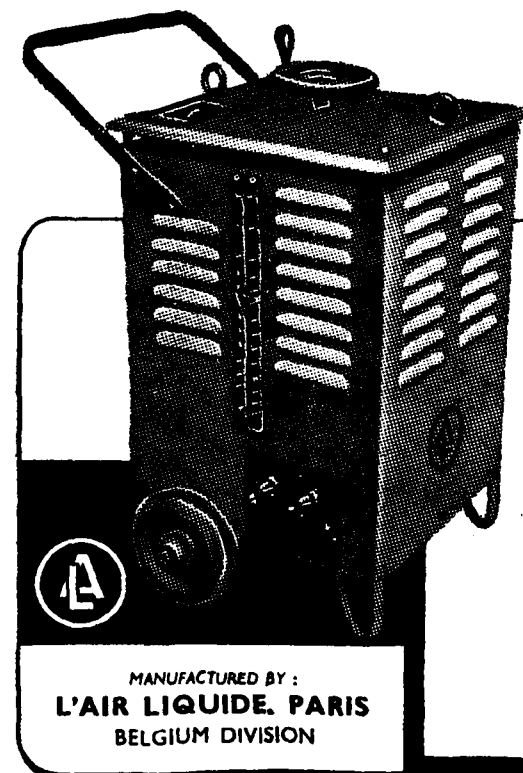
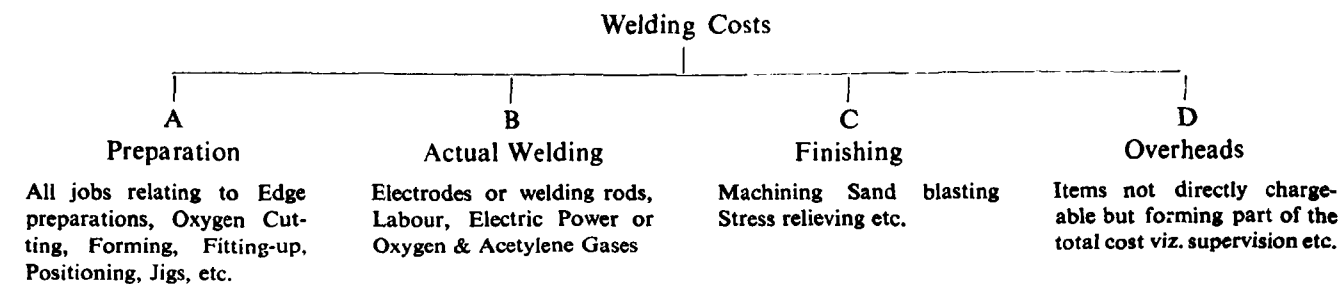
Estimating & Costing—Electric & Gas Welding

By P. K. V. Challam

IN any field of work, estimating and costing should play a significant role, as the aim of any undertaking should be to accomplish a job at a cost which is the lowest, consistent with efficiency and all other considerations. This principle equally applies to welding (both Electric and Gas) where, the non-observance of certain basic considerations may lead to a cost factor which might border on extravagance. An estimate is, however, only an intelligent anticipation

of the actuals subject to the influence of certain factors, and it will be appreciated that in welding, as most of these factors are more or less controllable, one can arrive at an estimated cost which may bear a very close relationship to the actual cost.

The following chart shows the various stages at which welding costs are incurred :



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A. PREPARATION

Oxygen machine or hand cutting or gouging has been recognised as an efficient tool in the preparation of ferrous metals prior to welding. The theory of metal cutting is that the metal to be cut is preheated to its kindling or ignition temperature and oxidised by means of a closely regulated jet or stream of Oxygen from a cutting torch. This oxidation creates an initial void or cut which is continued as the cutting torch is moved along the line of cut. By changing the angle of the cutting nozzle, we can achieve a bevel cut as will be seen from the various edge preparations shown below. Gouging helps grooves to be cut—see Fig. 3(e).

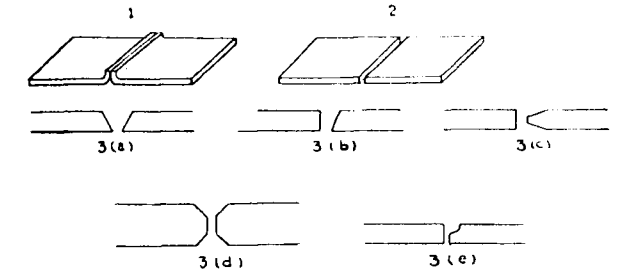


Fig. 1 shows edge preparation (flanging) for thinner sections and fig. 2 indicates square edge preparation for plates up to $\frac{1}{8}$ " thick. Fig. 3(a) to 3(e) show edge preparations for thicker metals.

Whether for gouging or for cutting, approximate data are readily available with regard to consumption of gases and thus cost calculations for the various preparations can be made with a fair degree of accuracy.

FORMING

Any economy effected in the process of Forming will naturally result in a corresponding economy in the ultimate cost. This process, however, depends for its economy not so much on any rigid pattern of forming, as on the skill of the operator or designer whose aim should be to form the plates to be welded in such a manner as to bring the ultimate costs to a minimum, compatible with strength. Perhaps the following illustration of two different methods of forming will help an easy understanding of the problem Fig. 4.

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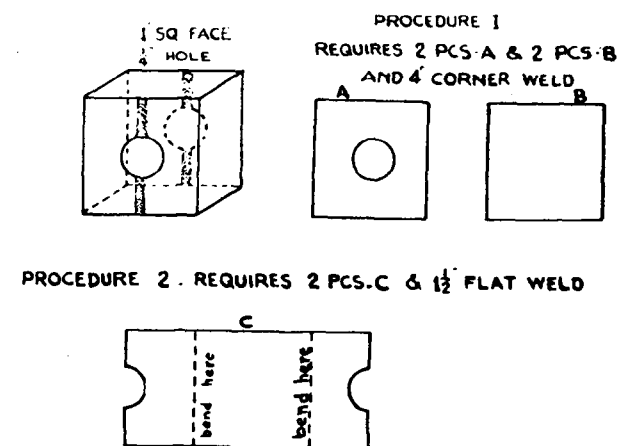
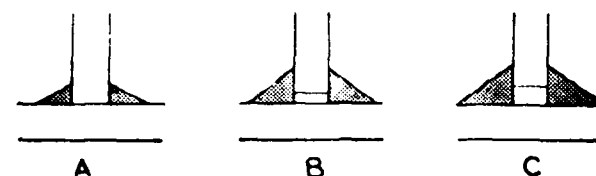


FIG-4

In the first case, we are met with corner joints and the total length of weld is also greater. In the second case, however, corner welds are avoided as also the total length of weld is considerably reduced. Where thousands of such pieces are involved, the ultimate economy can be easily understood.

FIT UP

An unconventional fit up may often retard the welding speed, besides increasing the volume of metal deposited and the ultimate costs. The following example illustrates this case. Fig. 5.



In the T Welds on $\frac{1}{4}$ " plates the metal deposited in the 3 examples are :

- A. .24 lb. per ft. of Joint
- B. .34 lb. " "
- C. .46 lb. " "

Fig. 5A does not show a gap but even if $\frac{1}{8}$ " gap were to be allowed, the difference in the metal

deposited between 5A & 5C is considerable. This is only one aspect of the problem. The other aspect is that a poor set up may retard welding speed by 50% in some cases, resulting in an avoidable increase in ultimate welding costs. The table below gives an idea of the retardation of speed for various unconventional set ups :

	Thickness			
	$\frac{1}{4}$ "	$\frac{3}{8}$ "	$\frac{1}{2}$ "	$\frac{3}{4}$ "
Speed with recommended gap of $\frac{1}{8}$ "	100%	100%	100%	100%
Speed with a gap of $\frac{1}{4}$ "	92%	89%	85%	83%
" $\frac{3}{8}$ "	76%	72%	68%	64%
" $\frac{1}{2}$ "	60%	56%	50%	45%
" $\frac{3}{4}$ "	51%	43%	36%	—

POSITIONING

It is an acknowledged fact that welding speeds are greater if the welder can always weld in the down

hand position. This, therefore, suggests that if the welder can convert other positions into downhand positions, there can be considerable economy in welding costs. Such positioning may not always be possible but in several cases a vertical upward weld can be brought to the flat position by proper positioning. The following illustrations will explain the position clearly. Fig. 6.

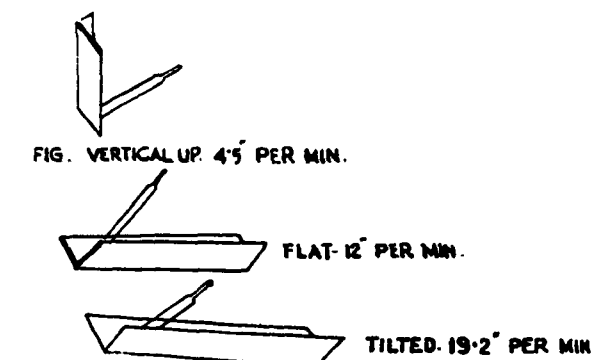


FIG-6

Another factor that affects ultimate welding costs is

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the use of jigs and fixtures which will cut down welding time considerably.

B. WELDING

The main items that go to make up the costs under this section are :

ELECTRIC WELDING	GAS WELDING
A) Electrodes	A) Welding rods & fluxes
B) Labour	B) Labour
C) Electric Power	C) Gases, Oxygen & Acetylene

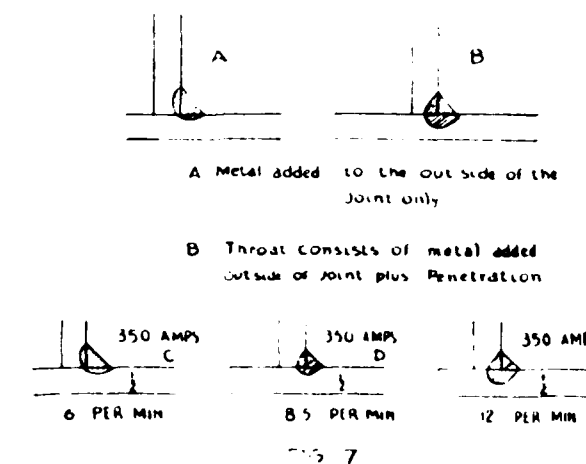
Let us now consider the various items as given above and analyse the factors that would go to reduce the ultimate costs.

C. ELECTRIC WELDING—ELECTRODES

Here the points to be considered are :

1. The size of the electrode to be used and, if fillet welds are specified, the correct size of the fillet welds.
2. The size of the electrodes used.
3. Selection of proper procedure.
4. Travel rate.
5. Current characteristics.
6. Type of Arc.
7. Building up V/S penetration.

The basic fact to be borne in mind when applying a certain welding procedure is that reduced costs are possible by faster travel speed and the use of the largest practical electrode with a correspondingly higher current. This does not, however, line up with the older thought that lower speed gives greater penetration. For example, a fillet weld with a faster travel speed and greater penetration appears smaller, but its strength is actually greater than the weld obtained on a lower speed. This is shown in the following diagrams : (Fig. 7).



All the welds (Figs. 7C to 7E) are carried out with a current of 350 amps. and all the joints have the same strength. This raises the interesting problem of slower welding resulting in build-up (Fig. 7C) V/S penetration obtained with a greater speed (Fig. 7E). The strength being the same the economy resulting from the method illustrated by Fig. 7E can be appreciated.

Fillet welds account for approximately 90% of welding in structural work and therefore, the selection of a proper size fillet compatible with strength and all other considerations becomes very important.

Supposing a fillet weld of leg length $\frac{1}{4}$ " is specified for a certain job and the welder for some reason or other chooses a leg length of $\frac{1}{2}$ ". The effect of this is that the area of cross section, and, therefore, the volume of the metal deposited for a given length of fillet weld were considerably increased as illustrated by Fig. 8.

The six graphs appended at the end of this article deal with data of quantities with regard to electrodes, labour and power for certain types of welds. From these, approximate cost of weld per foot can be ascertained for any given type of welding. Similar calculations exist for all types of welds in either sheet metal or thicker plates, but for want of space these could not be reproduced here. Perhaps a problem worked out will make the use of the graphs more clear :

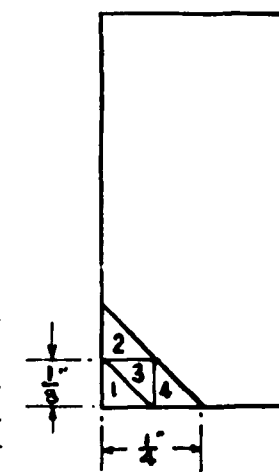


FIG- 8

PROBLEM

To find out the cost of welding 3 feet of $\frac{1}{4}$ " plates by adopting Butt Welding Single V groove in the flat position. Operator efficiency 50%.

BY REFERRING TO GRAPH 1

1. Electrodes :	
Lb. of electrodes per ft.	= .27
Lb. electrodes for 3 ft.	= .81 lb.
Cost of electrodes, say, at 0.12.0 per lb.	= 12 × .81
	= As. 9.72..(1)
2. Power :	
K. W. per foot of weld	= .45
" " for 3 ft.	= 1.35
Cost of 1.35 units at 0.2.0 per unit	= 2.70
	= As. 2.70..(2)
3. Labour :	
Maximum output at 100% efficiency	= 25 ft. per hr.
At 50% efficiency the output is	= 12.5 ft. per hr.
Cost of 12.5 ft. at 1.00 per hr.	= 1.00
Cost of labour per ft.	= 1/12.5 = 1.28 As.
" " per 3 ft.	= 3.84 As....(3)
Total	= 9.72 + 2.70 + 3.84
	= 16.26

To the total cost of 16.26 annas must be added overheads as discussed later. (Note: Costs of Electrodes, Labour & Power have been assumed).

C. FINISHING

Finishing the welds includes various operations such as grinding, stress relieving, heat treatment, painting etc. and the type of finishing necessary will depend upon individual jobs, and these are not amenable to any rigid specification or standardisation. It should be borne in mind that as these finishing costs form part of the ultimate costs, care should be taken to compute them accurately.

1) OVERHEADS

In any cost accounting, overheads are considered an important item and although an elaborate and

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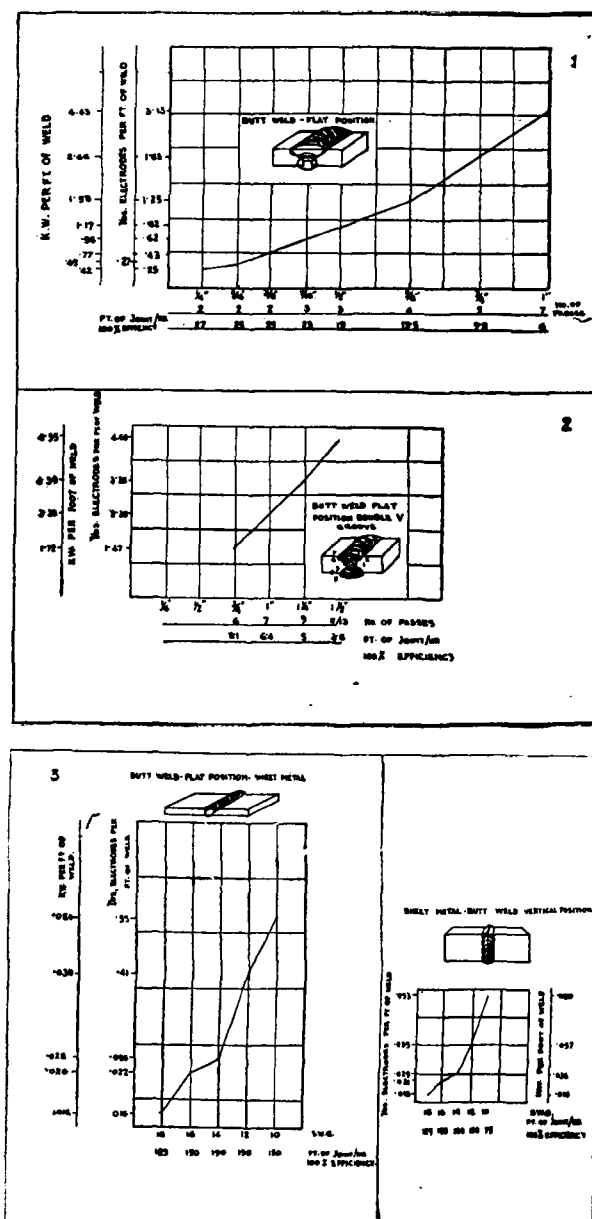
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accurate system of computation and allocation exists, in welding, it may be accepted as a round figure equivalent to labour costs. The scientific aspect of this formula may be open to question, but for purposes of estimates this basis may yield satisfactory results. Overheads, however, change from establishment to establishment and this is another reason why a rigid pattern of assessment of overheads is not possible.

COST OF COMPUTATION WITH REGARD TO GAS WELDING

The items to be considered are :

1. Welding rod and fluxes.

(Continued on page 59)

2. Labour
3. Gases Oxygen and Acetylene.

As ferrous metal welding, especially mild steel, is considered throughout this article fluxes are to be left out of consideration as no flux is required for M. S. Welding. With regard to welding rods and labour, the previous mode of Estimating (Electric Welding) can be applied.

Regarding calculations of gas costs, the following formulae can be employed.

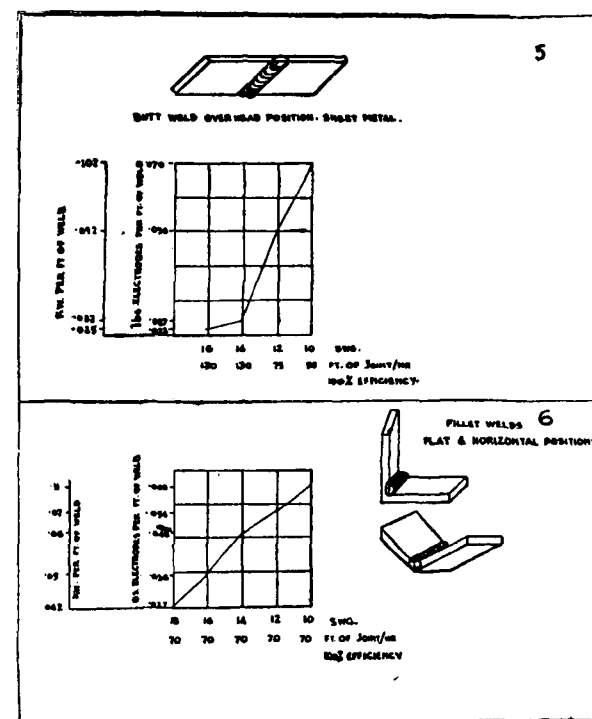
OXYGEN

The following 3 types of industrial Oxy cylinders are available.

80 Cft. 100 Cft. 200 Cft. at 120 Atm. pressure.

These cylinder will contain, 88, 110 and 220 Cft. at 132 Atm. which is the pressure to which Oxygen cylinders are filled at the moment.

To find out the quantity of Oxygen consumed in a particular job, record pressures before and after use, and find the drop in pressure in atmosphere (15 lb. per atm.) and use the formula :



Further BICC Submarine Power Cable Commissioned in Canada

ANOTHER GREAT ANGLO-CANADIAN PROJECT

ON Sunday, 13th July, 1958, a second circuit in the 138,000-volt submarine power cable link between Vancouver Island and the mainland of British Columbia was put in commission. The cable was manufactured for the British Columbia Electric Company by British Insulated Callender's (Submarine Cables) Limited at their Trafford Park Works, Manchester. British Insulated Callender's Construction Company Limited, who were responsible for the laying and testing, chartered H. M. T. S. Monarch to transport the cable from Manchester to Vancouver and to lay the four continuous lengths between the mainland and Vancouver Island.

The existing submarine power cables, which were also manufactured and installed by the BICC Group, have been in successful operation since September 1956. These, with the two continuous lengths of 16 miles and two of about 3 miles, required to complete the second circuit, plus a spare cable, bring the installed length of submarine cable for this remarkable power link to a total of over 133 miles. The combined

current-carrying capacity of the two circuits, which bring Bridge River hydro-electric power to Vancouver Island, is now 250,000 kilowatts, a capacity greatly in excess of that of any similar undertaking in the World.

The 138,000-volt cable is of the single-core gas-pressure type. The 0.35 square inch conductor consists of a spiral steel duct over which are applied two layers of copper wires and a conducting screen of three impregnated metallised paper tapes. The dielectric, which itself is screened with copper tape, consists of pre-impregnated paper tapes. The lead alloy sheath is reinforced by tin-coated bronze tapes over which is applied vulcanized rubber. Then follows a jute yarn bedding and a single layer of galvanized steel wire armouring. These wires are protected by two bituminized layers of jute yarn.

The overall diameter is nearly four inches and the weight of the entire 133-miles of cable is about 5,400 tons.

(Continued from page 58)

drop in Atmospheres	×	2/3 Cft. for an 88 Cft. cylinder.
do	×	5/6 Cft. for 100 Cft. cylinder.
do	×	1.2/3 Cft. for a 220 Cft. cylinder.

ACETYLENE

To find the amount of Acetylene used in a particular job, ascertain the weight of the full or partially full cylinder before and after use and calculate the wt. of Acetylene (in Lbs.) used, and apply the formula :
1 lb. of Acetylene = 14.5 Cft. of Acetylene.

IRON ORE MINING IN RATNAGIRI

An assurance that Government would give all possible assistance to the iron-ore mining industry in the Redi region in Ratnagiri District for its proper development was given by Shri S. K. Wankhede, Bombay's Minister for Planning and Industries, while presiding over a meeting of the Redi Development Committee.

Redi, a minor port at the southern tip of Ratnagiri District, has been exporting iron ore, of which there are large deposits in the area.

The Minister said that Government was aware of the development taking place in that region and complimented the private sector on prospecting the mines and exporting iron ore to foreign countries. He added that due importance would be given to the region in the Master Plan for Industries which was under preparation.

Automatic compressed Air Installation at Integral Coach Factory, Perambur, Madras

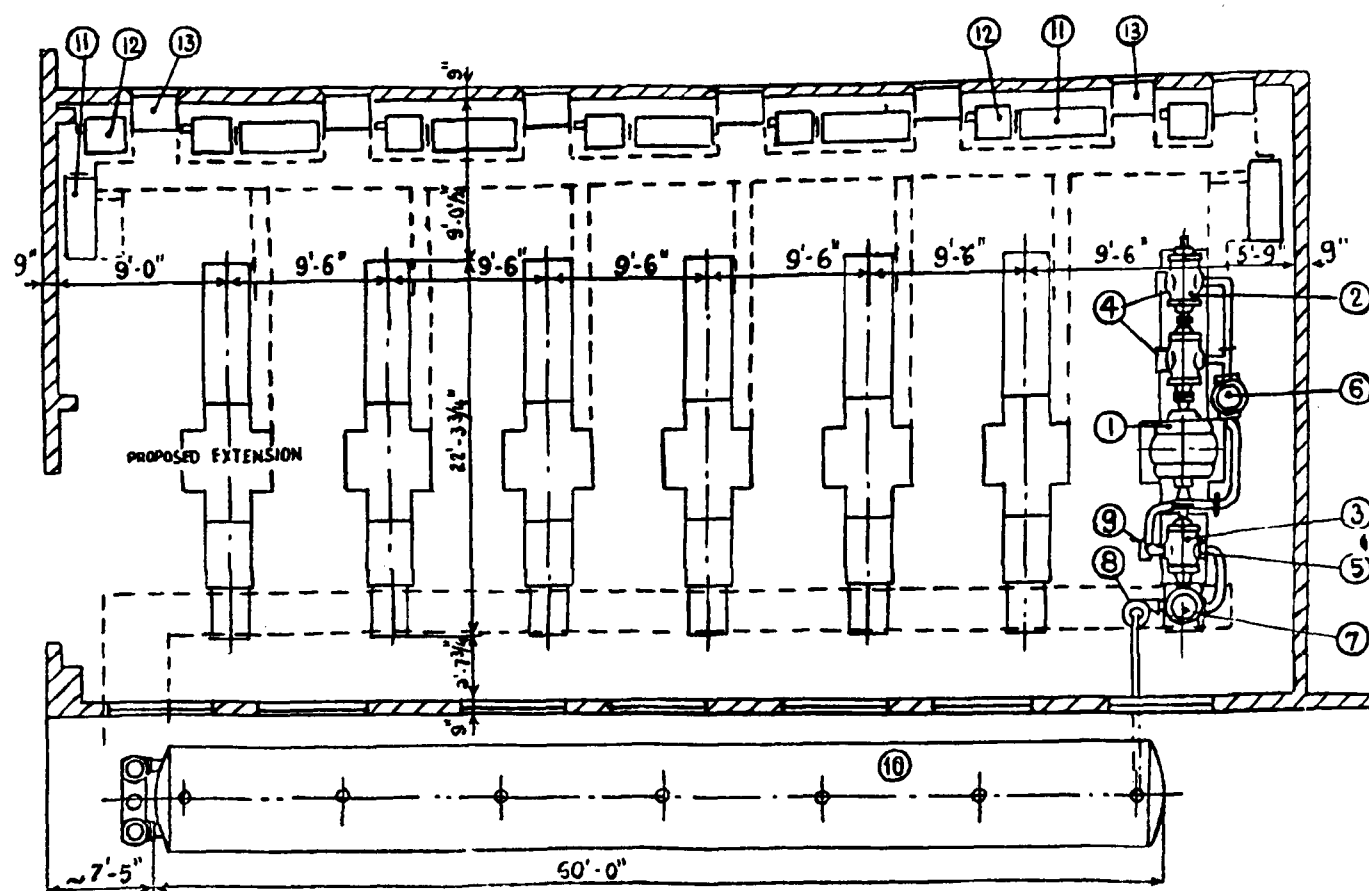
THE process of manufacture of coaches requires practically in all various stages and departments, compressed air in various quantities and at different pressures. As the demand of compressed air for such a large factory is fluctuating considerably, the layout of the compressor station has been given special consideration. In pursuance of the general policy the most efficient and modern equipment was selected.

While planning the installation, not only the general requirements and necessary pressures had to be taken into consideration but also the location of the compressed air station, the fluctuating demand and the peculiarities of the factory in general. The installation having to operate fully automatically, the space

available being limited and in order to reduce the receiver capacity to a minimum, selection of a rotary type of compressor was called for. This type offers considerable advantages, particularly in respect to automatic operation, continuous airflow, limited space required, light and small foundations.

The total requirement of the factory was estimated to 7100 cfm., divided for the various departments, as follows :

A) Sheet metal shop	700 cfm.
B) Body and Bogie shop	1300 „
C) Assembly shop	400 „
D) Smithy	3350 „



- | | | | |
|-------------------------------|--------------------------|-------------------------------|-----------------------|
| 1. Electric motor | 4. Air filter & governor | 7. Aftercooler | 10. Air collector |
| 2. Compressor K 95, 1st stage | 5. Non-return valve | 8. Condensate & oil separator | 11. Rotary converter |
| 3. Compressor K 95, 2nd stage | 6. Intermediate cooler | 9. Condensate trap | 12. Starting rheostat |
| 13. Apparatus cubicle, ASEA. | | | |

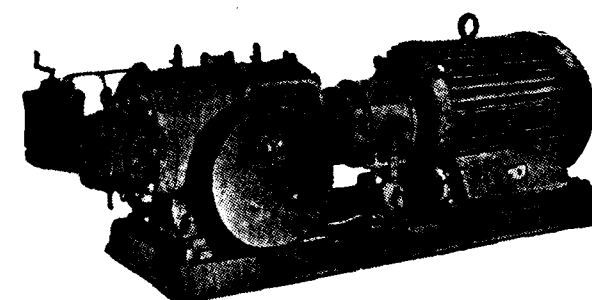
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Rotary Air Compressors & Vacuum Pumps

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Works under close technical collaboration with

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Our Current Programme (1st phase) includes :

- Single stage Units upto 535 cfm.
- Single stage Twin Units upto 1070 cfm.
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S L M are also well-known builders of:

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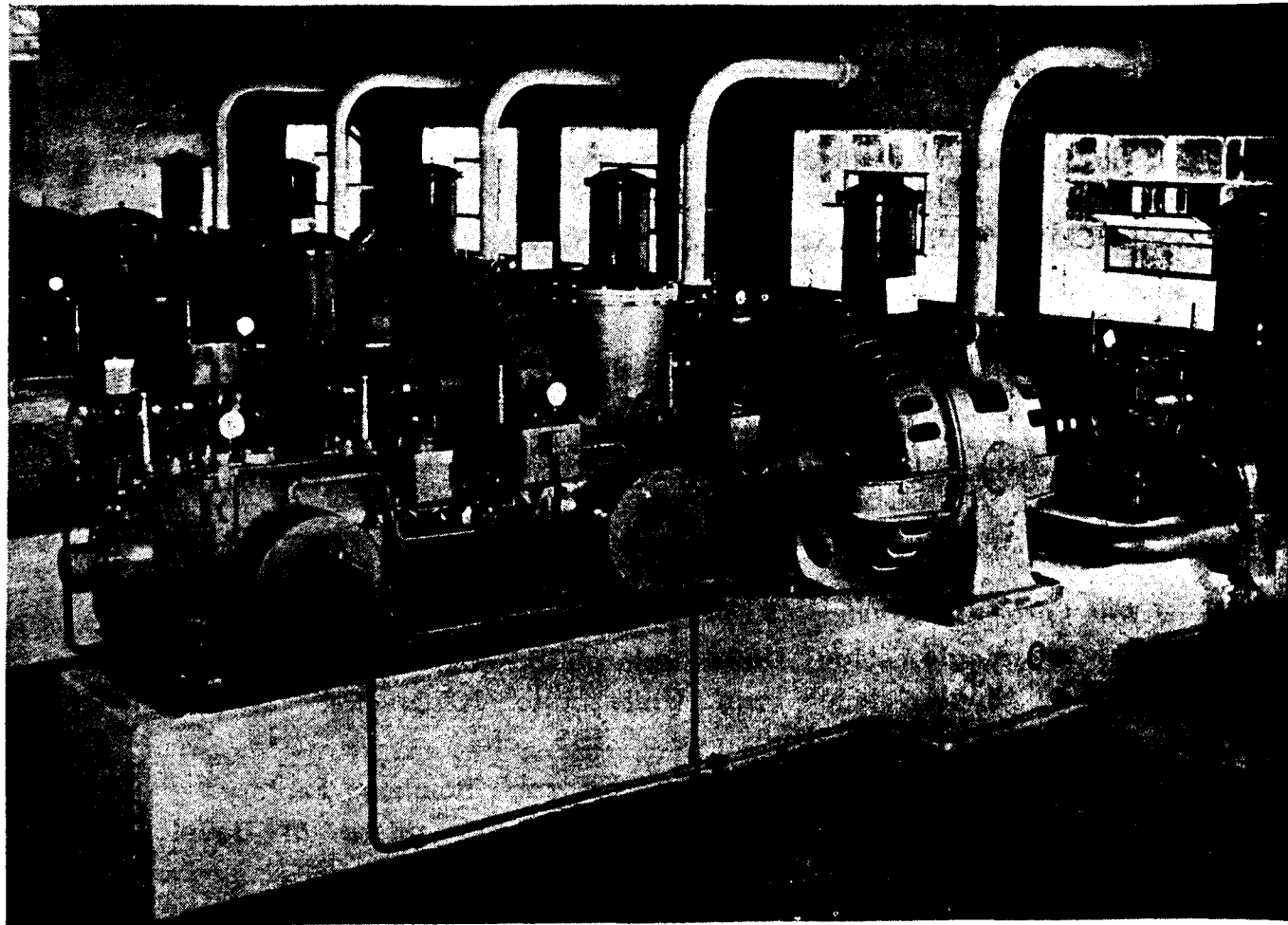
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D1) Fitter shop	350	„
E) Machine shop	300	„
F) Millwright/Tool and Dieshop	300	„
J) Window and Prototype shop	400	„

The working pressures were estimated to range from 85 to 120 psig. The order for the machines was subsequently placed with the Swiss Locomotive & Machine Works, Winterthur, Switzerland, through their Branch Office in Bombay.

For economy's sake and flexibility in service, 6 SLM 2-stage rotary compressors, each with a capacity of 1375 cfm. at 100 psig., running at a speed of 750 r.p.m., were selected. The twin first stages and a single second stage of the same size with mostly identical parts allow maximum interchangeability of spares.

The compressors are driven by auto-synchronous motors placed between the 2 first and second stages. This type of motors supplied by Messrs. ASEA was

selected, in order to improve the power factor of the factory.

All the groups are fitted with a double automatic regulation, cutting automatically the supply of compressed air when the required pressure is reached and switching off subsequently also the electric motors. The compressors are working at full capacity and maximum efficiency only, inasmuch as they will automatically be put into service only if the pressure decreases to a preset limit.

The automatic equipment includes also the automatic cut-in and cut-out of the cooling water. The compressors are also supplied with a centrifugal separator for the extraction of water and lubricating oil from the compressed air. The extraction of condensed water is of particular importance, especially in view of the fact that humidity at Madras is rather high.

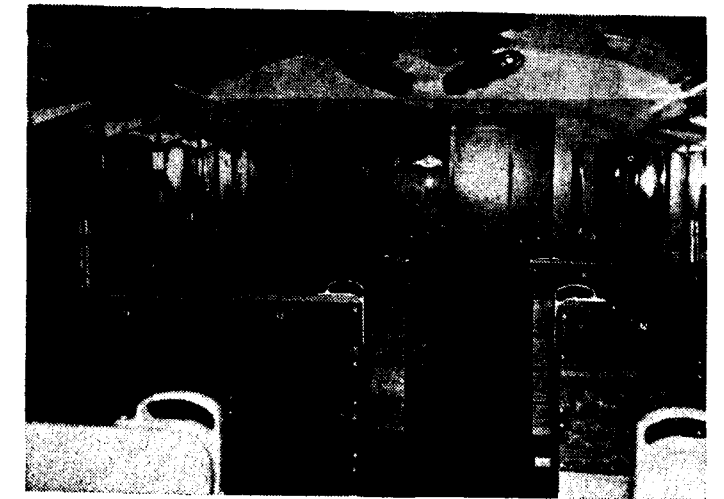
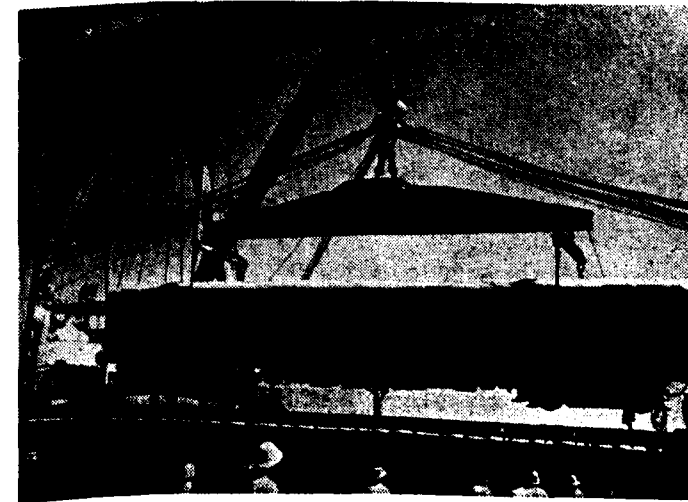
The air is supplied from the compressors to a

collector of 1870 cft. placed outside the compressor station. From this collector the air is distributed to the various departments and also to the smithy, where four additional receivers, each of 1400 cft., are provided to meet the highly variable load of the hammers.

The compressors are cooled by closed circulating system which includes forced draft cooling tower with sprayers.

In order to reduce the frictional and other losses to a minimum, sufficiently large mains have been selected, so that practically the pressure produced at the compressors is also available at the different consumer points. The mains form a ring, from which any section of the factory can be supplied in case of a local pipe defect.

The compressor-station has been placed inside shop B, i. e. opposite the smithy. The photo represents the compressor-station consisting of 6 units.



Interior view of the diesel railcar.

12 diesel rail cars and components for 660 metre-gauge rail wagons, the final shipment in a Colombo Plan project under which Australia provided Indian Railways with 24 diesel rail cars and 2,000 rail wagons (total value Rs. 4 crores), arrived at Madras early this month.



(Left) A high level Railway conference was held to review the progress of Railways and to devise measures for further improvement of Railway operation. Mr. Ramizuddin Ahmad, Central Minister for Communications, Govt. of Pakistan, presided.

Interesting N-E-W-S To Foundrymen!!

HAVE you ever had an opportunity to see the massive iron pillar near Qutubminar at Delhi? This iron pillar of Ashoka which had baffled metallurgists from all parts of the world is a sufficient proof to indicate that iron founding in India is an art which has been practised since times immemorial. The data collected by historians adequately confirms that in the mountain regions of Himalayas particularly in Nainital and Almora districts we had a flourishing iron industry several hundred years ago. Unfortunately this has become a thing of past and India is lagging far behind in this type of industry compared with the present developments in countries like the U. S. A., the U. K., Germany and Sweden. Now if we look into the existing conditions of foundries in our country it is needless to state that these are still lagging far behind in the concept of techniques, facilities, environment etc., all of which go to improve the productive capacity of any undertaking. Most of our foundries are still employing the age old methods of moulding viz. 'half in the floor and half in the box'. This will never answer the increasing demand; nor will it ensure the dimensional accuracy of castings. As we develop in our industrialisation, the specifications and the requirements of castings produced in the country would be more and more exacting and obviously the Founder of today will consistently and eagerly look forward to methods which will enable him to attain this objective within his limitations. Because of this growing industrialisation, the foundries in India will be faced with a challenge to meet the demands from the other industries. The 'big' question is: Can the foundry industry meet this challenge successfully? The answer to a large extent depends upon the ability of many foundries and foundrymen to change attitudes and practices long-standing. Many foundries are not making full use of the available technological and scientific knowledge. Many do not realise that it is not possible to produce quality castings in disorderly surroundings. Many resent new ideas, new techniques, new machines and new materials. It is high time the founders who still practice the age-old methods changed their attitudes and adopted the modern methods. Mechanisation is YOUR answer!

IF MECHANISATION IS YOUR PROBLEM,
ASK US FOR SOLUTION

If the thought of mechanisation in a foundry comes in, the immediate idea in one's mind would be

employment of *pneumatic moulding machines with the necessary moulding boxes, pattern plates* etc. for the same. It should be emphasised here that any success of mechanised foundry or for that matter any type of foundry, basically depends upon the conditioning and control of sand on the floor. It is imperative that a close control of sand and the conditioning practice that is being adopted in the unit should be exercised to have optimum rate of production in a mechanised unit. This has become a necessity because the foundry practice today is a scientifically developed method of work rather than the conventional way of practice that is being popularly adopted in our country. Few enlightened industrialists have accepted this and are gradually switching over to this concept and they are being rewarded for their efforts. *Thus the mechanisation commences from the point of conditioning the sand which will necessarily include sand conditioning plant consisting of a screener, magnetic separator, sand muller and an aerator.* From this unit one could obtain perfectly conditioned sand which will have to be distributed to the moulding station at different points according to the layout that has been decided upon depending on the conditions obtaining in the foundry. WESTERWORK Engineers are versatile in solving the foundries' problems.

THE WESTERN MANUFACTURING CO., are proud of their records of service to Indian industries over the past 15 years. The firm, though chiefly engaged in the design, manufacture and supply of complete foundry, mechanical handling equipment and furnaces of various types, has a separate Division for importation of latest and up-to-date plant and machinery and is in a position to cater for the requirements of industries in general and foundries in particular.

REMEMBER !

No Foundry is Too Small - None Too Large
YOU CAN ALWAYS COUNT ON THE TECHNICAL ADVICE OF
'W-E-S-T-E-R-W-O-R-K'
ENGINEERS - THE PEOPLE WHO ARE SPECIALISTS
IN THE LINE

Successful Foundries all over the world specify
'BMM' Moulding Machines
YOU NEED 'BMM' MACHINES FOR
CASTINGS OF IMPECCABLE QUALITY AND STANDARDS

THE MOSCOW METRO

By B. Meskin

EVERYONE who has occasion to see the Moscow Metro is struck by its spaciousness. It never even occurs to a visitor that he is deep down under the surface. Such is the abundance of air and light in the city's underground electric railway system known as the "Metro".

Muscovites love their Metro and are proud of it. Architecturally it is the finest in the world. More than 50 different varieties of marble, granite and other finishing materials have been used to trim the stations and vestibules, and the picture panels and sculptural compositions give the stations a festive appearance.

ORIGINAL IDEA REJECTED BY CZARIST CITY ELDERS

Though the Moscow Metro has been in operation

a little over 20 years, the idea of building an underground in Moscow first occurred much earlier. It was as far back as in 1902 that Moscow's ground was examined to see whether an underground railway could be built. But the city fathers—the city Duma—decided its fate. With undisguised cynicism, they said :

"Sure enough an underground will be more convenient and faster than the tram and the fare will be cheaper. But it will kill our tram."

And so the project was rejected.

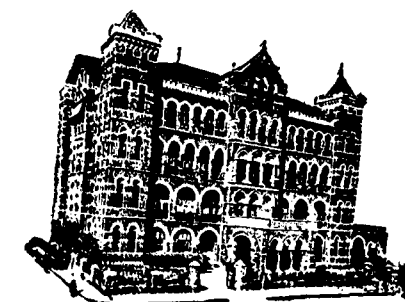
Balinsky, a Russian engineer, worked out another plan providing for partly underground and partly surface railway, but that plan also met the same fate.

Thus, the initiative of building an underground

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in Moscow was buried.

IDEA REVIVED AND EXECUTED AFTER REVOLUTION

After the Great October Socialist Revolution Moscow began to grow very rapidly. Many factories, schools, residential buildings and scientific institutions were built and new streets and squares appeared. Moscow became one of the world's largest cities.

Along with the growth of the town and its population the city's transportation facilities were being developed. By 1931 the capital's population had gone up 73 per cent compared with the time before the Revolution, and traffic had increased more than four-fold. There, no longer, was enough room to expand the surface transportation network and a metro became an urgent necessity.

In June 1931, the Soviet government adopted a decision to reconstruct Moscow, and the decision provided also for the building of a metro. A year later, an army of workers, many thousand strong, started on the job.

In New York it took seven years to build 20 kilometres (1 Kilometre = 5/8 of a mile) of subway, and it took London four years to build 10 kilometres. In the USSR 11.4 kilometres of tunnel were constructed in only three and a half years.

In February 1935 a train covered the whole route of the Metro's first section—from Sokolniki to Central Park.

SUBSEQUENT GROWTH

Twenty-three years have passed since regular traffic began on the underground railway, and during this time the Metro has grown beyond recognition. Mileage has increased almost sixfold and a considerably bigger number and variety of equipment has been brought into use. New types of coaches have been designed and built and an improved system of automatic blocking is widely used, ensuring a high degree of safety. Automatic and remote control operation has been widely introduced.

In choosing the direction of lines, the streams of



Construction of a passenger platform of the USSR Agricultural Exhibition Station of the Moscow Metro.

passengers and conveniences were both taken into consideration. For instance, the purpose of building the Great Belt was to connect almost all railway stations, and to improve the service to the advantage of Muscovites and transit passengers.

The underground electric railway saves much time for the capital's people. It has practically abolished the concept of distances even in such a large town as Moscow. Today it is only a matter of minutes to go from one end of the town to the other, which took hours previously.

Passenger traffic has gone up considerably. While in 1935 the Metro carried some 180,000 passengers daily, this year it carried 2,500,000 and some days 3 millions.

FACING THE FUTURE

In the office of the chief of Moscow's Metro hangs a large map, and stretching lengthwise and crosswise like the web of a spider are the Metro lines. That is a map of the Metro in the future. Work on its construction does not stop for a single day. Next year new sections will go into operations.

The long-range plan for the Metro's development envisages construction in the next few years of more lines in the new and rapidly growing districts of the USSR's capital.

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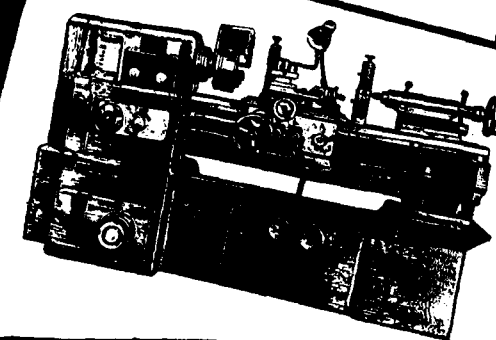
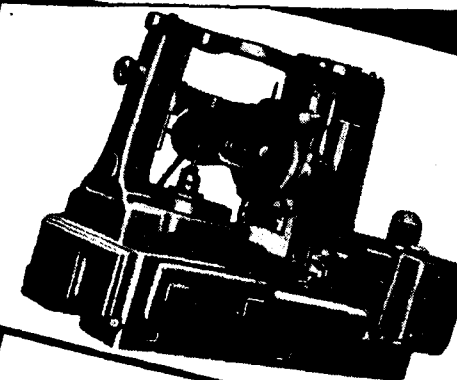
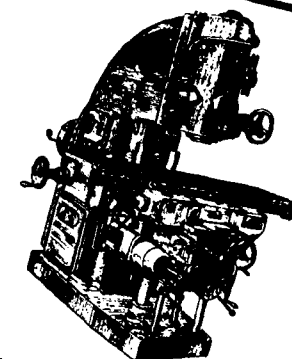
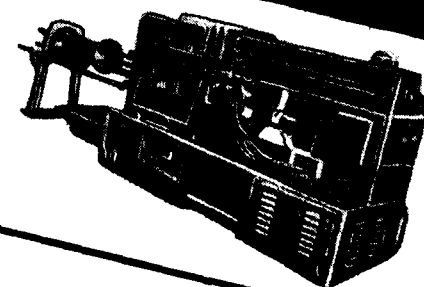
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CARRIAGE PAINTING

WITH the vastness of the Indian Dominion and the network of Railways passing through varied climatic conditions as it passes from one part of India to another, after years of prolonged exposure tests, Fancutt's Specification for painting of coaching stock was adopted. This process was used for a number of years with considerable success, but as it involved a thirteen day operation in all, it was felt that coaching stock could not be detained for so long, and hence in course of time, it was modified to suit the needs and conditions of the country.

The coach bodies in the past used to be entirely of timber, but with the passage of time and improvements which have taken place, the coaches are now also made of mild steel panels and there are a few also of aluminium.

The present specification consists of nine bay operation which include the following processes:—

EXTERIOR

The mild steel panels are deoiled and a protective primer applied prior to fabrication. The interiors of the panels are given two coats of Red Lead and allowed three to four days to dry in the construction shops. After complete construction of the coaches it is then sent to the Paint Shop, here it receives one coat of Red Oxide Oil Primer which is followed by a minimum of two coats of Brushing Filler. In the event of the plates being slightly dented these sections are filled up with Knifing Filler which is applied between the filler coats. The next operation consists of rubbing down between the filler coats with Pumice stone and Pumice Powder which gives a very fine surface to paint on.

This is followed by one coat of Synthetic Undercoating and allowed to dry overnight. The following day this is again rubbed down and given one coat of an approved brand of synthetic Enamel. The first

finishing coat of enamel is rubbed down with cuttle fish Paint and water. This operation gives an extremely smooth base for the second and final coat of synthetic enamel which follows.

In the next operation the lettering is completed with the monograms stencilled and then the entire surface is flatted down with No. 320 or 400 waterpaper and finally a coat of varnish applied as a protective. As stated previously, this entire operation takes nine days.

INTERIOR :

Over the mild steel plates, teak veneered panels of a beautiful design are fitted. These are treated with two coats of Ragging Wood Filler which fills the pores of the wood and provides uniform smooth finish. Thereafter it is given a minimum of four coats of French Polish which enhances the beauty of the veneer greatly.

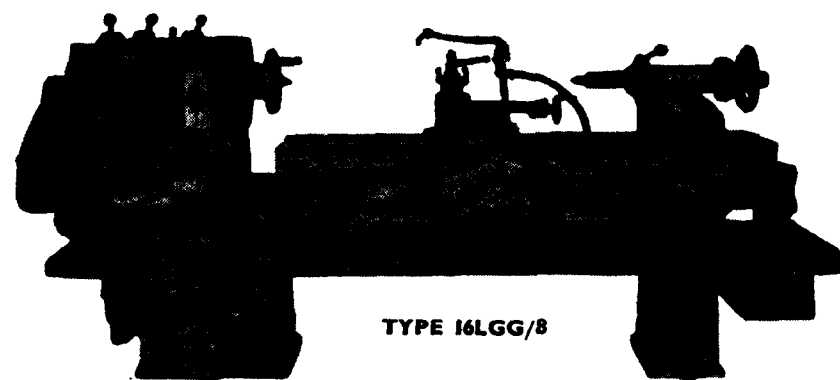
The ceilings are generally of three ply or masonite and occasionally of Hylam sheets, when available,

although 3 ply is largely in use, the ceilings are painted with 2/3 coats of Flat Oil Paint over a coat of Primer.

In the past, different Railways used to have a different colour scheme but with Independence, the colour scheme has been standardised for all Railways which consists of Gulf Red for the sides and black for ends.

Although the general public are not aware nor appreciate the amount of work that goes into the making and maintenance of these coaches, the Railway Authorities are constantly thinking of improvements both in material for building of the coaches, amenities for the passengers and cooler and cheerful colour schemes to make the journey no matter how short or long, a pleasant one.

In order to maintain these coaches in an absolutely first class condition, the Mail and Express Coaches including air-conditioned coaches return after nine months for what is called 'C' class painting schedule which consists of washing down of the



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LATHES Type 16LGG, 8" centre, 8' gap bed, all geared headstock heavy duty lathes.

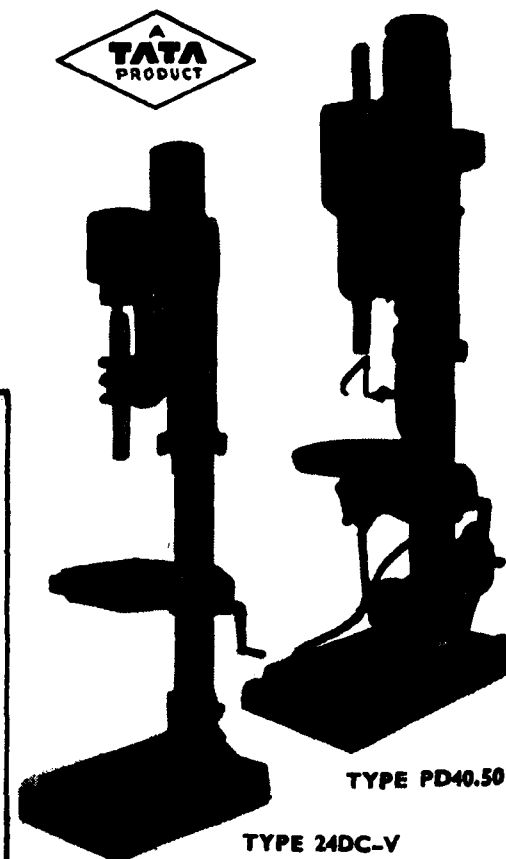
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24DC-V Model, 1 1/4" capacity, 6 speed, all geared, direct coupled motorised autofeed pillar drilling machine.

PD 40.50 Model, 1 5/8" capacity, 6 speed, all geared, direct coupled motorised autofeed pillar drilling machine.



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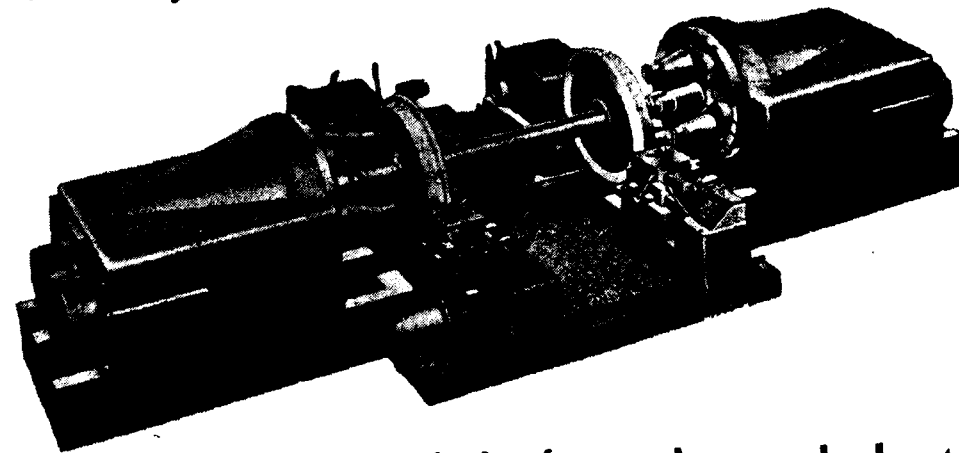
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type TLA-112

dia range 750 - 1120 mm

gauges 1000 - 1676 ..

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- RAFAMET** supply machine tools for all types of wheel sets
- RAFAMET** guarantee full and prompt service to their customers
- 1000 RAFAMET**—machines are operated in numerous railway workshops and repair shops all over the world

PRODUCTION PROGRAMME

Semi-automatic lathes for machining railway wheel sets

dia. range 550 - 2250 mm

gauges 100, 1435 - 1324, 1676 mm

Special boring and turning mills for tyres and wheel centres

dia. range 500 - 2100 mm

Machines for burnishing axle journals and burnishing attachments to be used with universal lathes for machining locomotive piston rods and short shafts

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piston rod dia. range 30 - 110 mm.

shaft dia. range 30 - 110 mm.

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coaches all over again, and applying one coat of Undercoating, two coats Synthetic Enamel which is followed by lettering and a protective coat of varnish as previously. Other coaches return after 15/30 months for repainting.

Normally the 'A' class painting schedule which was explained at first, is followed by three 'C' class schedule of painting over a period of four years before the old paint is completely stripped to the bare metal and repainted again with the complete process.

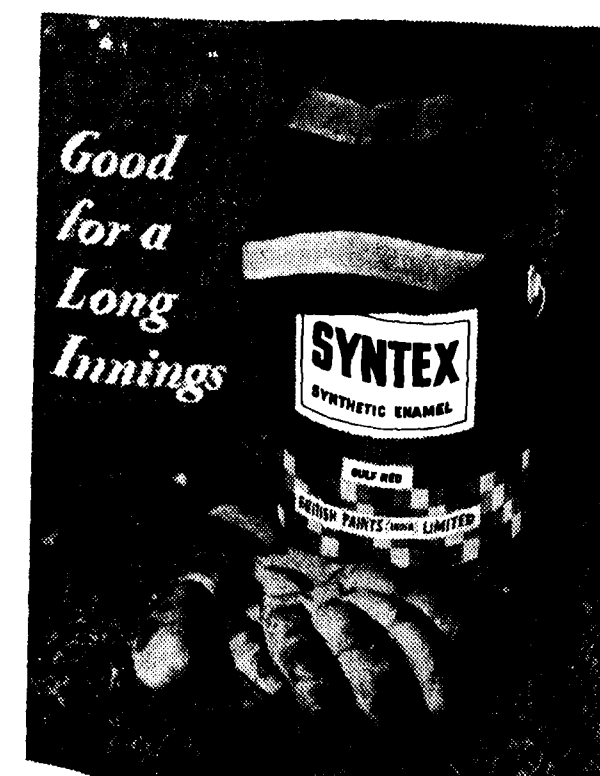
It has been found that Alkyd types of resin give the best results for coach painting in so far as durability and exposure to the elements are concerned.

Very few of the public are aware of how much hard work has to be put in the painting of these coaches both internally and externally. Each operation requires careful examination and proper rubbing down before the next coat is applied and this care and attention must be maintained throughout the painting, otherwise the results will not be satisfactory. That

the results are excellent goes to prove that men with many years of experience each in his own line, combine together to produce beautiful painted coaches for the general public. Unfortunately, the public do not appreciate this, in the way baggages are stacked against the walls of the compartments or the beautifully painted surface is covered with dirty hand-marks, no sooner the new coach is put on the rails.

In spite of this, Railway Authorities are constantly in search of improvements and better amenities for the travelling public. The recent being the use of Pliofoam cushions for the upper class coaches. For the lower class coaches they have increased the seating accommodation which originally allowed for 18" of depth but it now provides a minimum of 21". They have also designed a back rest which folds and forms into a bed.

Finally the interior of the coaches are painted in carefully selected pastel shades which harmonise with the upholstery of the coaches and gives a cool and pleasing effect.



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The Kolomna Diesel Electric Locomotive Works

By Y. Graftsky

THE locomotive emitted a low whistle, signifying "Step Aside", the factory gate opened and the locomotive moved out, its fresh paint gleaming.

That was not an ordinary locomotive, but as the inscription below the number read: "the last steam locomotive to be built by the Kolomna Works."

Kolomna, an ancient Russian town on the Oka, a tributary of the great Volga River, has been a centre of locomotive industry in Russia for a long time; its first steam locomotive was manufactured in 1869. Almost half the locomotives made in tsarist Russia were built by Kolomna workers.

After the October Revolution, the factory was completely reconstructed and line production was introduced. Production increased several fold. In 1949, 135 out of the 140 types of locomotives produced in the USSR were manufactured at the Kolomna plant.

And then, towards the end of August 1956, the factory made its last steam locomotive. Well, a machine like a human being, lives its day and passes out. No matter what you will do with a steam locomotive you will not get more than eight per cent efficiency out of it, which means that more than nine-tenths of the fuel consumed by the engine goes to waste.

Today, more productive and more economical engines are supplanting the steam locomotive, which has served man not at all badly. Its place is being taken by new locomotives—electric, diesel-electric and gas-turbo locomotives.

A new page in the story of the Kolomna plant opened when the factory went over to the manufacture of diesel-electric locomotives. Diesel electric locomotives have an efficiency of 25 per cent, develop higher speed than steam locomotives, and pull trains of 3,000 tons or more easily over the most difficult gradients.

Some specialists abroad assert that at least 10 years

are required to convert a steam locomotive plant to one producing diesel electric locomotives. In Kolomna the job was done in one year.

What has changed in the factory?

The machine shops have gone over to a higher precision category. While before, most operations required a fourth to seventh precision category, second and sometimes even first category is required in machining diesel electric locomotive parts.

This required the installation of many new machines. While formerly in the section of the machine shop of which Romanov is foreman the holes for bolts in the connecting rod were scraped by hand, today several modernized machines have been installed, which, besides making it possible to mechanized a difficult labour-consuming operation, also makes possible the scraping to be replaced by grinding, ensuring greater exactness in machining the surfaces of parts.

Substantial changes have taken place in the production of castings. Three heating furnaces have been set up in the heat treating shop for annealing moulds, and in view of the considerable increase in the output of aluminium parts, the chilled moulds section of the non-ferrous metals foundry has been substantially enlarged and a new section put in, in which automatic machinery for skin-dried moulds has been installed, which does away with machining of the castings.

The assembly department too has changed beyond recognition. The only thing left from the steam locomotive days is the pits over which the steam locomotives were placed for final finishing and checking of the mechanisms. The shop has been enlarged to practically double its former size. You will not find there today the clouds of smoke over hanging the lights or the oil spots smeared all over the floor. The assembly shop has become cleaner, brighter and more spacious, and new sections have appeared: tubes, electrical, fitting and final inspection.

And the workers have learnt new trades.

For example, Yevgeni Barkov and his brigade used to assemble the steam-distributing mechanism—the heart of a steam locomotive, and now they have been given the task of assembling the main unit of the diesel generator and the power mechanisms.

The whole brigade had to be trained again. Barkov was sent at the factory's expense to Kharkov in the Ukraine to train at the diesel electric locomotive works in that city and the other brigade members were trained at the Kolomna works. The training did not cost them a farthing, while learning their new trades they received their average wages.

Special courses were arranged in the factory for hundreds of workers who had to learn new trades.

Lev Lebedinsky, the factory's head designer, told us that the plant was now manufacturing locomotives with 2,000 h. p. diesel engines and weighing 20 tons. However, they have completed the design of a new engine of 3,000 h. p. weighing no more than 12 tons, and soon the plant will begin to produce them. In addition, they are working on the design of a gas-turbo installation for gas-turbine locomotives.

New Rail Line via Second Yamuna Bridge

MEASURE TO AVOID CONGESTION

IN DELHI AREA

The Railway Board has sanctioned the construction of a new railway line, 16 miles long, between Ghaziabad and Tuglakhabad along the second bridge over the Yamuna river at Delhi. The line is estimated to cost Rs. 2.97 crores.

The primary object of constructing the new line is to provide an "avoiding" line for diverting goods traffic from Tuglakhabad and Ghaziabad without its having

to pass through the extremely busy yards at Delhi and New Delhi.

The second object is to start passenger trains bound in the direction of Allahabad, Lucknow and Calcutta from New Delhi instead of Delhi Main, as at the latter station the platform capacity is extremely limited. The construction of the line will also help to add to the number of trains that can be handled in the Delhi area.

The construction work is being entrusted to the Northern Railway.

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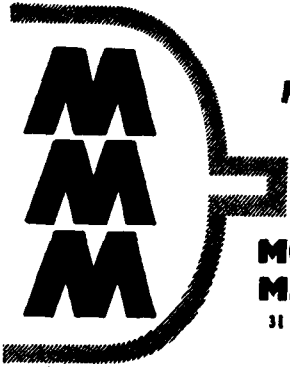
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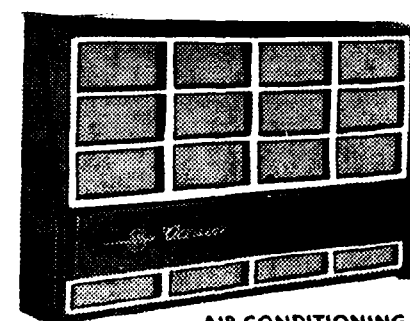
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Production of Integral Railcoaches at HAL

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 revolutionary 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

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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 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.

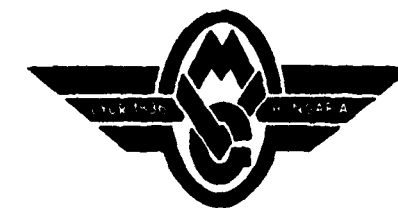
Apart from its contribution to the modernisation of third class travel in India, HAL's railcoach manufacturing project has helped the country save much needed foreign exchange. In the construction of the present conventional type of coaches, more than 95% of the materials and fittings used are of indigenous origin. Even wheels are obtained locally. The only major item which is still being imported is the under-frame. 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 dependence 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.

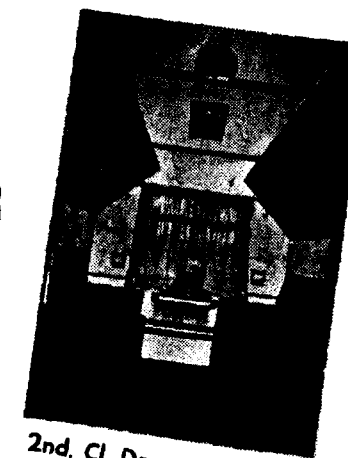
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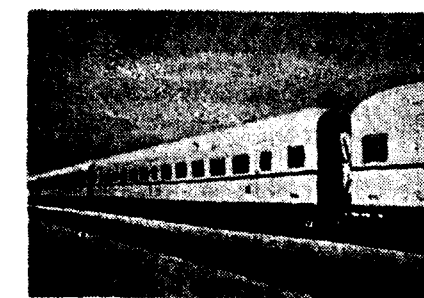


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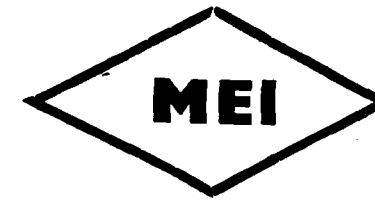
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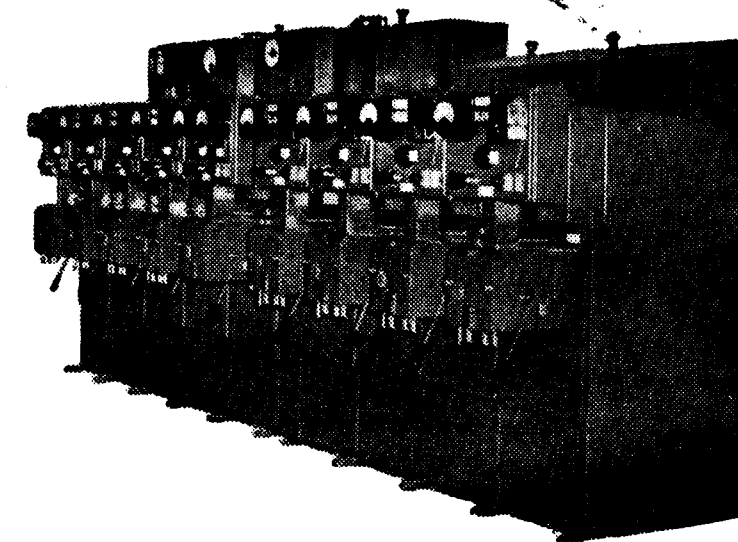
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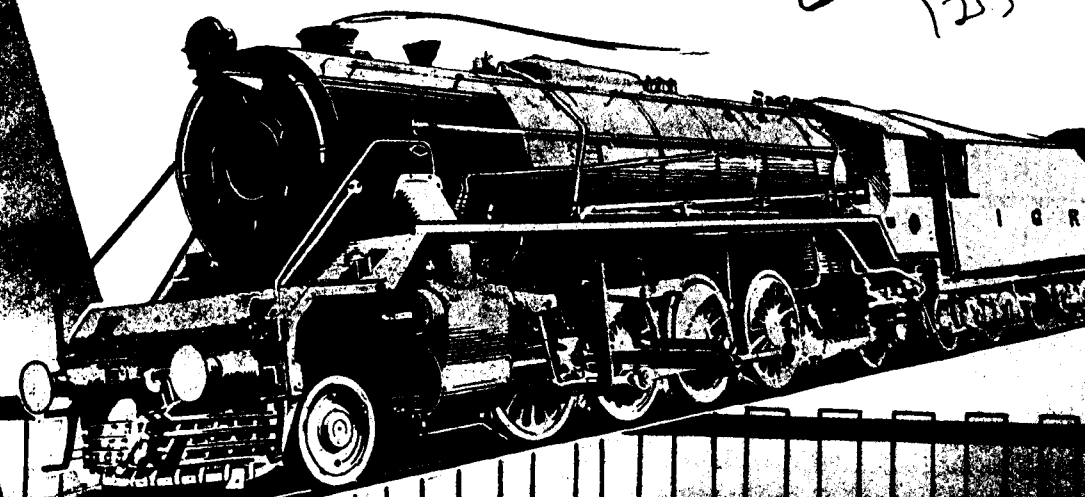
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**SOUTHERN
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July 1958

Price As. 4/-

G-E Develops Suspension System for New High-Speed Locomotives

A new high-speed locomotive suspension system has been developed here by General Electric's (U. S. A.) Locomotive and Car Equipment Department for use on its universal locomotives.

The new system literally "floats" the locomotive's superstructure on rubber mounts located on the swivel trucks, Globe Press Service reports.

G-E engineers say that this system offers by far the best method of absorbing both lateral and vertical rail shocks, thus improving the riding qualities of the locomotive.

According to J. K. Erzer, Manager of Diesel-Electric Engineering at the Locomotive and Car Equipment Department, the new suspension system has "great potential for reducing truck and track maintenance."

The trucks, which constitute the locomotive's running gear, consist of truck frames, axles, wheels and electric traction motors, and carries the locomotive superstructure. All G-E universal locomotives have two trucks, each with two or three axles.

These locomotive trucks are made to swivel so the locomotives can easily negotiate curves. The locomotives are used in any type of railroad service—freight, passenger or switching.

The basic principle of the G-E floating bolster truck design is the use of four curved rubber mounts (on each truck) that carry the entire weight of the locomotive. These rubber mounts are located between the truck bolster and the truck frame proper allowing lateral motion between the truck frame and the cab. The curved shape of the pads provides a banking motion for the cab when this lateral movement takes place.

Many attempts have been made to give locomotives a comfortable and smooth ride. The most successful previous method was the use of the swing-bolster truck, which provides a banking motion during lateral swing.

"However", Erzer says, "the conventional swing-

(Continued on page 5)

bolster support is expensive; first, because of the initial cost of the intricate arrangement of heavy steel parts, and second, because of the additional length for a truck where the traction motors on each of the axles occupy all of the useful space between the axles.

The new swing suspension system, Erzer says, "eliminates the complicated and inaccessible support members on conventional lateral motion trucks. Gone, too, are the fast-wearing metal-to-metal contact surfaces that are inherent in other suspension systems".

A very important advantage of rubber over spring suspension is its ability to absorb high frequency vibration. During a lateral motion of the locomotive, the rubber's natural restoring action returns the superstructure to its normal position.

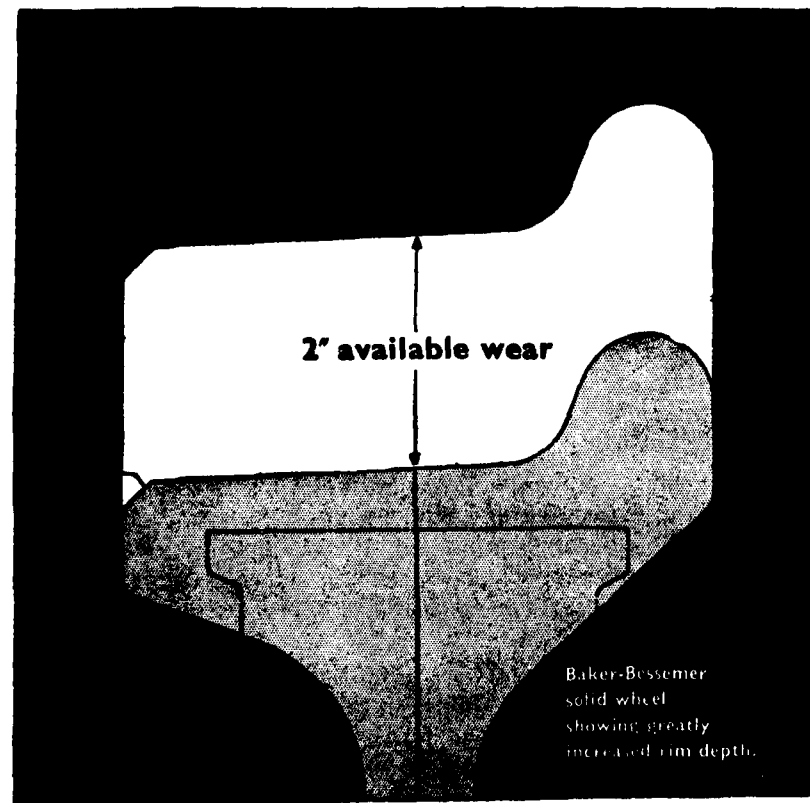
Erzer says this new system is particularly useful on high-speed rail vehicles.

"As speeds of trains are increased," he explains, "the axles tend to oscillate laterally more violently between the tracks. It is essential that a truck for a high-speed locomotive be provided with a suspension which will absorb these oscillations without transmitting them to the cab. This provides a more comfortable ride for the crew and reduces road shock to the equipment.

Furthermore, the excellent riding qualities of the new suspension system will not deteriorate during the life of the truck. There are no wearing parts in the rubber mount, as there are in the swing-bolster suspension system.

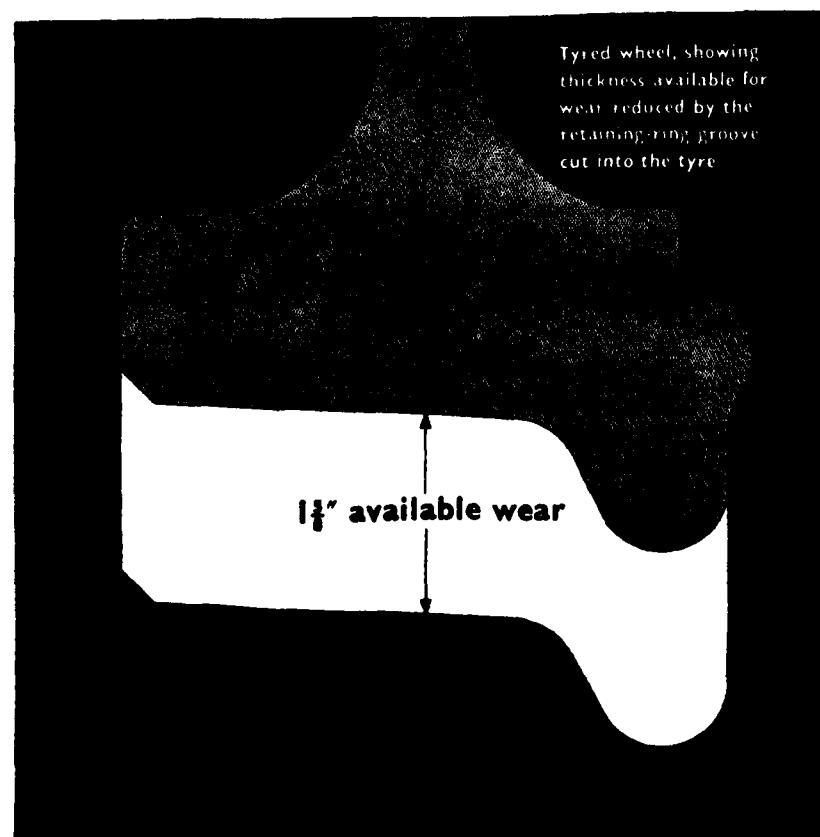
Also lower locomotive maintenance cost comes as the result of the elimination of wearing parts in the suspension system. With the rubber mounts, it is also easier to maintain trucks since all truck parts and traction motors are more accessible.

Track damage is lessened by the rubber mounts' ability to prevent excessive lateral forces from developing.

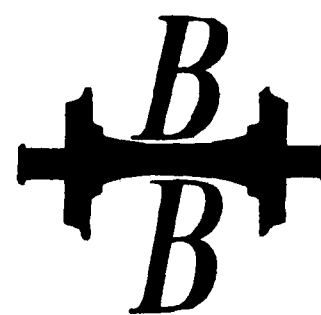


The solid wheel has an initial life 20% greater than the corresponding type of tyred wheel. This is fully illustrated by a comparison of the solid wheel, I.R.S. Drawing No. WA. 22, and the built-up wheel to I.R.S. Drawing No. WA. 23.

More than 20% increase in life



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THE MANUFACTURE OF ROLLING STOCK IN FRANCE

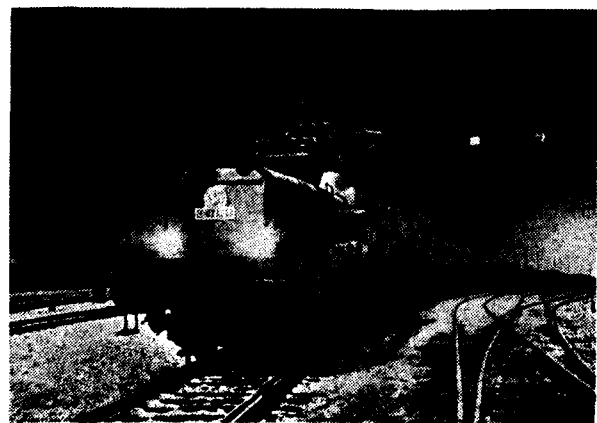
(From our Overseas Editor)

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).

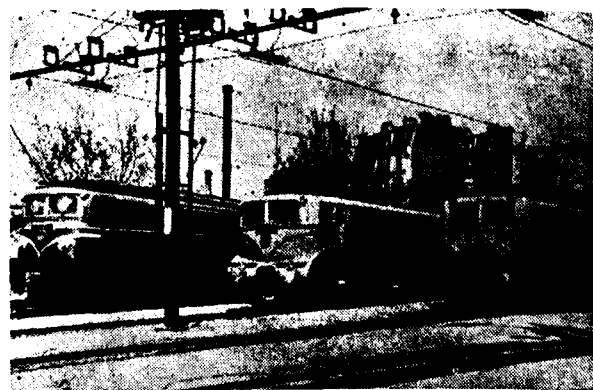
French construction is essentially quality construction, stemming from both the skill of technicians and labor, and from the continuous co-operation which exists between the builders and the S. N. C. F. (French National Railways) engineers. This collaboration has brought about distinguished accomplishments



Electrification with industrial AC. current (25,000 V, 50 cycles). A locomotive of the "mono-continuu" group serie CC. 14.100, starts a freight train of 1800 tons with ease 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 built with wide margins of safety.

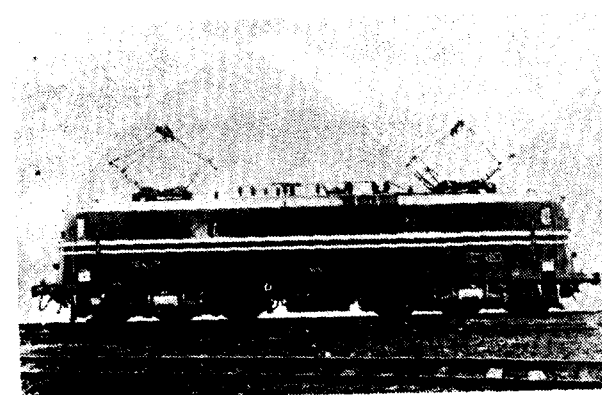
Also to be included in the list of French technical successes is the development of electric tractions on 25,000-volt alternating industrial current. For this, BB 84-ton engines are used (75 m. p. h., accelerated freight trains, passenger trains), as well as 126-ton CC's (38 m. p. h. for heavy trains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

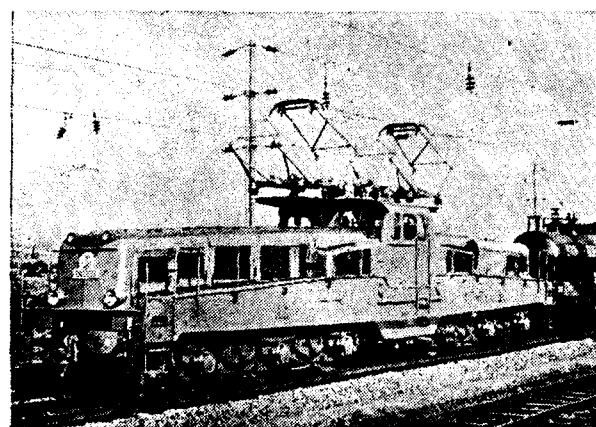
- 120 tons, Diesel motor (slow) of over 2,000 H. P. for heavy freight trains,
- 100 tons, 2 Diesel motors (rapid) with a total power of 1,800 H. P., destined to replace completely steam locomotives in an entire area.

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 suitable 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-continuu" group, serie CC. 14-100.

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

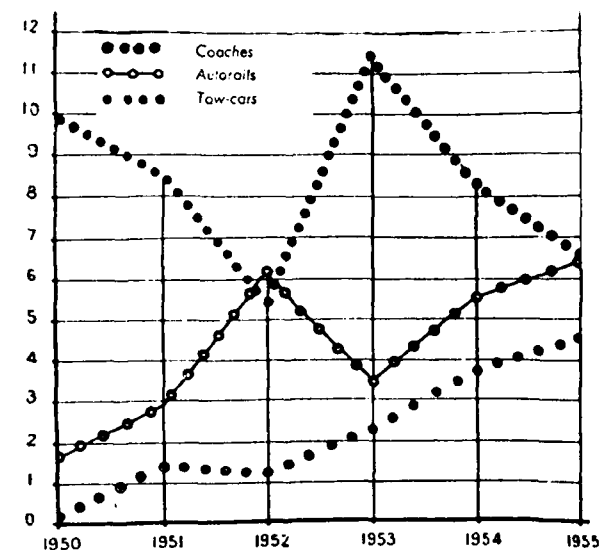
Research to make autorails as light as possible has led to a general use of light alloys and welding.

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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

ROLLING STOCK



increased speed and comfort, are indeed the train of the future.

* * * * *

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"

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.

(Continued from page 1)

All G-E universal locomotives now use the new suspension system, including those sold to railroads in Argentina, Brazil, Chile, Colombia, and Turkey. This same system could be used for other types of rolling stock, and G-E has applied for a patent for the system along these lines.

MORE G-E INDUSTRIAL LOCOMOTIVES FOR TATA STEEL MILL

Working to step up local production of steel and give India a more favourable trade balance, the Tata Iron and Steel Co. has purchased six modern General Electric (U. S. A.) diesel-electric industrial haulage locomotives for use in its mills.

The order was placed with the International General Electric Co., and the locomotives were constructed at G-E's Locomotive & Car Equipment Department in Erie, Pennsylvania. Delivery was completed in June, Globe Press Service reports.

This order brings to 30 the total number of G-E industrial locomotives purchased by Tata. Twenty, including the most recent six, are 80-ton models, two are rated at 115 tons, three at 35 tons and five at 25. All are 66-inch gauge and outfitted with special equipment allowing them to operate in the extreme dust, heat and humidity conditions encountered in the blast furnace area of the mills.

Total value of the recent order is approximately \$ 600,000.

At present, India produces approximately 1,900,000 ingot tons of steel per year—approximately one per cent of all the free world's production—and must import several hundred million dollars (U. S.) worth annually to meet her expanding needs.

Through the construction of three new mills and the stepping up of production in two existing mills, including Tata, India hopes to correct this import situation and obtain a more favourable balance of trade.

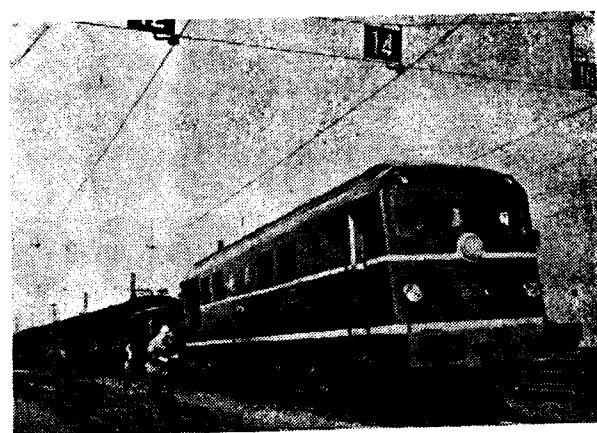
An industrial haulage locomotive is a vital part of a steel mill's operation. It is used to haul ore, coke and other steel-making ingredients into the plant; carry carloads of molten metal from the blast furnace to molds; transport finished steel to shipping depots; and remove waste slag to dumping areas. In short, it is used in every phase of production.

The new G-E equipment for Tata has been specially modified so as to permit operations within the physical limitations of the company's mills.

The steel industry is the biggest user of industrial haulage locomotives and the purchase of modern motive power by Tata is the necessary first step in her planned production increases.

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.

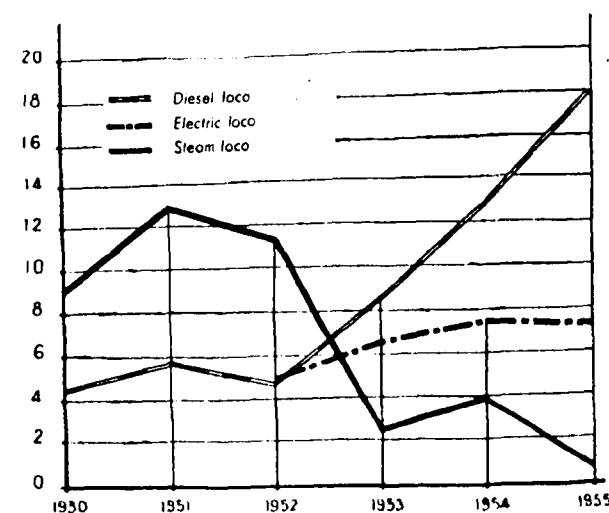
Railway car manufacturing plants are equipped for assembly line production and also for the most complex types of special equipment.

* * * * *

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 cross-ties 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

Modern Arc Welding Techniques

IN some way or other all important branches of metal working industries get in touch with electrical arc welding. This holds good for the processing of steel in all its alloys as well as coloured and light metals. If the dominant factor of materials to be welded shifted to a different category, the process chosen for welding has been shifting accordingly. This is to be observed most clearly in the welding of light metal or highly alloyed steel. The following lines are meant to give a short survey of the present state of welding by means of the electric arc.

Principally we must make a difference between hand welding, semi-automatic, and automatic welding, welding with shielded or unshielded electrodes as well as welding under exclusion of air (under-powder welding and gas shielded welding). It goes without saying that in the process of welding—as it is performed under high temperature conditions—the air from the surrounding atmosphere exercises a very unfavourable influence on the information of the welding bath and on the welding process proper, too, in the last analysis. The oxygen from the air effects chemical alterations. It has been tried to circumvent this influence in the welding with electrodes by providing the electrodes with a kind of coating, the ingredients of which are to counteract the influence of the oxygen from the air. Despite great experience made in this field, electrodes and even special makes of electrodes could not meet the requirements when a particular quality of welding was necessary.

It was about 1940 that a new method was beginning to be more widely used for the first time. This new

(Continued on page 16)

method is characterized by the fact, that the welding process proper is going on under a shield of a powder layer covering the welding bath. By this the oxygen from the air has no access to the hot welding bath. As a side-issue it should be mentioned that this process renders possible a considerably increased efficiency as related to that of electrode welding. In the same unit of time you can melt of larger quantity of material. This process is widely applied in welding all kinds of steel.

Another more recent development, which began only about five years ago, is welding under gas shielding around the welding bath. During, the welding process the arc is being lopped round by a gas, which does not form any detrimental combinations with the weld or only minor ones. As shielding gas you may use, above all, noble gas, e. g. argon etc., but also carbon dioxide may be used as shielding gas. Saying this we must, however, make the modification that for the welding of coloured and light metals only noble gas, mostly argon can be used whereas you may utilize CO₂ gas for the welding of steel.

Regarding the carrying-through of the welding process we must distinguish three essential characteristic features, normal hand welding, semi-automatic, and automatic welding.

In normal hand welding—as is well-known—shielded electrodes are generally used. These electrodes melt off and consume themselves. After some time they have to be replaced by a new one since the core-wire of the electrodes enters into the welding bath.

Some Problems of Expanding Railway Transport in India

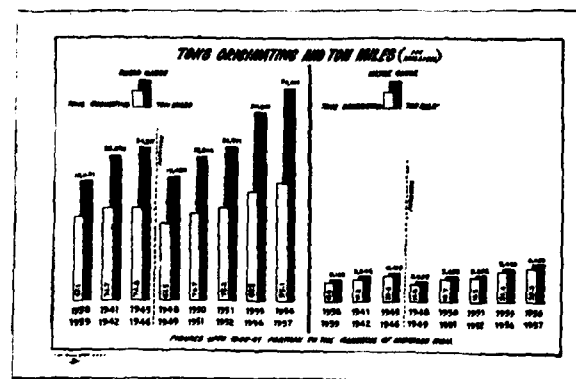
By K. B. Mathur

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



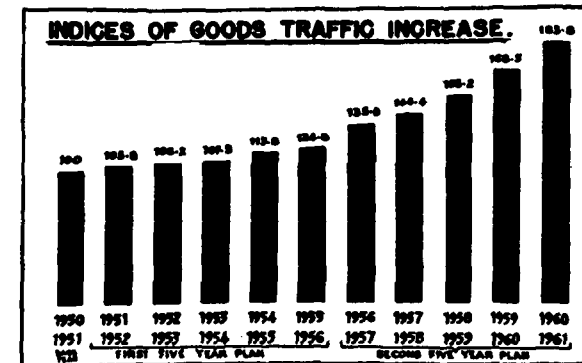
levels at important stages viz. the pre-war period, the war peak, the post-partition period and the commencement of the First and Second Five Year Plans.



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



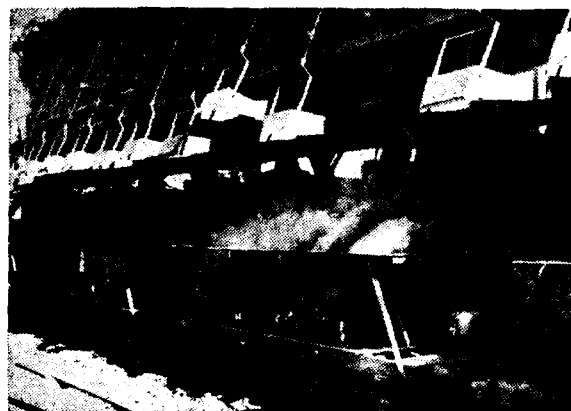
during the first two Five Year Plans. Subsequent Plan periods are expected to result in a similar rate of increase over the preceding period, if not more. The increase in passenger traffic is also expected to continue at the rate of about 3 per cent per annum. In fact during the two years of the Second 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 1st 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 produc-

tion of about 35 million tons a year at the beginning of the Plan the expansion contemplated in the Second Plan 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



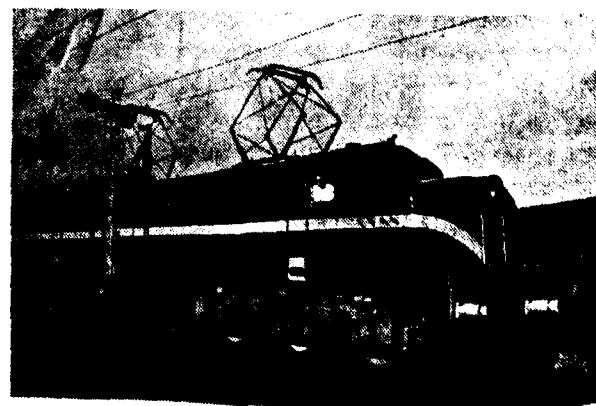
Loading of ore from chutes in hopper wagons at Badampahar on South Eastern Railway.

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.

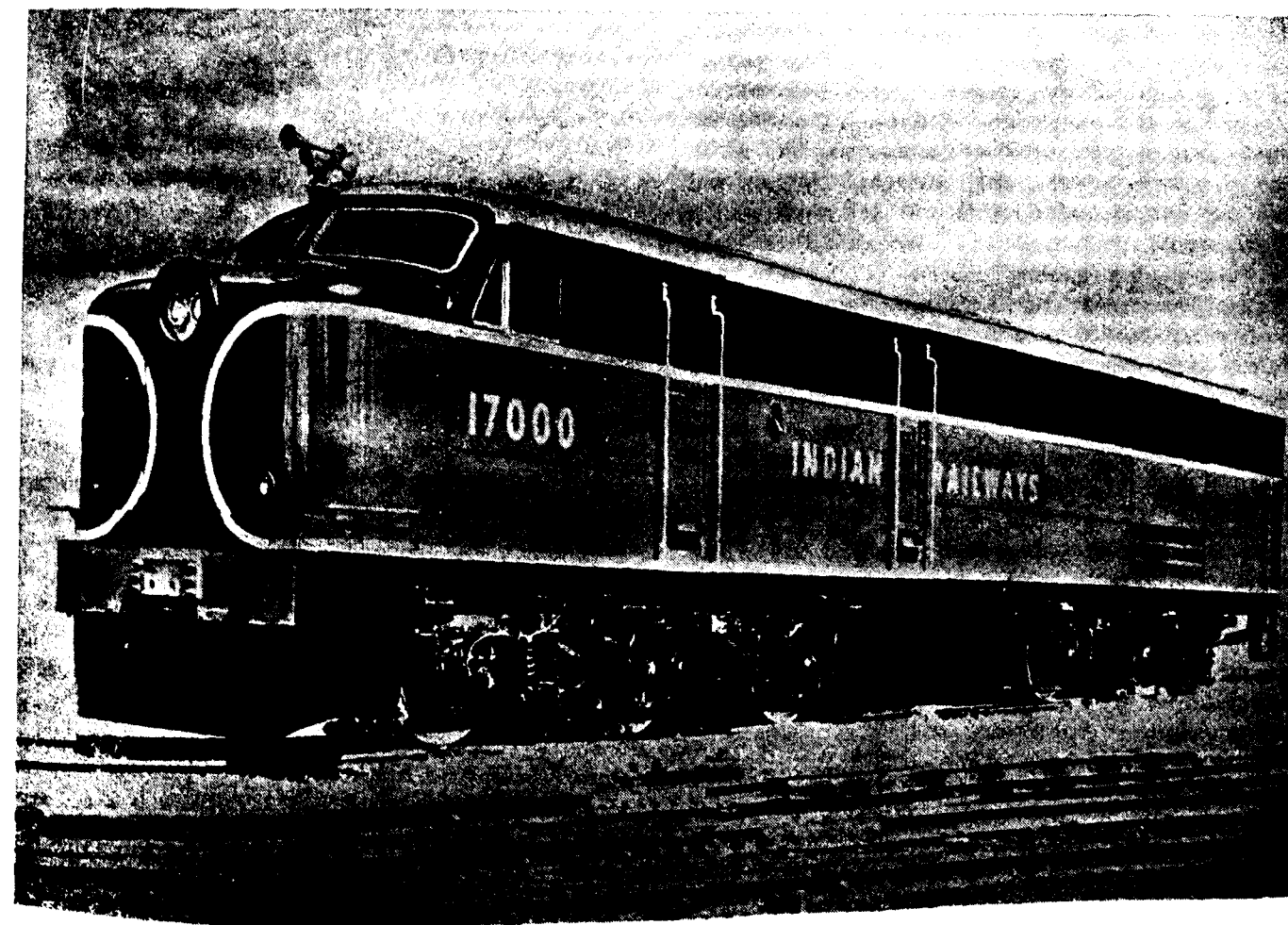
How does Dieselisation or Electrification increase the transport capacity? What is called "line capacity" in Railway language and what in ordinary language means the number of trains which can be run on any section of a line every day, is a very vital factor to be tackled in expanding railway transport. 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 train 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.

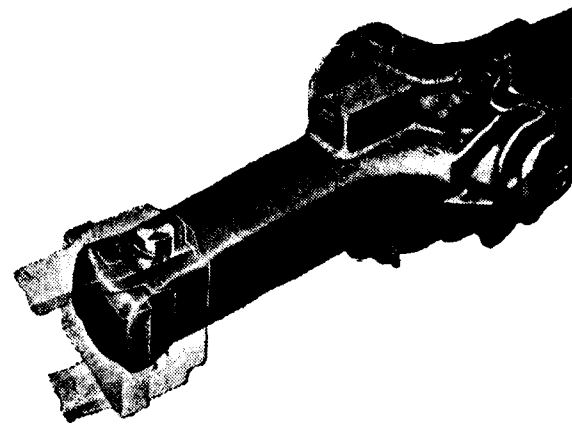
from the U. S. A., 20 of which have already arrived and have acquitted themselves well in the task assigned to them.

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 rivetted 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.

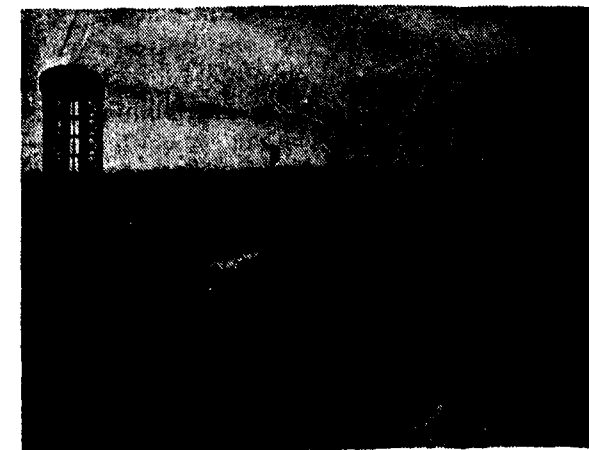
Our plans, therefore, have to proceed with due regard to this factor. We have, therefore, to start with, decided to run such wagons in closed circuit in full train loads for which our steel factories afford ample opportunity.

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.

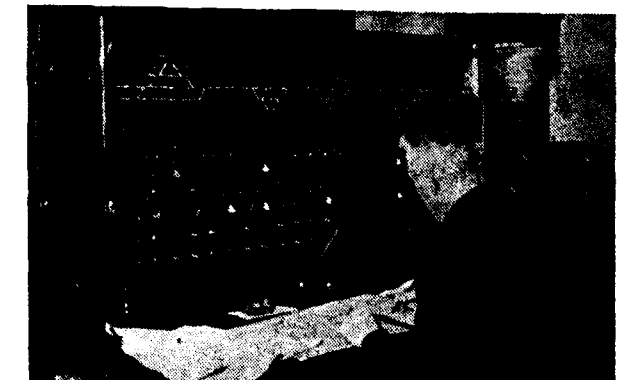
Linked with line capacity is the ability of terminal stations and yards to handle the incoming and outgoing traffic. The problem at terminal stations where the traffic originates or terminates is one of expeditious loading and unloading. On the journey of the wagons, however, between the terminals, marshalling 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 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 and 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 7.5 locos 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 1955. 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 stepped up to 36,000 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	7281	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 trains came, stopped and passed and 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 raw materials even for one day and so their flow must be 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 so that nothing 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 consistent 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.

FOUR STEEL RE-ROLLING 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.

(Continued from page 7)

Caused by the development of gas shielded welding, the field of hand welding has been extended lately; namely in such a way that argon is widely applied in hand welding. The electrode proper is made of precious metal, for instance tungsten which consumes itself only to a small degree. In such a case the electrode does not give any metal into the welding bath. The additional material which must go into the welding bath for welding, is available in the shape of an additional wire made of suitable material. This method is preferably used in welding light metal, copper etc. It provides the advantages of a welding seam absolutely free from pores and a considerable increase in efficiency. As a further advantage you may list, that the arc can be easily watched during the welding process, in contrast to welding under powder.

Semi-automatic welding is characterized by the fact that the bare welding wire is fed also under a gas shielding or under powder. Another characteristic is the feeding of the welding wire which is done automatically, whereas the movement of the welding nozzle along the seam is done by hand. Semi-automatic welding can be done with a shielded electrode and also under gas shielding.

In case of welding under gas shielding we speak of sigma-welding.

Automatic welding represents a further range of application of modern welding technics. This method has been laid out for all the three processes mentioned, i. e. welding by means of shielded electrodes, welding under powder shielding, and under gas shielding. It distinguishes itself by the automatic movement of the welding wire as well as that of the welding nozzle along the seam.

In spite of the attractive characteristics of automatic welding this method is not applicable in every case. Because of that the two former methods mentioned above remain of importance in their respective fields.

Furthermore it is important to state that direct current as well as alternating current can be used in arc welding. The kind of welding to be made and the material (work piece or electrode) have a decisive bearing in deciding upon the kind of current to be chosen.

Regarding the sources of welding current we have to mention that a great variety of rotating welding generators and welding transformers are available. The range of capacity varies from 180 amperes at 25 volts

to 1000 amperes at 40 volts. These sets supply a pure direct current which is best suited for the purpose of electric arc welding.

These very same considerations hold good for the welding rectifier, which has been very much used lately. There are no rotating parts in these, the rectifying of the alternating voltage is done by means of rectifying elements (mostly selenium rectifiers). In this line, too, we can offer all sizes up to 1000 amperes current supply.

Furthermore we might mention welding converters, the secondary side of which supplies of course alternating current. The price of these sets is comparatively low, and due to that they are used in many cases although alternating current welding cannot be used so universally as direct current welding; or to put it in a different way, it puts greater demands on electrodes used.

It goes without saying that all sources of welding current have to be laid out in such a way, that the welding voltage or welding amperage supplied respectively can be easily regulated, in order to adapt the sets to the requirements of the welding operation concerned.

Apart from their application in normal hand welding, on which we need not comment here, the above mentioned sets can be used also in automatic and semi-automatic welding. Especially characteristic features of semi-automatic sets are hollow-cable apparatuses. In these the mechanism to feed the wire is installed separately from the welding nozzle, which is in direct contact with the work piece. The welding nozzle and the wire feeding mechanism are connected to one another by a cable. The outer side of the cable serves to conduct the current and in its interior the welding wire is conveyed to the welding nozzle and to the spot of welding. These sets distinguish themselves by comparatively little electrical and mechanical demands and have proved to be goods in practice. They are also used in a slightly different make asdiao-called sigma sets for gas shielding welding.

For practical welding operations particularly when long seams are to be welded, automatic welding machines for an amperage of up to approximately 2000 amperes are also available. This high amperage is reserved more or less to under-powder welding, whereas lower amperage up to approximately 1000 amperes is used particularly for gas shielding welding.

IN YOUR OWN INTERESTS HOW TO PURCHASE TICKETS

Buy your tickets only at the proper place. The authorised offices are (i) the Booking offices at the railway stations, (ii) the Town or City Booking Offices, (iii) the out-Agencies, (iv) Travel Agent. Never buy tickets from any other source as that may lead you to trouble. Please note that tickets are not transferable.

Buy your tickets in the proper time. You can avoid unnecessary excitement and trouble if you come to the station in good time, that is at least half an hour before the scheduled departure of your train. The Time Tables of the Railway are on sale at Booking Offices and Bookstalls.

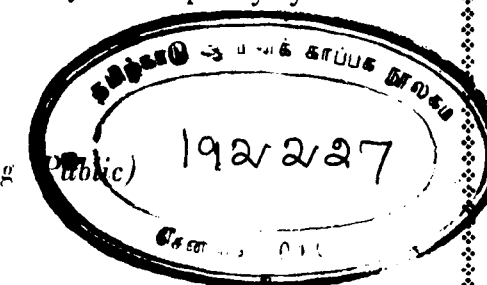
Buy your tickets in the proper manner. Queue up at the Booking Window and you can get your ticket easier and quicker than by crowding at the counter.

By handing in the *exact fare in good coins or currency* you get the ticket easier and quicker, and save for yourself and the Booking Clerk time and trouble.

Check up your ticket and money before leaving the counter and draw the attention of the Booking Clerk to any discrepancy you may notice.

(Inserted in the interests of Travelling Public)

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CLEANLINESS LEADS TO HEALTH AND HAPPINESS

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

Cleanliness prevents disease; medicine only attempts to cure.

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

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