(A Quarterly Journal devoted to Railway Matters of technical interest)

79, Jayprakashnagar, Goregaon,
BOMBAY

Grams: INDRAIL, Goregaon *Phone:* 84311

VOL. 3 NO. 3 JANUARY 1956

CONTENTS

Managing Editor
T. S. N. Rao

Advertisement Manager
B. Amruta

1181

THE INDIAN RAILWAY ENGINEER

VOL. 3 NO. 3 JANUARY 1956 PRICE AS. 8

INDEX TO ADVERTISERS

FIRST THINGS MUST COME FIRST

THE Second Five Year Plan is now in the last stages of its finalisation and as far as can be gleaned from the statements made in the Newspapers the financial allotment to the Railways appears to show very wide fluctuations.

One day the Planning Commission talks of an allotment of 1480 crores for the Railways out of the 6000 crores for the whole of India and hardly a month has passed when that figure all of a sudden gets reduced in another statement to 900 crores.

The Railway Board, whose experts are supposed to have an adequate knowledge of the requirements of the Railways of the country, in order that they may be run with greater efficiency, have informed the Planning Commission that if the higher figure is to be watered down to a lower figure now talked about then it will be necessary for the Commission to scale down considerably their planned targets for the production of Coal and other mineral ores, Iron and Steel, Cement, Fertilisers, Agricultural products, Light and Heavy machinery and consumer goods.

The Government is out to please the masses by offering them amenities by various costly projects such as, first fans and now air-conditioning in third class coaches, cool drinking water at large halting stations, covering of station platforms, bigger and better appointed waiting halls for third class passengers, quarters for lower paid Railway staff etc., etc. There is no doubt that all these are necessary, but surely "first things must come first".

No one will deny that if the Railways in this country are to be comparable with some of the advanced countries of the West then accent must be placed on Efficiency, Economy and Expansion in that order.

Efficiency is a matter of paramount importance at the moment when there is a tendency to tolerate inefficiency in many directions in Railway working. If greater attention is to be paid to this aspect of our Railway working then much more attention will have to be given to Operation, Signalling, Track, Rolling stock, Workshops etc.

With regard to Operation, the need of the moment is to discover all the ways and means to increase the transport capacity in men and materials to the maximum extent in the shortest time with the existing facilities. This means stepping up of the throughput capacity of certain sections, and resolving bottle necks at Marshalling Yards and Open Line sections so that they could deal with much more traffic. This means further the concentration of a combined effort of all staff from the highest to the lowest simultaneously for the better utilisation of the existing resources and cutting out idle time spent unnecessarily by wagons and coaches at sick sidings and awaiting repairs in sheds and overhaul in workshops. It is necessary to pursue relentlessly the effort for a quicker turn round of wagons at junctions and terminal points and to make greater use of mechanical handling equipment to handle greater volume of traffic in a shorter time.

One of the ways of solving this great need of the moment for increased transport when track capacity is fully utilised is not by incurring heavy expenditure on additional track such as doubling single lines or quadrupling double lines, but by introducing modern and improved signalling apparatus and techniques which would make quicker disposal of Passenger and Goods trains.

We have examples of the ability of some advanced countries of the West such as Switzerland, U.S.A., France, Germany etc., who have been able to double their capacity on single lines as well as double lines by a vastly improved and modernised signalling system.

It is even reported that on the New York Central System, one of America's leading Railway Companies, by the installation of up-to-date and highly efficient signalling apparatus quadruple lines have been reduced to double and double lines to single and yet the efficiency of operation has increased. Surely then this is a subject which should receive very serious attention from our higher authorities who control our Railway system in this country.

Another aid for carrying greater traffic is better tracks and their higher standard of maintenance by which it will be possible to increase considerably the speed of both Mail, Express and Goods trains without risk to safety, thus resulting in the passage of more trains in the same sections every 24 hrs. If this higher standard of track maintenance has been achieved by other countries then this must be investigated and implemented here.

No country can achieve success in its rail transport without following the lead of other advanced countries and it will be in no way impair our prestige if we copy their achievements.

While we are still talking of bigger and more powerful Steam Locomotives to replace our over 40 year old Museum pieces to run on a heavier track, it should be noted that the U. S. A. has thrown overboard the outmoded iron horse of the George Stephenson's age and has taken a plunge for Diesel traction on an extensive scale and from 1952 onwards the rate of increase in Diesel Locomotive Power in America and the reduction of Steam indicates show some astonishing figures.

Diesel traction has undoubtedly established its superiority for Railway transport and the argument now is whether it is going to be plain Diesel, Diesel Electric or Diesel Hydraulic drives.

Even while Diesel Locomotives are establishing their superiority research is going on rapidly towards Atomic Power and with its likely use for civilian purposes and undoubtedly it is going to be the power for the future. With the application of

complete atomic power with such success to the submarine Nautilus in America, the transfer of such a form of power to Locomotive traction is only a matter of the not too distant future.

For coaching stock America and Italy are again in the lead with light weight and extremely comfortable trains handling heavy loads and designed by the Railway Engineers of the General Electric Company of America and the Italian State Railways respectively.

For Goods traffic the need of wagons in large numbers has been apparent to all concerned for some time. Our need has been pitched by the Government at 30,000 wagons per year during the next five years, but with the development of the hinterland it is likely to even exceed this figure. Existing capacity for wagon construction in the country has been fully absorbed. Further output as is likely to be obtained from new factories is to be taken up as and when it offers itself.

A high powered Committee has been touring the country investigating the possibility of additional capacity from sources which have not been tapped before, both in the country and abroad. Japan is once again entering competitively in the field of Railway Rolling stock and from the rock bottom prices which they are offering it would appear that the European manufacturers will be left guessing.

Finally there are the Railway Workshops and here without any fear of contradiction it might be said that labour is not pulling its weight and the policy of the Government in placating workshop labour has gone a little too far. While the policy was excusable during the war emergency, there is certainly no justification for it when we will have to fight with our backs to the walls to prevent a breakdown in our transport system. Efforts will be necessary to retrieve the disciplinary powers which the Executives have lost as compared with what they had 30 years ago. Per capita out-turn must be doubled both from machines and skilled labour in other branches. The pace of standardisation and more production must be accelerated. Introduction of modern production techniques such as time and motion study, labour saving devices, incentives etc., must be speed up. Advance techniques in management control, Supervisory leadership, labour and Management co-operation and relations must be introduced so that productivity can be augmented.

The addition of the proposed 3500 miles of Railway track envisaged by the Planners in a vast country like ours with a growing population and increased tempo of industrialisation although a step in the right direction should be taken up only after the existing line capacity is found to be fully saturated and things like amenities etc. could be easily left over without any harm to the Third Five Year Plan.

WEIGHING ON THE RAILWAYS

(From Our Engineering Correspondent)

WEIGHING machines are a means of converting weight values into money values, besides having other functions, so that they play a most important part in Railway affairs. A review of the modern weighing equipment used by Railway Companies will therefore be useful and informative. Various types of machines are described, according to the class of traffic handled.

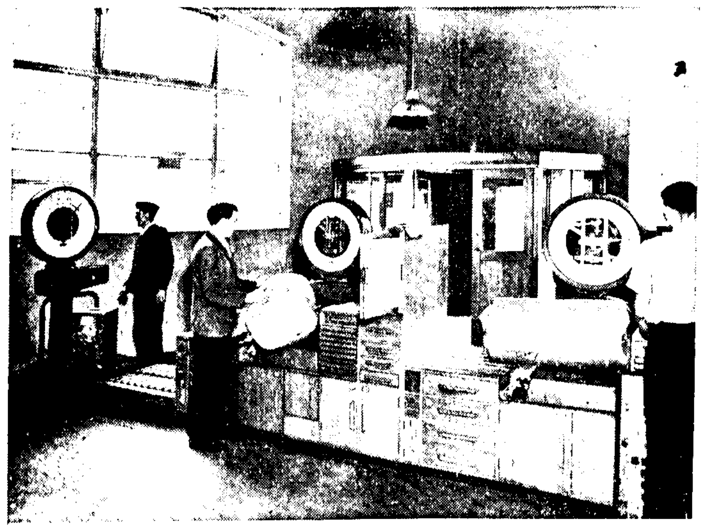


Fig. 1

PARCELS OFFICES

The types of scales for weighing parcels for conveyance by passenger train are illustrated in figure 1. The floor type (left) handles the heavier packages, the bench type those of lighter weight.

Figure 2 shows a scale with platform at floor level, designed for weighing passengers' luggage.

GOODS DEPOTS

The type of dial platform scale for use in goods depots is seen in figure 3. The platform is at floor level, and is available in several sizes and capacities.

Fig. 2

Fig. 3

Traffic transported by road demands the installation of a road weighbridge for checking the gross weights of motor vehicles, from which net loads can be calculated. Figure 4 illustrates an installation of two such weighbridges for controlling both inwards and outwards traffic with the weigh office situated between the machines. Figure 5 shows the interior of the weigh office, with the indicators of the two weighbridges facing the recording clerk.

The weighing of rail traffic requires consideration of the make-up of the goods trains likely to pass over the weighbridge for the weighing of the individual trucks in the train. In figure 6 is a weighbridge for weighing four-wheel wagons, while figure 7 shows a triple combined weighbridge which will handle three trucks at a time, for weighing individually or collectively. The lengths of weighing units can be determined by the lengths of the rolling stock likely to pass over the machines, and whether or not weighing in motion is contemplated.

In certain situations it is possible to install a weighbridge which is capable of weighing both road and rail traffic, and such a weighbridge is seen in figure 8. It is always undesirable for traffic not requiring to be weighed, to be allowed to pass over a weighbridge with any regularity. Where it is not possible to divert such traffic, a "live" and "dead" rail weighbridge, as seen in figure 9, should be installed. Traffic not for weighing is switched on to

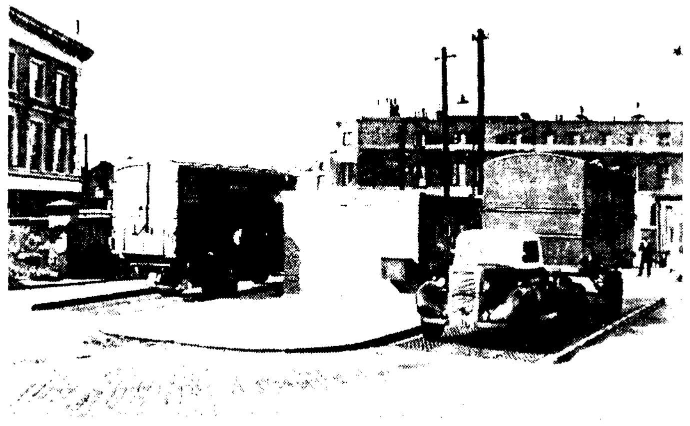


Fig. 4

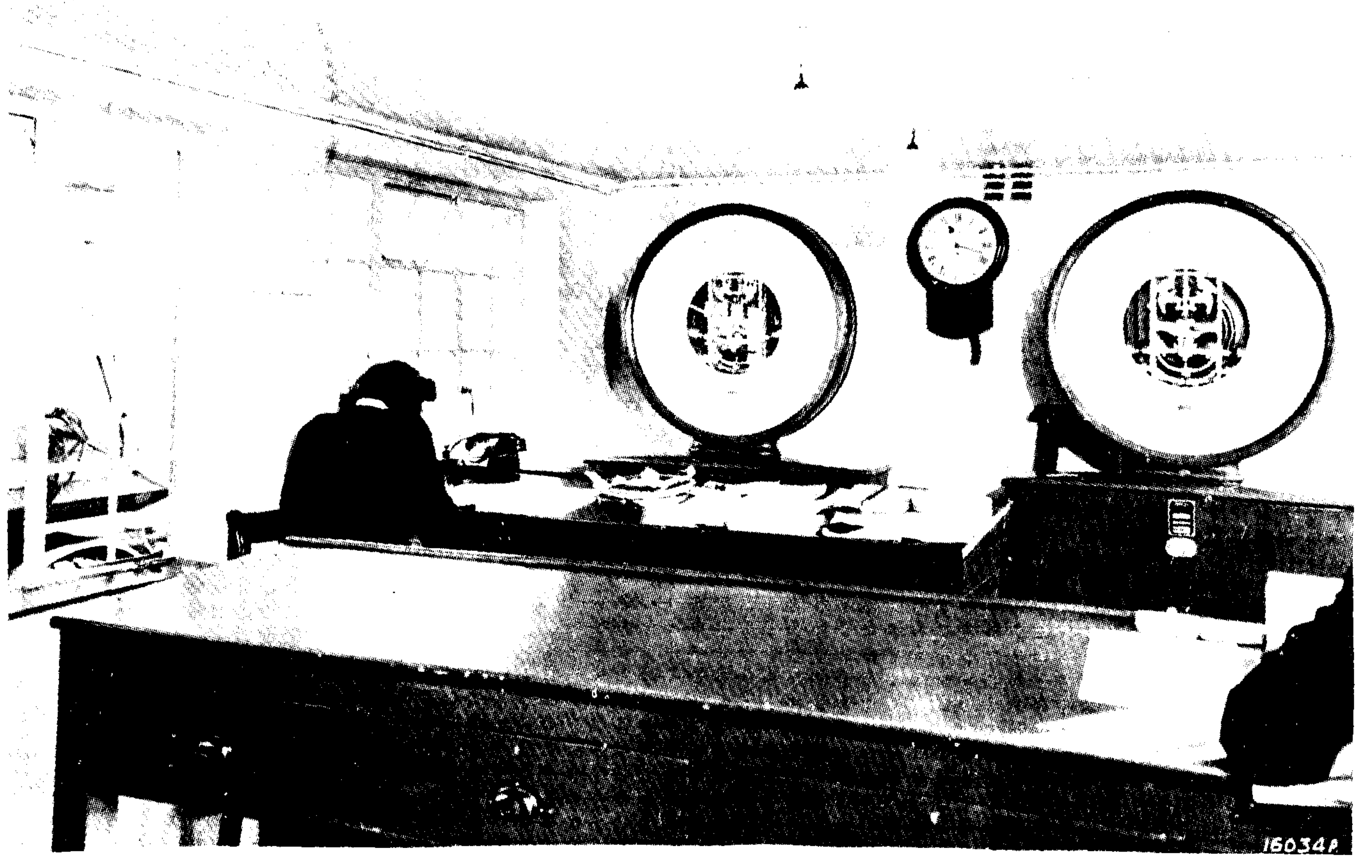


Fig. 5

WEIGHING ON THE RAILWAYS

(From Our Engineering Correspondent)

WEIGHING machines are a means of converting weight values into money values, besides having other functions, so that they play a most important part in Railway affairs. A review of the modern weighing equipment used by Railway Companies will therefore be useful and informative. Various types of machines are described, according to the class of traffic handled.

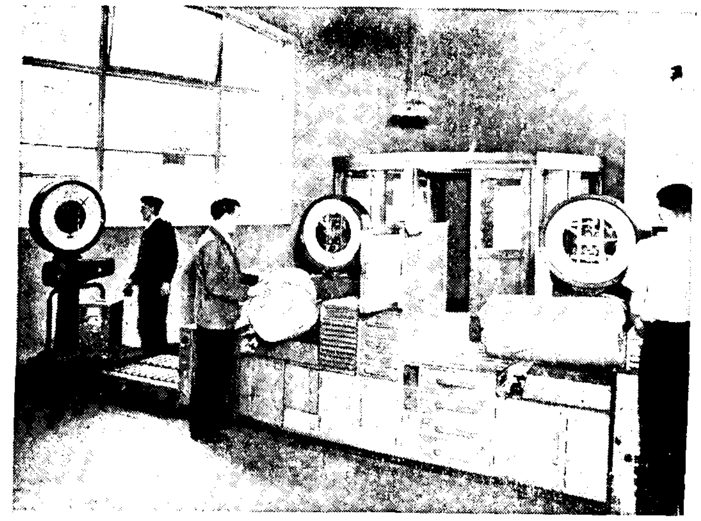


Fig. 1

PARCELS OFFICES

The types of scales for weighing parcels for conveyance by passenger train are illustrated in figure 1. The floor type (left) handles the heavier packages, the bench type those of lighter weight.

Figure 2 shows a scale with platform at floor level, designed for weighing passengers' luggage.

GOODS DEPOTS

The type of dial platform scale for use in goods depots is seen in figure 3. The platform is at floor level, and is available in several sizes and capacities.

Fig. 2

complete atomic power with such success to the submarine Nautilus in America, the transfer of such a form of power to Locomotive traction is only a matter of the not too distant future.

For coaching stock America and Italy are again in the lead with light weight and extremely comfortable trains handling heavy loads and designed by the Railway Engineers of the General Electric Company of America and the Italian State Railways respectively.

For Goods traffic the need of wagons in large numbers has been apparent to all concerned for some time. Our need has been pitched by the Government at 30,000 wagons per year during the next five years, but with the development of the hinterland it is likely to even exceed this figure. Existing capacity for wagon construction in the country has been fully absorbed. Further output as is likely to be obtained from new factories is to be taken up as and when it offers itself.

A high powered Committee has been touring the country investigating the possibility of additional capacity from sources which have not been tapped before, both in the country and abroad. Japan is once again entering competitively in the field of Railway Rolling stock and from the rock bottom prices which they are offering it would appear that the European manufacturers will be left guessing.

Finally there are the Railway Workshops and here without any fear of contradiction it might be said that labour is not pulling its weight and the policy of the Government in placating workshop labour has gone a little too far. While the policy was excusable during the war emergency, there is certainly no justification for it when we will have to fight with our backs to the walls to prevent a breakdown in our transport system. Efforts will be necessary to retrieve the disciplinary powers which the Executives have lost as compared with what they had 30 years ago. Per capita out-turn must be doubled both from machines and skilled labour in other branches. The pace of standardisation and more production must be accelerated. Introduction of modern production techniques such as time and motion study, labour saving devices, incentives etc., must be speed up. Advance techniques in management control, Supervisory leadership, labour and Management co-operation and relations must be introduced so that productivity can be augmented.

The addition of the proposed 3500 miles of Railway track envisaged by the Planners in a vast country like ours with a growing population and increased tempo of industrialisation although a step in the right direction should be taken up only after the existing line capacity is found to be fully saturated and things like amenities etc. could be easily left over without any harm to the Third Five Year Plan.

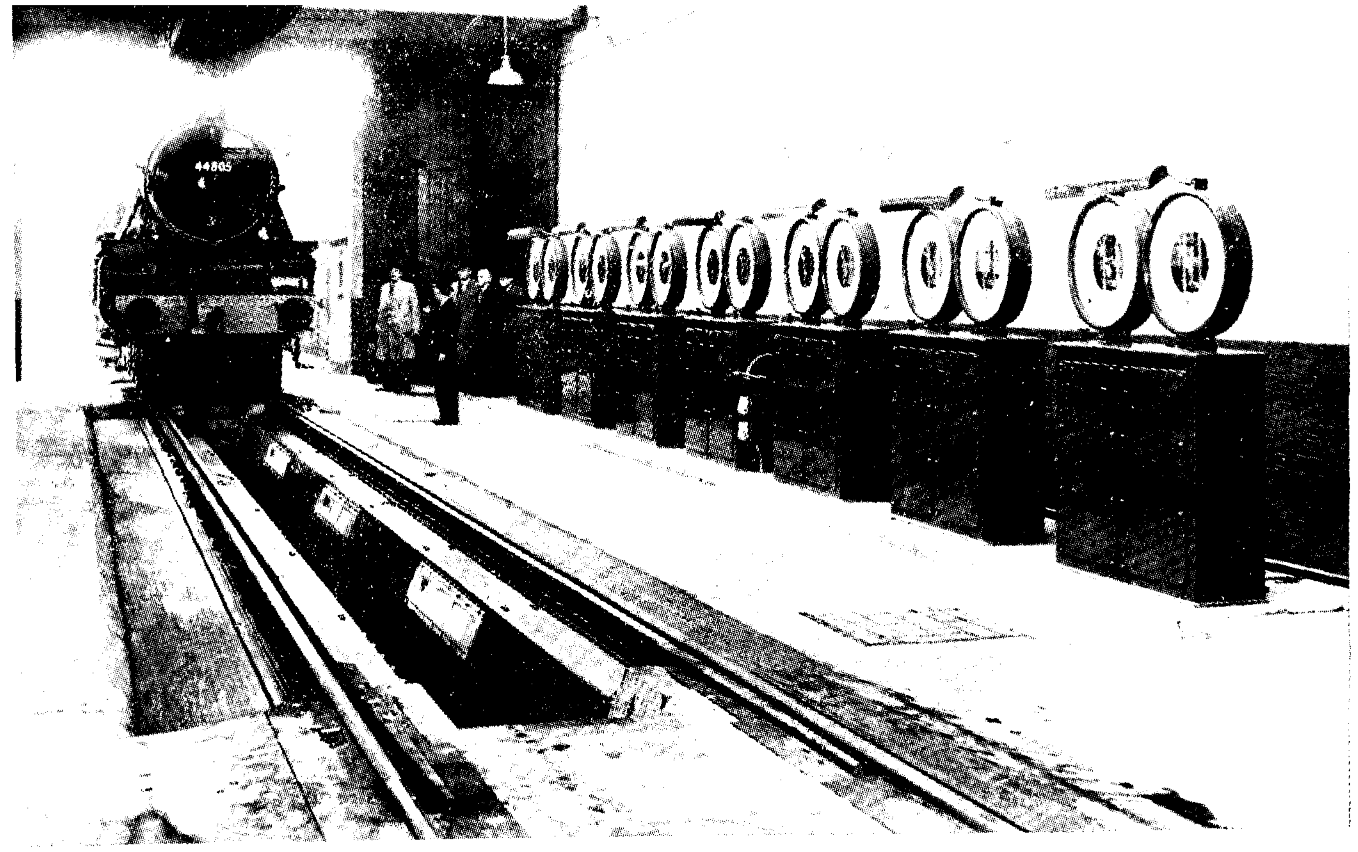
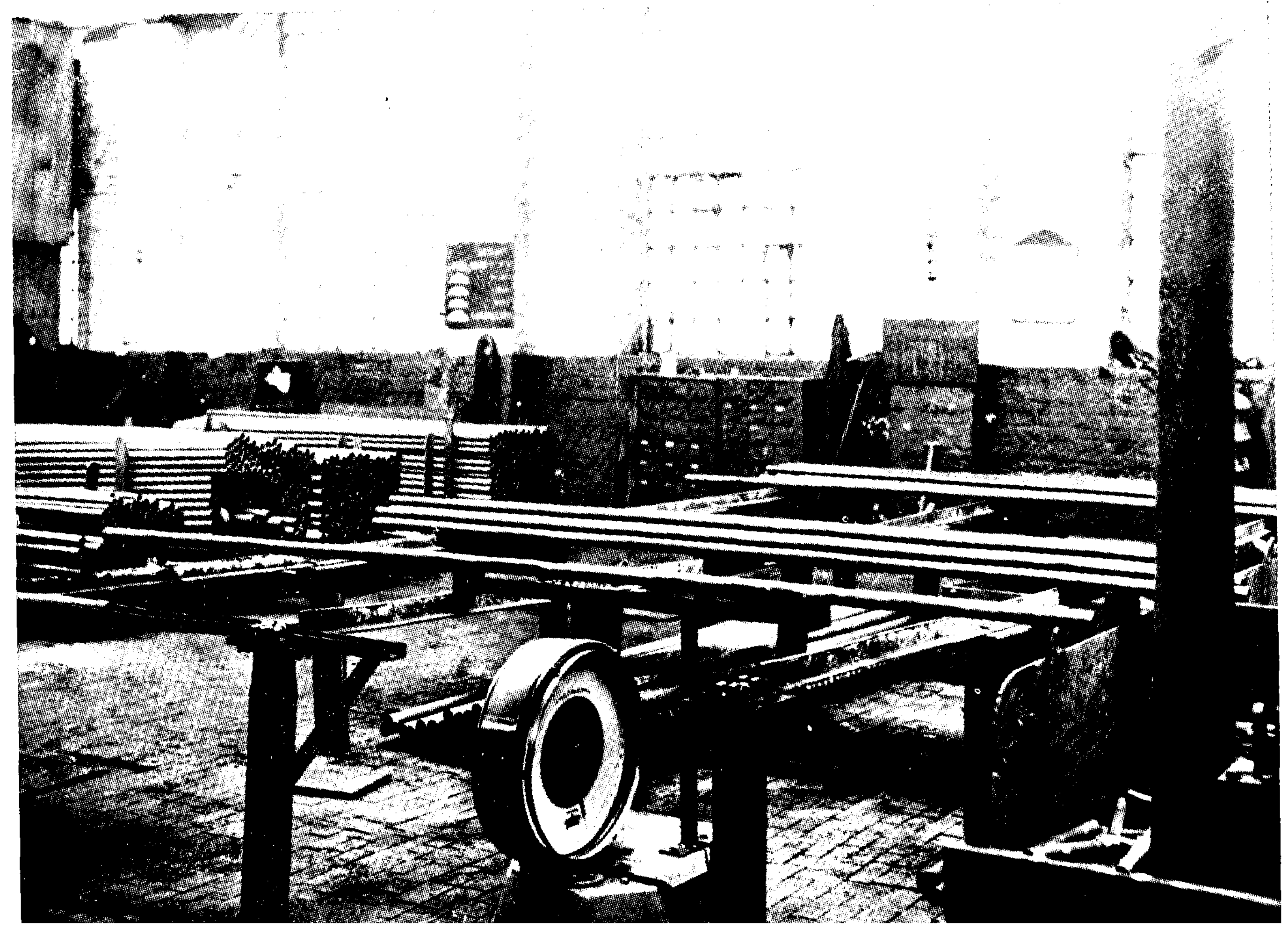


Fig. 12



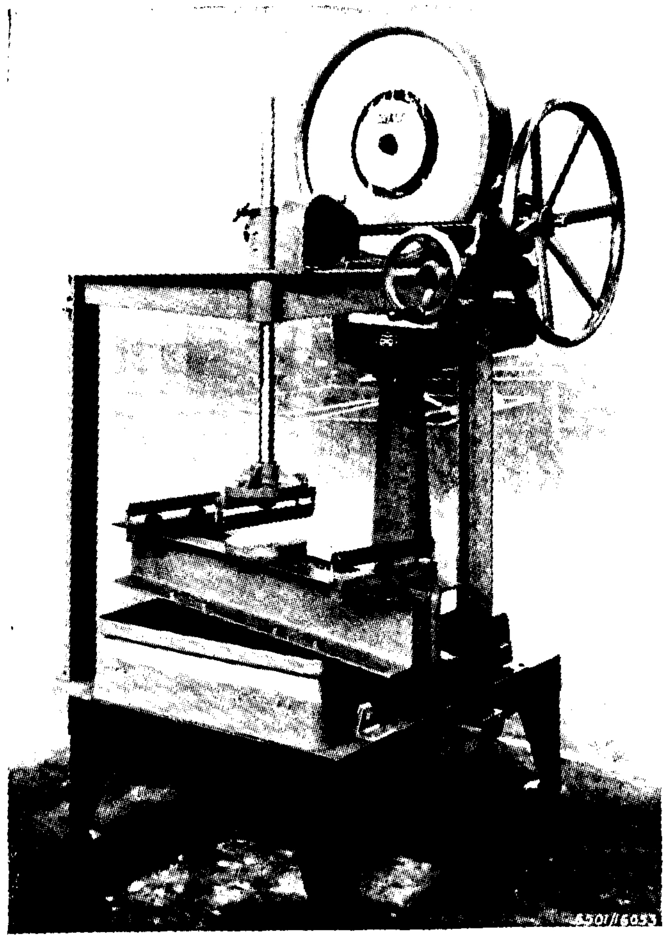


Fig. 14

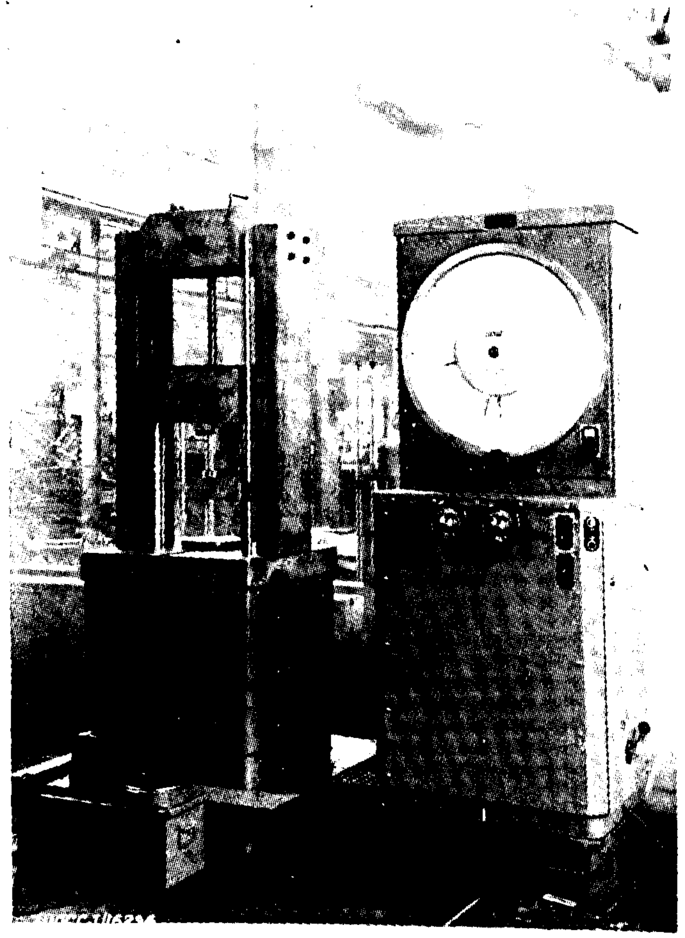


Fig. 15

compression, bending, shear and Brinell, hardness, and also transverse tests in cast iron. A mechanical recorder can be fitted.

For the illustrations we are indebted to W. & T. Avery, Limited, of Soho Foundry, Birmingham, England.

GANDHIAN LITERATURE AT RAILWAY STATIONS, INSTITUTES AND SCHOOLS

The propagation of Gandhian literature at railway stations throughout the country is to be encouraged, with the object of helping to build the national character.

The Central Railway, which also has in hand a social education programme with a similar objective, has taken steps towards ensuring the display and sale of Gandhian literature at station bookstalls.

The Railway Board has also directed that selected Gandhian publications should be kept in libraries attached to Railway institutes and Railway schools throughout the country.

In the choice of this literature, care is being taken to include publications suitable for the families of railwaymen as well. Books published in Hindi and other Indian languages would also be included.

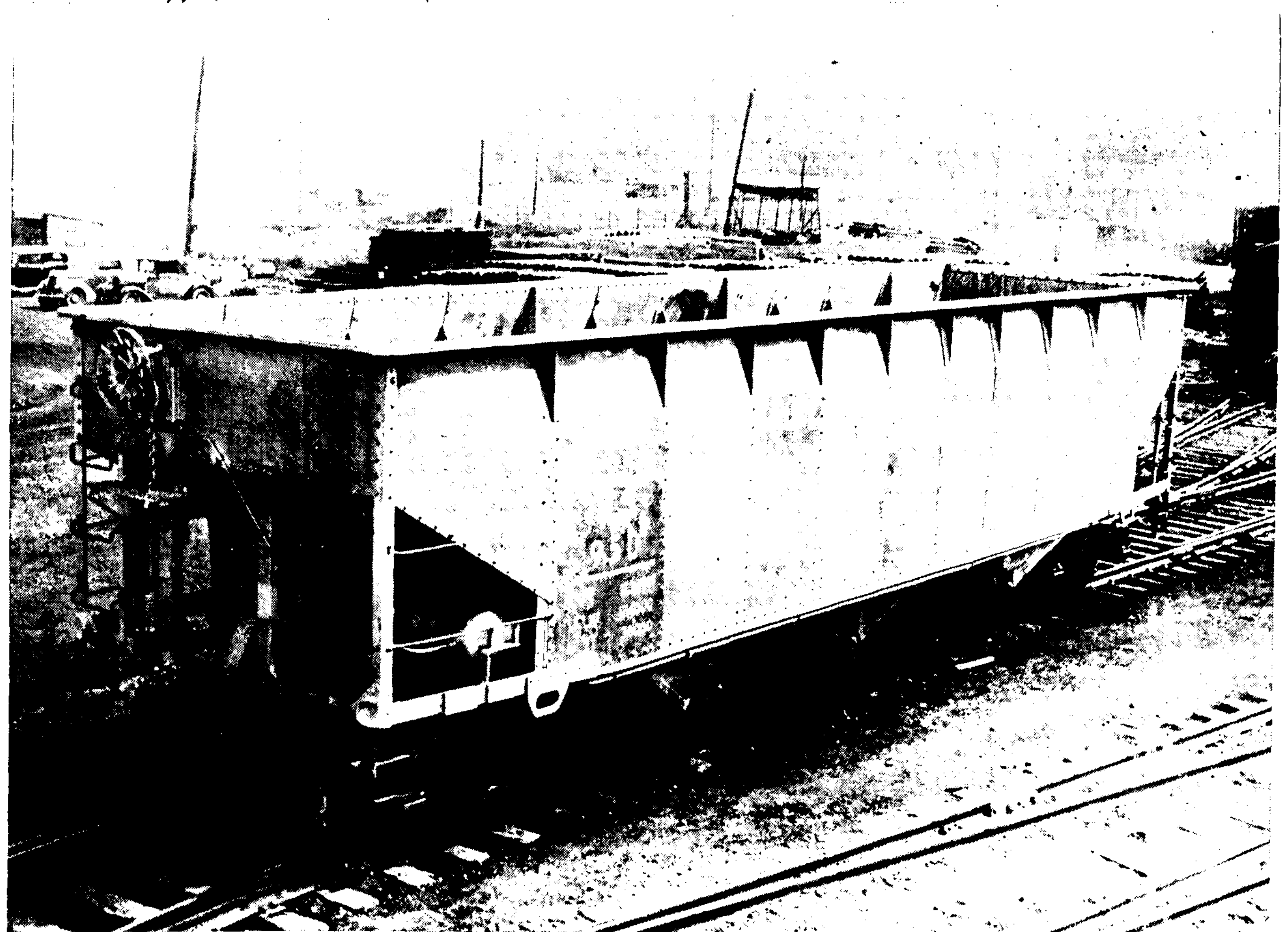
ALUMINIUM HOPPER CARS

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

STRENGTH, lightness and durability of aluminium and in particular its resistance to corrosion, have gained for itself wide spread acceptance as a structural material of high utility. With the world aluminium industry now producing nearly three million tons of new metal a year, it is, to-day, not only the world's most abundant non-ferrous metal, but also a very cheap metal. It can, therefore, be rightly claimed that this is indeed a " light metal age ".

The impact of aluminium, discovered only 100 years ago, on modern progress has been forceful and far-reaching. This is strikingly evident in the transport industry, where its introduction induced a rational revaluation of materials and their relative utility. Because of the many and varied advantages offered by the aluminium-built stock, it is finding an increased favour in almost all the countries throughout the world. Among the special advantages are light weight with consequent higher capacity, economies in running and maintenance costs, savings in energy consumption, greatly improved stock availability and superior corrosion resistance. The other advantages include improved riding qualities, less tyre wear and a higher scrap value even after many years of strenuous service.

One of the most advanced examples of freight transport service is provided by a fleet of aluminium box cars designed and built, in about 1947, by the Roberval & Saguenay Railway Company of Canada with the co-operation of the Aluminium Co. Ltd., and the Canadian



Aluminium Hopper Car—which saves 9,600 Pounds in weight and gives out a silvery appearance.

Pacific Railway. These cars increased freight deliveries to the extent of 552 tons in a 100 car train.

The proven efficiency of these cars as regards greater load-carrying capacity resulting from the reduction in dead weight, higher operational efficiency and above all, longer life than the ordinary all steel car, has led the same railway company to design and get built by the Eastern Car Company of Trenton, Nova Scotia, another similar fleet of thirty 70-ton capacity aluminium Hopper Cars in 1948. In 1949 again, they have added another fleet of 50 cars to their existing strength.

WEIGHT SAVING

Each of the hopper cars weighs 38,000 lbs. as against 47,600 lbs. for a similar steel car resulting in a total weight saving of 9,600 lbs. in each. Having a capacity of 2775 cu. feet, level full, and depending on the type of material loaded, the carrying capacity of each of these cars is approximately 6 tons more than what it is with a normal steel car. This means that 13 of these new aluminium hopper cars carry as much as 14 cars constructed of steel.

Aluminium was used generally throughout the cars in the shape of plates and extruded sections, but securing of extreme light weight was not the main consideration in the undertaking of these hopper cars construction. Production of a light weight car having the required strength and rigidity equal to, or greater than that of the standard type car and securing the advantages which are gained through the use of up-to-date material and modern fabricating techniques, were actually aimed at in evolving its design.

DESIGN FEATURES

The design features incorporate the use of 3/16 in. thick aluminium sheets for the side and end plates and 1/4 in. thick aluminium plates for floors and doors. For corner posts, braces etc., and also for re-inforcing side stakes and angles, side plates, side and end sills, aluminium extruded sections have been used. For such

End-view of the Car

items as the centre sills, body bolsters, cross-bearers, brake gear, safety appliances and door frames, where stiffness and strength for minimum overall dimensions are the main requirements, steel sections have been used. Aluminium rivets were used for the aluminium/aluminium joints and for the aluminium steel and steel/steel joints rivets were used. All the joints were made with hot-driven rivets. Zinc Chromate jointing compound was applied to all bimetallic joints to prevent, galvanic corrosion, and all steelwork adjacent to aluminium was finished with aluminastic paste.

While the aluminium plates and section used were of aluminium alloy which is commercially known as *Alcan* 65ST, the aluminium rivets employed were in *Alcan* 55-S. The alloys used were fully heat-treated.

USE OF STANDARD FITTINGS

Equipped with such American standard railway fittings as " Wine " door mechanism for the drop hopper doors, Ajax hand brakes, Miner draft gears, Imperial rotary coupler devices, Doray hand brake stabilizer and Symington Barber Stabilized trucks, these cars represent the most economical mode of construction. The only departure that had to be made from the use of standard fittings, was in the type of brake fitted since the standard railway type "AB" brakes do not provide the required braking ratio for the empty or loaded cars because of their extreme light weight.

LOAD COMPENSATING BRAKES

The brakes used were of special design and are known as Westing house ABCL Load Compensating Brakes. These hopper cars are the first cars in Canada to have this type of brakes which are under extensive study by the American Association of Railroads and of interest to all railway engineers in both USA and Canada.

Equally interesting are the Barber variable friction stabilized trucks which are well known for their ability to control spring action satisfactorily even under extra light loads and at all speeds. They have stabilized lateral motion features providing thereby smoother riding with less shock and greatly reduced upkeep costs. While they are equipped with one wear steel wheels and unit cast steel brake beams, the journal box lids and truck levers are of aluminium alloy.

SILVERY APPEARANCE

The aluminium surfaces of the cars have been left unpainted as a result of which they present a bright and silvery appearance. This will result in a reduction in their maintenance cost as they will not have to be pulled out of service for the usual layup for painting. Steel parts and trucks have however been painted black, air brake parts in aluminium and all safety appliances in bright yellow. The letterings are in orange yellow.

These cars have now been in operation long enough to prove their efficiency and also to show that they are rapidly paying for themselves. Approved for interchange service, as they are, by the American Association of Railroads, they have been in regular service between the United States and Canada and wherever they have been seen they have aroused exceptional interest and favourable comment.

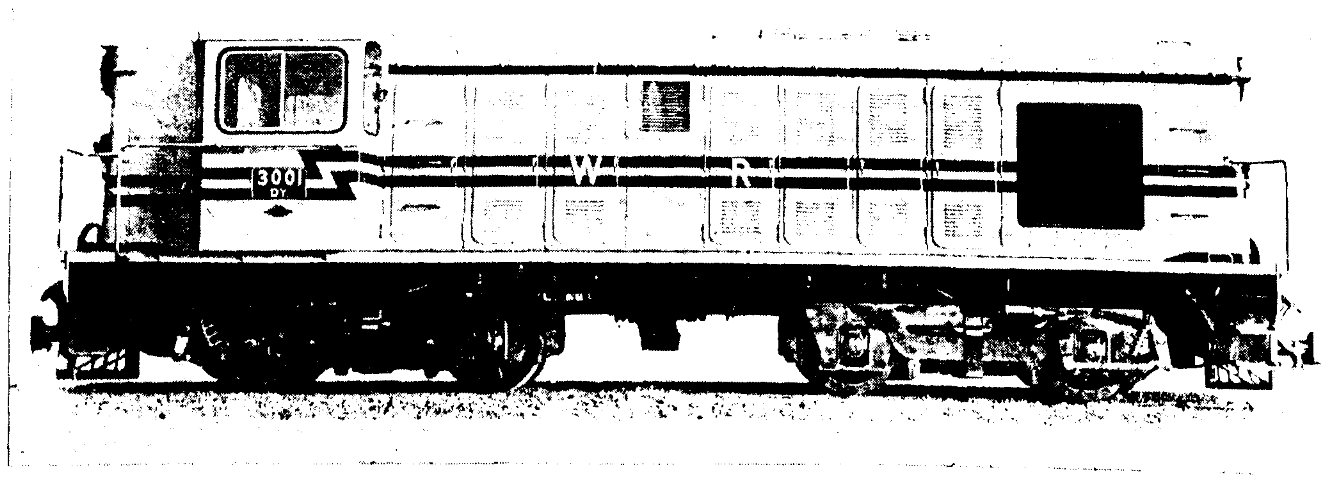
DIESEL RAILWAY LOCOMOTIVES

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

DIESEL traction on British Railways was introduced shortly after the second world war when two diesel electric locomotives were built by the former London, Midland & Scottish Railway. The frames, running gear and cabs were constructed in the L. M. S. works at Derby while the diesel-electric generators were made by the English Electric Co. Each locomotive has a 16 cylinder diesel engine developing 1,600 horse power and driving an electric generator which supplies current to the six traction motors mounted on the axles. In addition to the generating equipment each unit carries an oil fired boiler for heating the passenger coaches steam heating being standard practice on British Railways. For some time two locomotives, with a vestible connection between them hauled the Royal Scot heavy expresses between London (Euston) and Glasgow. Later, they began operating independently on the Southern Region of British Railways.

The direct application of the internal combustion engine working on the diesel principle to railway traction, is complicated by the fact that this type of power unit develops its maximum power at a constant speed. some form of intermediate transmission is necessary so that the power of the diesel engine can be variably transmitted to meet the changing speed requirements of the locomotive. Electrical mechanical hydraulic and pneumatic systems of transmission have all been tried and of these the first three are now proved to be satisfactory. For high powers, electrical and hydraulic systems have seemed to be the most suitable but for lower powers mechanical gear systems have proved satisfactory.

Towards the end of 1946, the Directors of the former Southern Railway Company decided to embark on diesel electric locomotives for express passenger services. No. 10,201 and No. 10,202 were designed but the work was not commenced until after the Southern Railway had become the Southern Region of British Railways. They were built in the locomotive workshops at Ashford, Kent, the diesel engine and power equipment being supplied by the English Electric Company. Each locomotive has a 16 cylinder, pressure charged four stroke



Diesel locomotive for Western Railway, Kandla Deesa Branch.

the electric current supplies four traction motors mounted near the axles of the driving wheels. The hot, exhaust gases from the turbine pass through a heat exchanger which warms the incoming air before it is drawn into the combustion chamber, thereby obtaining a higher thermal efficiency than would be possible if air were drawn directly from the atmosphere. The locomotive is 63 feet long overall and weighs 115 tons. Its maximum speed is about 90 m. p. h.

No. 10,800 is British Railways first diesel electric mixed traffic locomotive. It was built in 1950 at the Glasgow works of the North British Locomotive Company. It is designed for secondary duties such as the operation of branch line and local train services. The 827 horse power 16 cylinder diesel engine was built by Davy Paxman & Co of Colchester while the British Thomson Houston Company of Rugby were the main contractors for the electrical equipment including the six pole 522 kw generator, the four traction motors and the control apparatus. The driver's cab has a centrally placed control desk with all controls duplicated to permit driving from either side and a vernier control is fitted for the precise regulation of locomotive speed during hump shunting or as required during normal rail operations. The control scheme allows five diesel engine speeds. The two four wheeled, swing bolster bogies have S. K. F. roller bearing axle boxes and a combination of coil and laminated springs for suspension. The wheels are 3 ft. 6 ins. in diameter. The maximum speed for which No. 10,800 is designed is 70 m. p. h. and the maximum tractive effort is 34,500 lbs. with a continuous rating of 18,800 lbs. at 12.3 m. p. h.

The experience with diesel traction on British Railways has been of value to overseas railways who are now commencing to utilize this form of traction. The development of oil plants in India will ensure an adequate supply of oil for these locomotives and much time will be saved in timetables due to engines not having to stop frequently for water. Diesel shunting locomotives have already been in use a number of years, at certain terminal stations and diesels for main line operation will be to hand soon.

20 diesel hydraulic locomotives have been completed at the works of the North British Locomotive Co. Ltd. and will shortly be placed in service on the Kandla Deesa section of the Western Railway. This branch is about 170 miles long with a ruling gradient of 1 in 200 except for a section about one mile outside Deesa where the gradient is 1 in 150. While the altitude in this area is under 100 feet, the locomotives were designed to work up to 200 feet with a horse power of 605 since the locomotives are to be regarded as a prospective standard metre gauge unit. They are powered by Paxman, turbo charged 12 cylinder V engines and drive to all four axles. The locomotives are capable of a maximum speed of 55 m. p. h., weigh 43 tons and have a wheelbase of 25 ft. 6 ins.

SUSPENSION MONORAIL OF WUPPERTAL

(Wuppertaler Schwebebahn)

By H. Sreenivasiah, B.E. (Mech): A.M.I.E.: VDI. Hindustan Aircraft Ltd., Bangalore.

THOUGH Wuppertal is a small town in West Germany near Dusseldorf, it is well known throughout the world for its Schwebebahn (Suspension Monorail Train) or handing train as some people call it, which shows the genius and skill of German Engineers in creating a new mode of transport which came as a boon to this growing industrial town. The Wuppertaler Stadt Werke Company which is running this train in the town has already celebrated Golden Jubilee of this train which was inaugurated by William the Second on 24th October 1900.

Wuppertal is a small industrial town in West Germany with a population of 3,65,000. A small river "Wupper" flows in the centre of the town. As the iron and steel industries increased, the transportation problem also increase along with the increase in population of town. The roads and railway lines were not planned to cope up with the increase in population. The space was limited to provide any new additional transport facilities. Already bus, tram, and railway transport were fully engaged to their capacities. Then how to provide an additional transport to the increasing travelling public? Necessity of providing an additional quick transport arose in the year 1888. Planning of new projects began from that year. As there was absolutely no space for the new roads or railway lines on the ground, additional transport could be provided by having an underground railway, just like in London and Paris Other alternative left was to utilise the air space available over the Wupper River which runs right in the centre of the City along the Town. Except these two, there was no other way to solve this problem.

Some how more attention was given to utilise this space available over the river. To utilise this space, in the year 1893, Herr Eugen Langen made researches in Colgne-Bentz with the view of providing a quick transport. (Fig. 1) In a short time he succeeded in running a Suspension Monorail Train at a speed of 7 miles per hour. He was able to run a hanging train at a speed of 15 miles per hour with a swing of 25° without any danger to the passengers, standing or sitting. He took the patent in the year 1899 and completed the first 2¾ miles suspension Monorail from Kluse to Zoo in 1901 over the river Wupper. Finally 8¼ miles of railway line was completed in the year 1903.

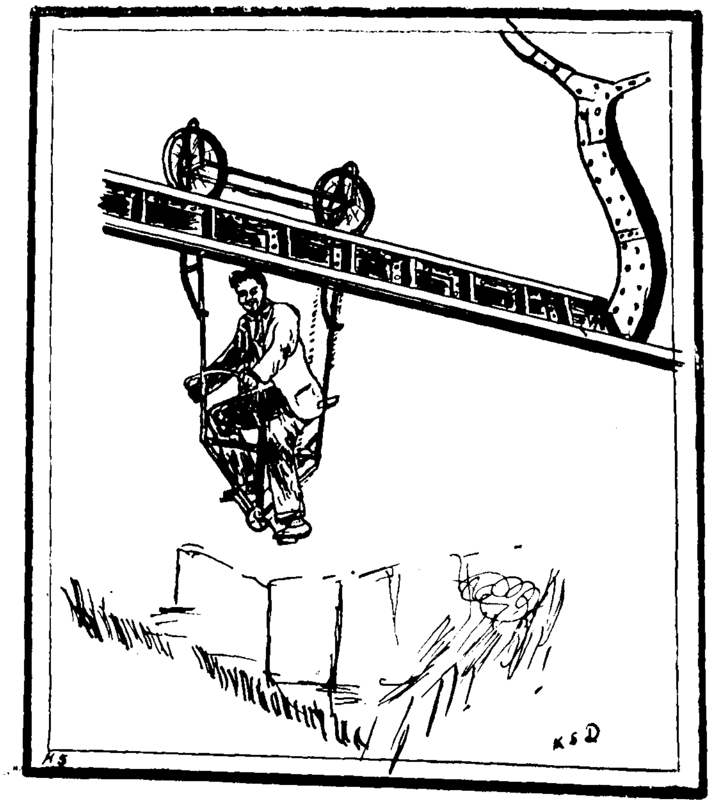


Fig. 1. So it was found! One of the trails to find the hanging train.

This Suspension Monorail runs directly over the Wupper river and Sonnborner Strasse Road connecting two end stations, "Oberbarmen" and "Vohwinkel" in the centre of the City passing through several important places. The railway line is 8.25 miles long, out of which 6.2 miles runs over the river and the remaining over the road Sonnborner Strasse (Fig. 2). There are 18 Stations in total, approximately at an average distance of 3.5 furlongs in between. The total weight of the steel that is used in constructing this railway is 19,000 tons including stations. The main railway line is at about 27′ minimum height from the ground and 40′ from water level, and bottom of the train is at a height of 15′ from the ground. The electric lines of Trams are 1′ below the bottom of the coach.

The whole train as an unit, consisting of two self-powered coaches coupled together, moves on a Suspension Monorail which is connected to the main structure

Diesel-electric locomotives Nos. 10000 and 10001. These locomotives, which are in experimental service on British Railways, are seen here hauling the "Royal Scot" heavy express. Each locomotive has a 16 cylinder diesel engine developing 1,600 h.p. Both were built at the Derby Works of British Railways and are equipped with diesel-electric generators made by the English Electric Co.

diesel engine rated at 1,750 horse power. Pressure charging of the cylinders is carried out by four Napier exhaust gas turbo blowers. There are six traction motors suspended on the driving axles. The design of the bogies is similar to that used on the three Southern Region electric locomotives but there is an additional idling axle for weight carrying and guiding. The driving desk is on the left hand side of the cab and controls are arranged at each end of the locomotive. Fitted into the desk opposite each driving seat is a dead man's pedal which has two treadles to suit either standing or sitting positions. The design of the locomotive body follows simple lines and the curved sides are of the same contour as the post war coaches of the former Southern Railway. Steel panelling is used throughout except for the six hinged cover lids above the diesel engine which are of aluminium alloy. An oil fired boiler supplies steam for heating the passenger coaches. The overall length of the locomotive is 63 ft. 9 ins. and the total weight in working order is 135 tons. The high availability of this type of motive power has enabled each locomotive hauling heavy express trains, to make two return trips from London (Waterloo) to Exeter, a total distance of nearly 700 miles in a working day.

No. 10,100 is unique on British Railways for it has four separate diesel engines transmitting their power to the wheels through a gearbox. This system eliminates the heavy generators and traction motors used on other main line diesel locomotives running on British Railways. The locomotive has eight coupled wheels and a four wheeled guiding bogie at each end. The design of the machine is based on a new principle in diesel power application. Four Davy Paxman super-charged diesel engines each developing 500 horse power, are installed in pairs at each end of the locomotive; these drive the wheels through fluid couplings and a special gearbox which ensures that the power of the engines is maintain-

ed as nearly constant as possible over the designed range of locomotive speeds. The special gearbox unit, which combines the power output of the four main engines, is placed in the middle of the frame and the drive to the wheels emerges from the gearbox through two transverse shafts coupled flexibly to the two inner driving axles. These flexible couplings allow for the rise and fall of the axles in the horn guides and also protects the gearbox from traction shocks. It is claimed that the low weight of this form of transmission—compared with the electrical system—makes it possible to install diesel engines of much greater piston area than in any existing diesel locomotives of the same weight for a given tractive effort. No. 10,100 was built at the Derby works of the London Midland Region and weighs 120 tons. It has a maximum speed of 78 m. p. h. and can be used either on heavy goods or express passenger services.

Diesel shunting engines are much more economical than steam engines particularly when they are standing idle. If the locomotive is kept stationary for more than a few minutes, the diesel engine can be switched off thereby saving fuel and reducing wear and tear. British Railways had considerable experience with diesel electric and diesel mechanical shunting locomotives and they have been throughly proved in their arduous type of duty. It has been planned to build 85 diesel electric shunting locomotives during the years 1954–55 as part installment of their five year programme to build 573 locomotives.

No. 18,000 is British Railways first gas turbine locomotive to run on British Railways. It was ordered just after the second world war, from the well known Swiss engineering firm of Brown Boveri. It was delivered to British Railways soon after nationalisation and began operation in February 1950 on the western Region between London (Paddington) and Plymouth. The locomotive is powered by a gas turbine which drives an electrical generator through reduction gearing while

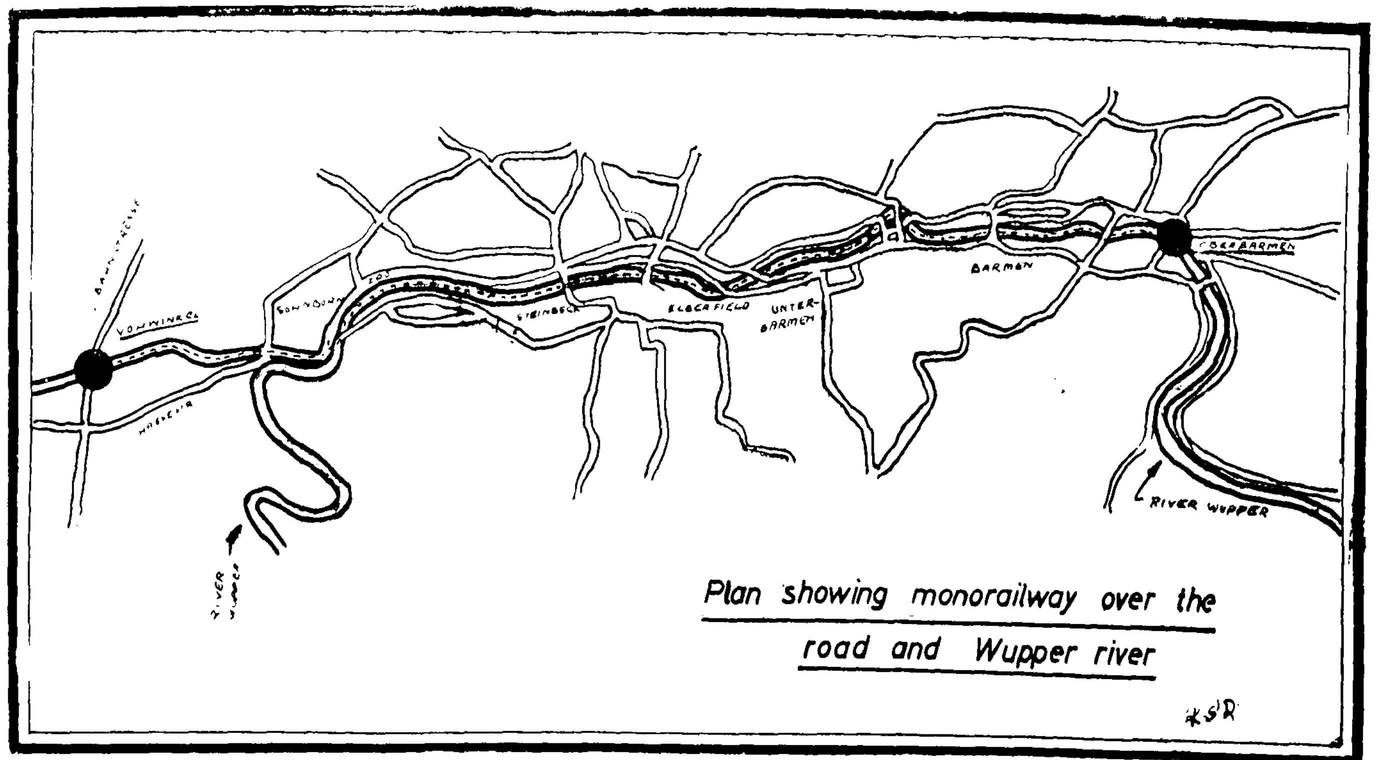


Fig. 2. Plan showing the route of the suspension monorailway over Wupper River and Sonnborner Strasse Road. Dotted lines shows the length of the monorail and two end stations are marked in Big dot.

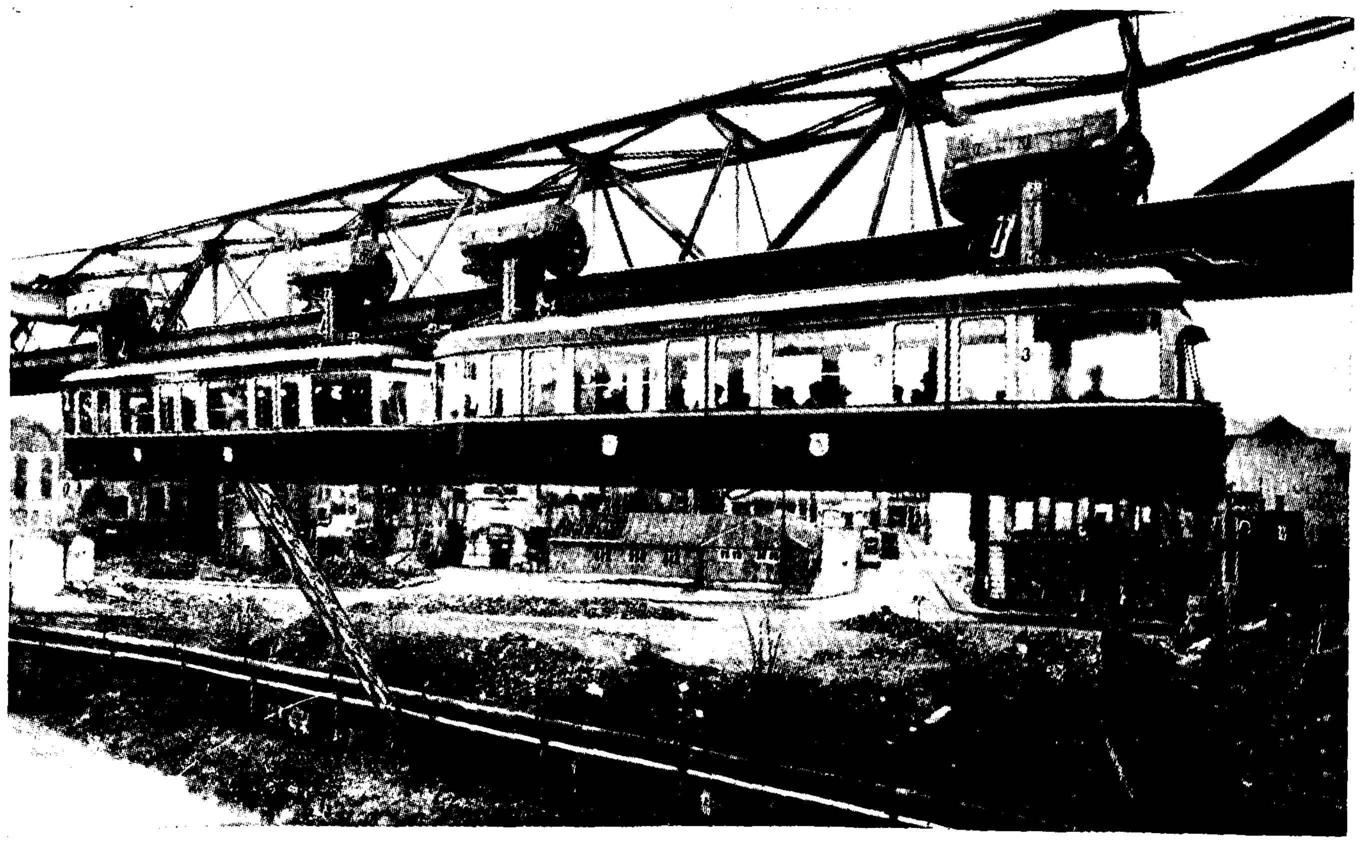


Fig. 3. Hanging train over the River.

in the centre (Fig. 3). The main structure is supported by steel pillars on both sides from the ground. After various experiments, running two coaches as an unit was found to be more economical, speedier and safer. Each coach with passengers weighs 18 tons. These trains are designed to swing on both side of the rail to a maximum of 15°. But practically they swing only 8 on both sides (Fig. 4).

The train takes 35 minutes to go from one end Station to the other with an average speed of 15 miles per hour as compared to an average speed of an underground train of Paris, New York, Berlin and London, 15, 16. 16, 18, miles respectively. This train is designed to run at a maximum speed of 35 miles. At a curve with the minimum radius of 300′ the train can easily go at a maximum speed of 19 miles. Every 3 minutes there is a train when there is a heavy traffic at peak hours, and every 12 minutes a train at other times.

The train runs on a special rail which is supported by a structure which in term is supported by strong pillars from the ground. As the train runs over the road and river, there are two kinds of support to the main structure from the ground. The structure in the river area is supported by Beams and pillars with a strong foundation on either side of the river (Fig. 5). The structure on the road is hung to a steel arch (Fig. 6). These

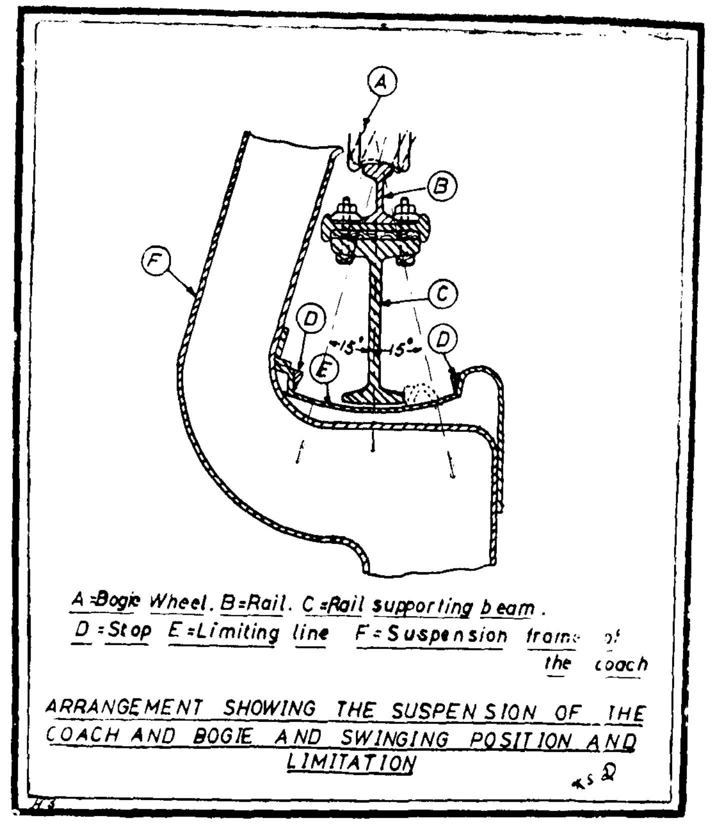


Fig. 4. Arrangement showing the suspension of coach and wheel and swinging position with limitation.

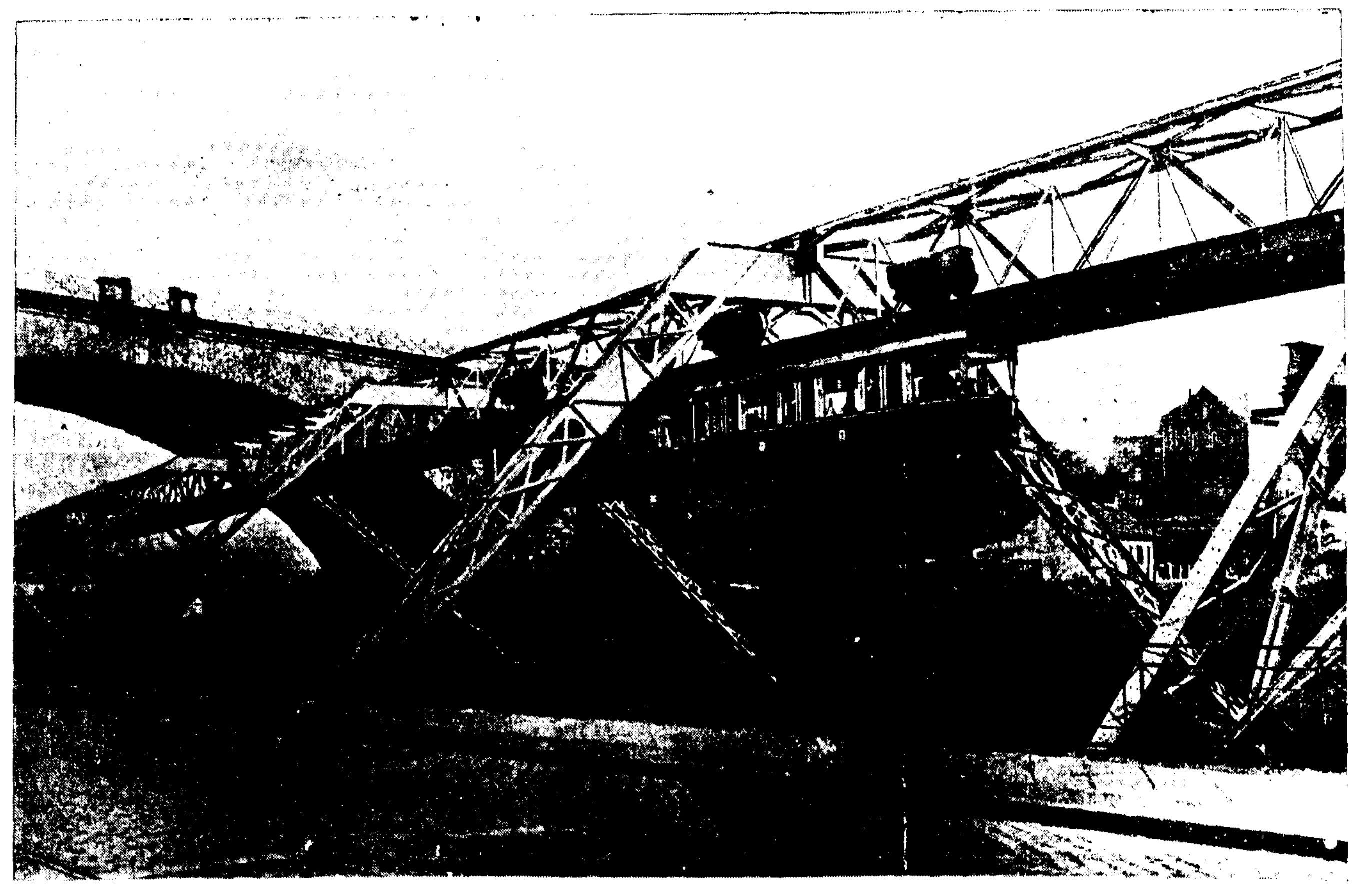


Fig. 5. Main structure is supported by side pillars on either side of the river.

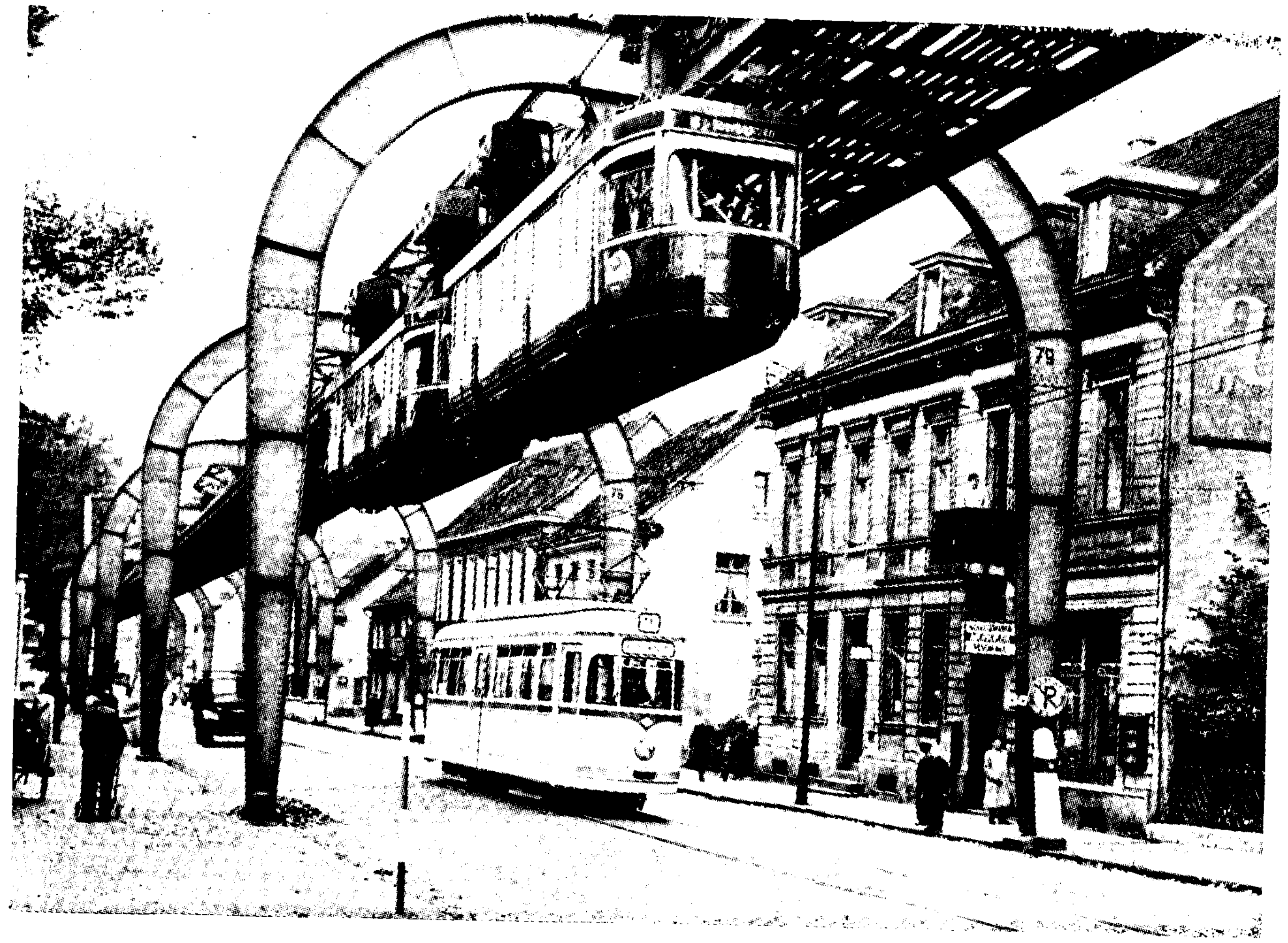


Fig. 6. Hanging train over Sonnborner Strasse Road. The main structure is supported by an arch type of steel structure.

structures are designed to take up expansion and contraction due to the variation in weather. The train runs in one direction and has got two different lines for up and down journey, in the same structure. Distance between two supports is about 100′ average. Difference in level of the rail is (maximum) 130′ in the total distance of 8¼ miles. Maximum gradation is 1 : 37. Special Stations are built at a level of about 15′. It looks as though the Station is at the first floor of a building. (Fig. 7) 600 Volts Direct Current is supplied to run this train. The structure was almost completely destroyed in the Second World War. But it is rebuilt and again is in service from 1948.

The train consists of 2 self-powered coaches hung by 2 Bogie units, each with two wheels with gear drive, with one Motor (Fig. 8 & 9). The coach runs in both direction. There are five different models uptill now built in different years. The following data gives the details of the latest model B. 50 Coach.

Year Built—1950.

Coach :	Length 11.83 meter (39′ approximate) Width 2.2 meter (7.2′ „) Height 2.75 meter (9′ „)
Bogie :	Diameter of the wheel—0.9 meter (2.95′ approximate) Distance between wheels—1.5 meter (4.9′ „)
Bearing :	Roller Bearing.
Drive :	Worm Gear.
Transmission :	1 : 9.75
Motor :	No. in each coach—2. Hourly rating—45 K.W. Revolution Minute—1,700. Voltage—600 Volts D.C.

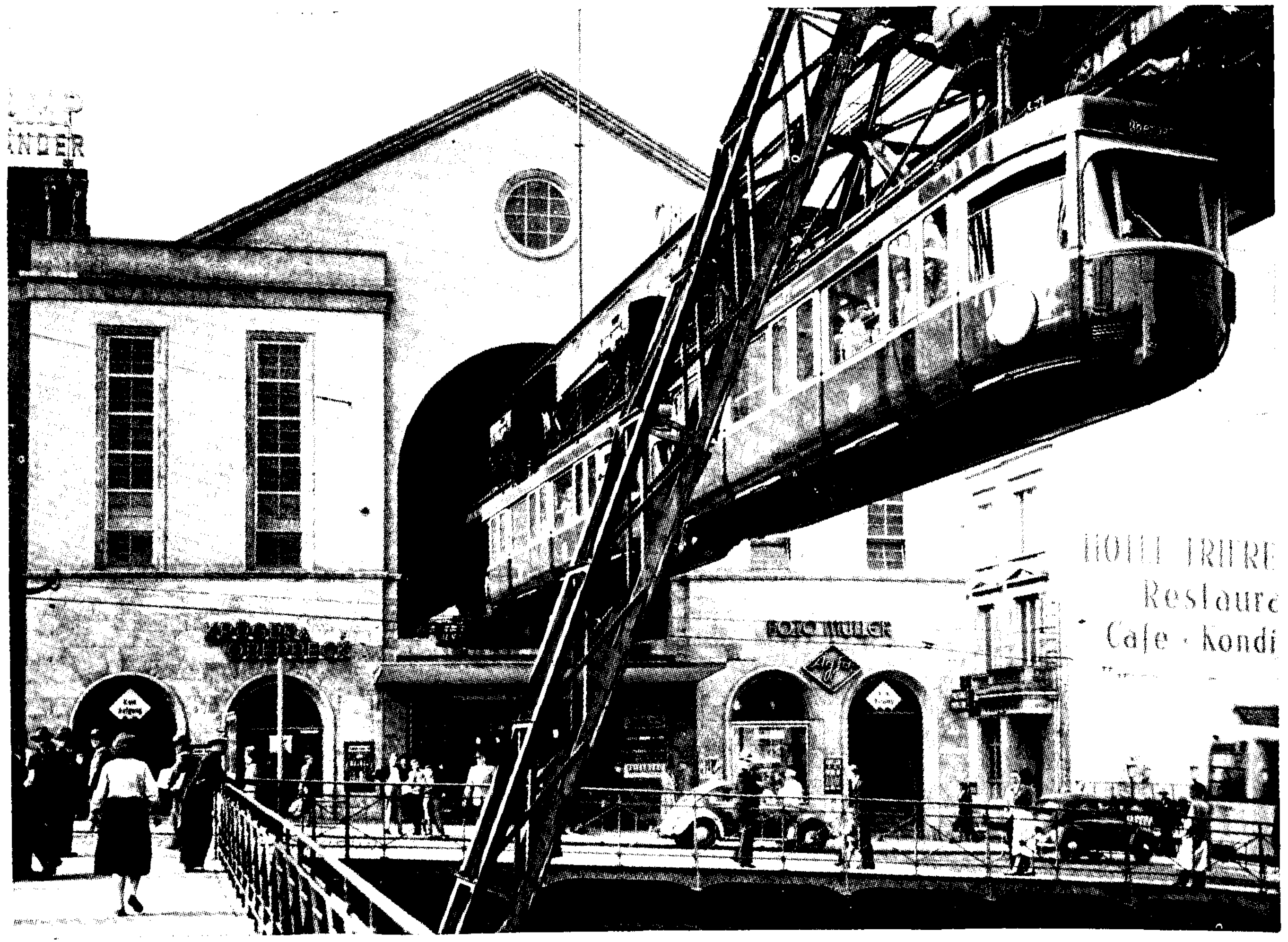


Fig. 7. Hanging train coming out of the station.

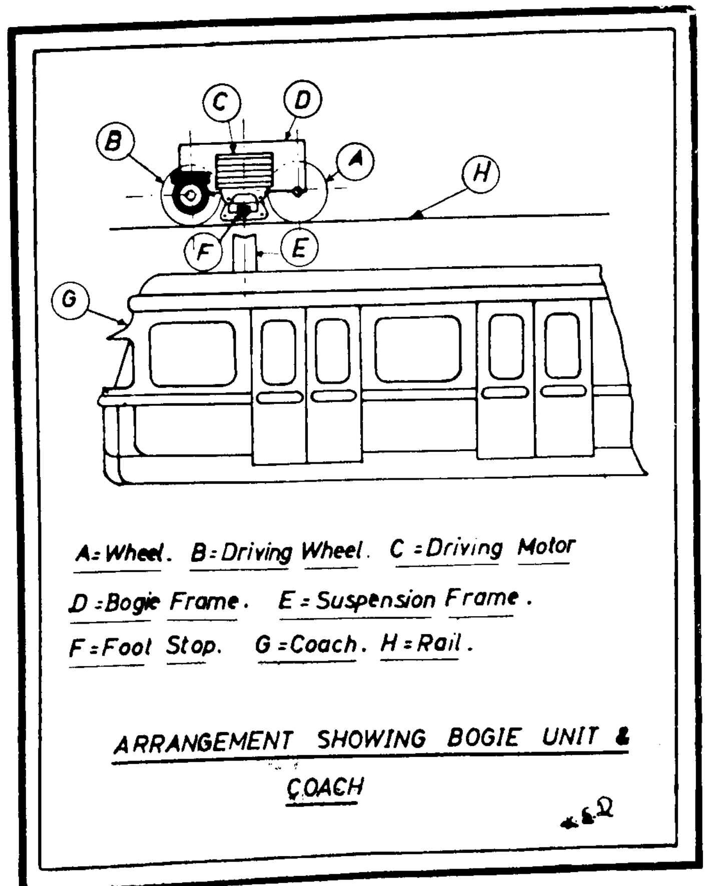


Fig. 8. Details showing the arrangement of Bogie unit and Coach.

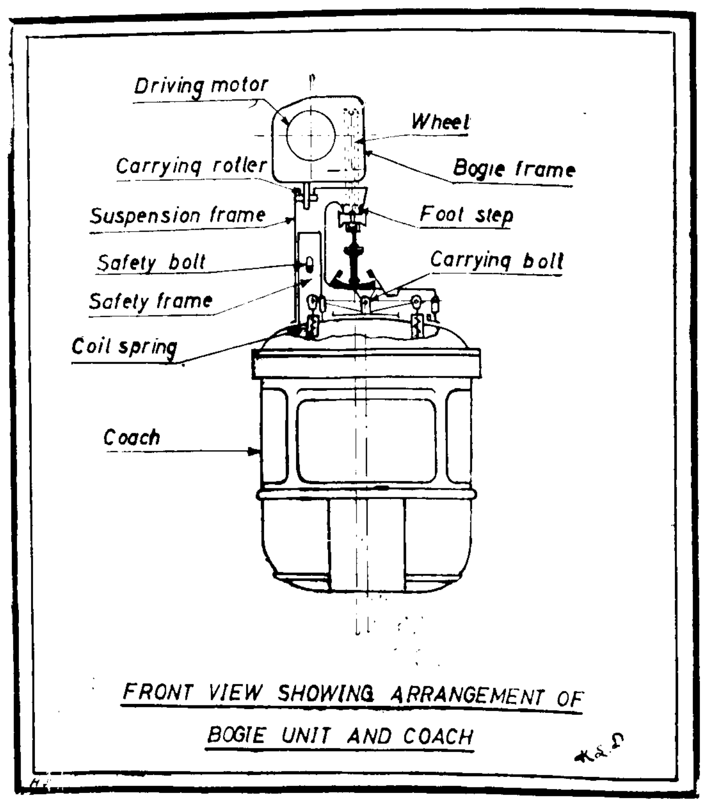


Fig. 9. Front view of the Hanging Train showing the attachment detail of the Coach and the Bogie on the Rail.

Weight :	Empty Coach—11 tons.
Brake :	Vacuum Brakes are installed at the bottom of the coach as well as at the wheels.
Coupling :	Automatic coupling is installed at the top of the coach and a mechanical coupling at the bottom.

Brushes are provided on the top of the Coach to take up the current from the Main Positive conductor.

Passenger Capacity :			
	Sitting	II Class	10
	Standing	,,	15
	Sitting	III Class	21
	Standing	,,	34
		Total	80

The coach has two Classes, viz., 2nd and 3rd Class. 1/3 of the area of the coach is occupied by 2nd Class and the remaining space is by 3rd Class. The 2nd Class seats are cushioned (Fig. 10).

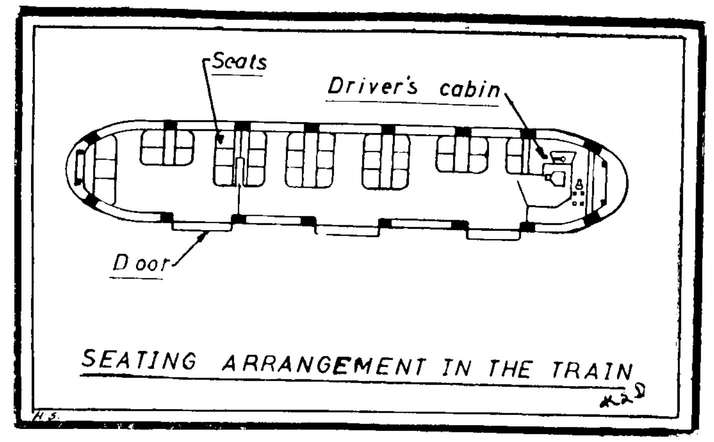


Fig. 10. Seating arrangement in the train.

As there is no fear of collision, the body of the coach is built as a composite body with steel and wood in view of the light weight. There is a partition in between the 2nd and 3rd Class Compartments with a sliding door, so that passengers may change their Class even though they have alighted the wrong Compartment in hurry. Three sliding aluminium doors are provided which are operated by automatic electro-pneumatic control from the Driver's panel with a signal lamp for operation.

Driver's Cabin consists of Steering, Brakes, Hand-brakes, Safety Fuses, Overload Fuses, Heating system

SIGNALLING AND INTERLOCKING

Chapter 20.

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

ILLUMINATED DIAGRAMS

IN an earlier chapter, it has been explained that in Manual signalling installations, where all points and signals are operated from a mechanical lever frame, a large coloured plan of the area controlled is placed in a glass frame and hung at the back of the levers for the signalman's reference. The tracks are depicted by broad lines, running lines usually being painted blue and sidings and goods lines brown. All signals and points, with their numbers, corresponding to the lever number from which they are worked, are shown on it and also a descriptive schedule of the levers in the frame.

Where a station yard has only a few track circuits their condition, whether occupied or clear, is indicated to the signalman by small electrical instruments fixed above the levers. These usually take the form of a red bar which is horizontal when the track is occupied and turned to an angle of 45° when clear. The position and extent of the track circuits is shown by colour on the signalling plan. Where there are a number of track circuits in use at an installation, it is more usual to provide what is known as an illuminated diagram. This device is not of recent origin but was first introduced in the early part of the present century at Acton Town Station on the District Railway at that time called Mill Hill Park.

The illuminated diagram is a development of the cabin signalling plan already described and by which the condition of the track circuits are shown on the diagram and not by means of electrical instruments beneath it. It includes the area controlled from the signal cabin and all points, signals, etc. are shown on it. The position and extent of each track circuit is coloured in soft pastel shades, contrasting colours being used for adjacent tracks for easy discrimination. Every track circuit is given either a letter or number for reference. In the centre of each track is a small circular or oblong hole behind which one or two electric control, Doors Control Lamps, Measuring Instruments for Oil and Vacuum pressure.

This train carries an average of 3,500 passengers per hour and about 56,000 passengers per day. $\frac{1}{5}$th of the total travelling public of the town, travel in this train. When compared to the length of transport facilities available including train, bus, tram, the Suspension Monorailway is only 1/22 of the total length in the town of Wuppertal. Many think that this hanging train costs too much due to the heavy super structure, it requires. But actually it costs less than what an underground railway costs per mile. The Wuppertal hanging train has cost about 16 Million German Marks, i. e., about 1.7 Million German Marks per mile. According to their calculation at the time of constructing this Railway line, an underground line costs about 7 to 11 Million German Marks per mile, 4 Million German Marks for ordinary railway line per mile.

Maintenance costs much less, except for covering of the structure with paint periodically. They are painting the structure once in five years. Total persons in service are only 475. It will be a surprise to hear that there is no trouble of any kind after the installa-

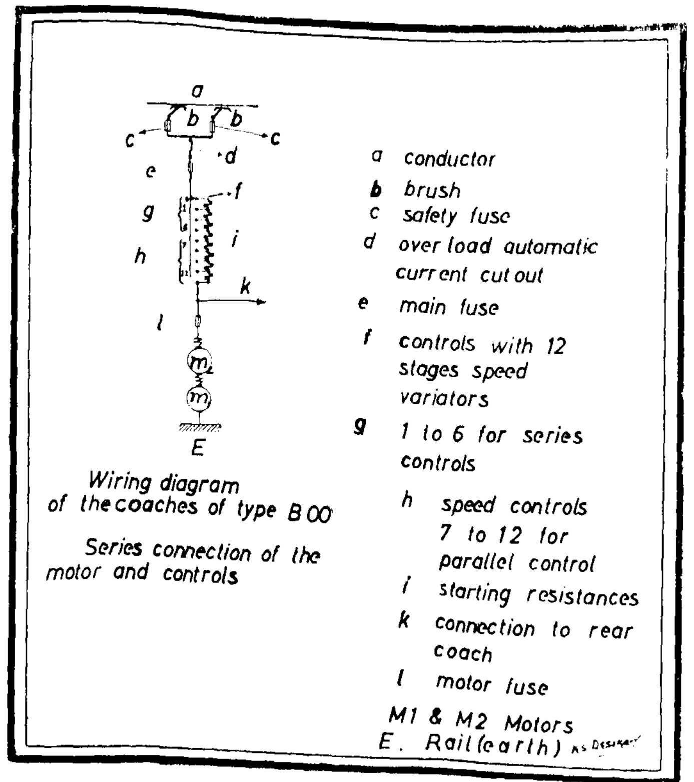


Fig. 11. Simple wiring diagram of the Coach type B.00.

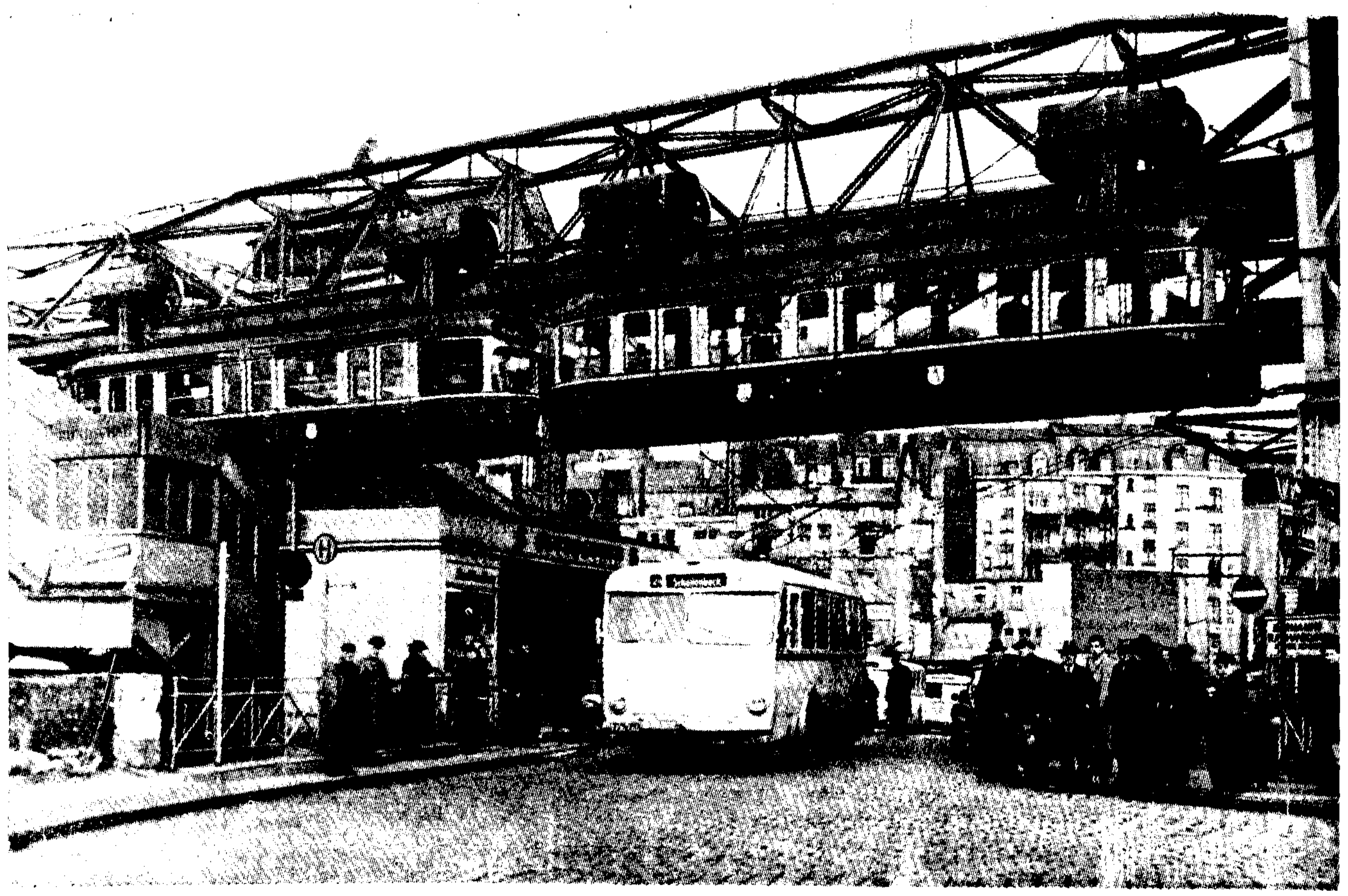


Fig. 12. Hanging train in between the end station and the repair shop, over the road. Trolley Bus is passing under this train.

tion for the last 50 years. At the end Stations the trains can change the railway line for repair and maintenance purpose.

In its 50 years of service except one small accident, it has proved itself cent per cent safe in all respects. No passenger can travel hanging to bars or as foot-board passengers as all doors are automatically closed by the Driver, before the train leaves the Station, leaving no space to stand in the door-way. The train is completely controlled by Electrical Automatic Signals which are connected to the main power lines of the train by which no mis-happening can occur. Each train is equipped with a Telephone, so that they may have contact always with the Stations and vise-versa for easy and quick operation. As the complete train is suspended by a Bogie on the rail and also it can swing up to 15° on both sides, the passengers will not feel the jolting or the vibration. The passengers will feel as though they are travelling in a cradle. The train runs only in one direction. There is no disturbance or interference to any other traffic (Fig. 12). It is also independent of rain, snow and water. Once they tried as an experiment to know the feeling of an animal when it travels in this train. A small elephant was given a joy ride in this train. Unfortunately it dashed through the window and fell down from the train into the river immediately after the train left the Station.

Various experiments are conducted with this practical experience of Wuppertal Suspension Monorail. Dr. Rudolf Wanger conducted his experiments on Propeller train of speed about 70 miles per hour. Dipl. Ing. Franz Kruckenberg with his experience as an Air-craft Designer, tried his rail zeppline in the year 1924. Various trials were done in Japan also. George Bennie of England worked in Glasgow on his rail plane or flying train to attain a speed of 150 miles per hour with Electric Motor. In France, Mr. Dunn did experiments on the same line of Mr. George Bennie. An improved hanging train of speed 150 miles per hour was tried in America.

Wuppertal hanging train is already 50 years old. Further improvements on this train will be very beneficial. Instead of only 2 coaches in a train, a train of 10 coaches minimises the cost as well as the time. Increase in speed of the train and improvement in swing from 15° to 30° in a smaller curve will definitely give comfort to the passengers. At present, the train is running only in town. Trials should be made to run this type of Suspension trains from town to town which ease the transport problem. Such experiments will really solve not only transport problem but also save space, time and money with a maximum safety and comfort as, it moves in contact with the ground as compared to the plane.

Ref: Author is indebted to Wuppertaler Stadtwerke, Wuppertal, West Germany for supplying necessary information and permitting to publish it with Photos and Sketches.

EXPRESS GOODS SERVICE PROVING POPULAR

The Express Goods service introduced last year on an experimental basis is now running to published time-tables like passenger trains and has proved attractive to the commercial community because, compared to ordinary goods trains, its running time has been reduced practically by 50 per cent.

This experiment resembles practices followed on the more advanced French and German Railways. Originally introduced as Weekly Express Trains, the popularity of this experiment quickly enabled the Railway Board to issue instructions for their conversion into daily services with effect from June last. At present, there are 32 Express Goods Trains—24 on the broad gauge system and eight on the metre gauge system. Twenty of these are daily services, the remainder running weekly, bi-weekly or at more frequent intervals.

The Express Goods Trains generally run through from the starting to the terminating stations, stopping only at a few selected intermediate stations for watering, refuelling and changing of engines and staff. To take advantage of these stops, traffic is booked at these stations and traffic coming in from the branch lines is also cleared onwards from there by the Express Goods Trains.

Train departures are not delayed merely on the ground that full train loads are not forthcoming by the scheduled departure time. If, however, more goods are offered than an Express Train can carry, a schedule of priorities operates. Within each priority category, traffic is cleared on the "first come, first served" basis.

The Express Service helps both the Railways and the commercial community. It helps in the quicker turn-round of wagons and enables the consignors and consignees of goods to move their wares from place to place faster.

THE INDIAN RAILWAY ENGINEER is the first Railway Engineering Journal to be produced in India for the benefit of the Engineers of all Departments of the Indian Railways, and particularly for the younger generation of our Railway Engineers.

You will find it profitable to go through a copy of it and know all the latest trends and developments in the technique of "RAILWAY ENGINEERING", besides deriving the pleasure of reading valuable technical articles and papers from Experts in the field.

Enter your subscription to-day if you like to take advantage of this new Technical Journal. Our annual subscription is as low as Rs. 2/- for readers in this country and only Rs. 4/- for Overseas Subscribers.

Please cut out the coupon below and post it to us after filling in with particulars together with the remittance without delay. Thank you!

CUT HERE

Subscription Order Form

Beginning with the next issue please send "The Indian Railway Engineer" for one year

NAME..

ADDRESS..

....

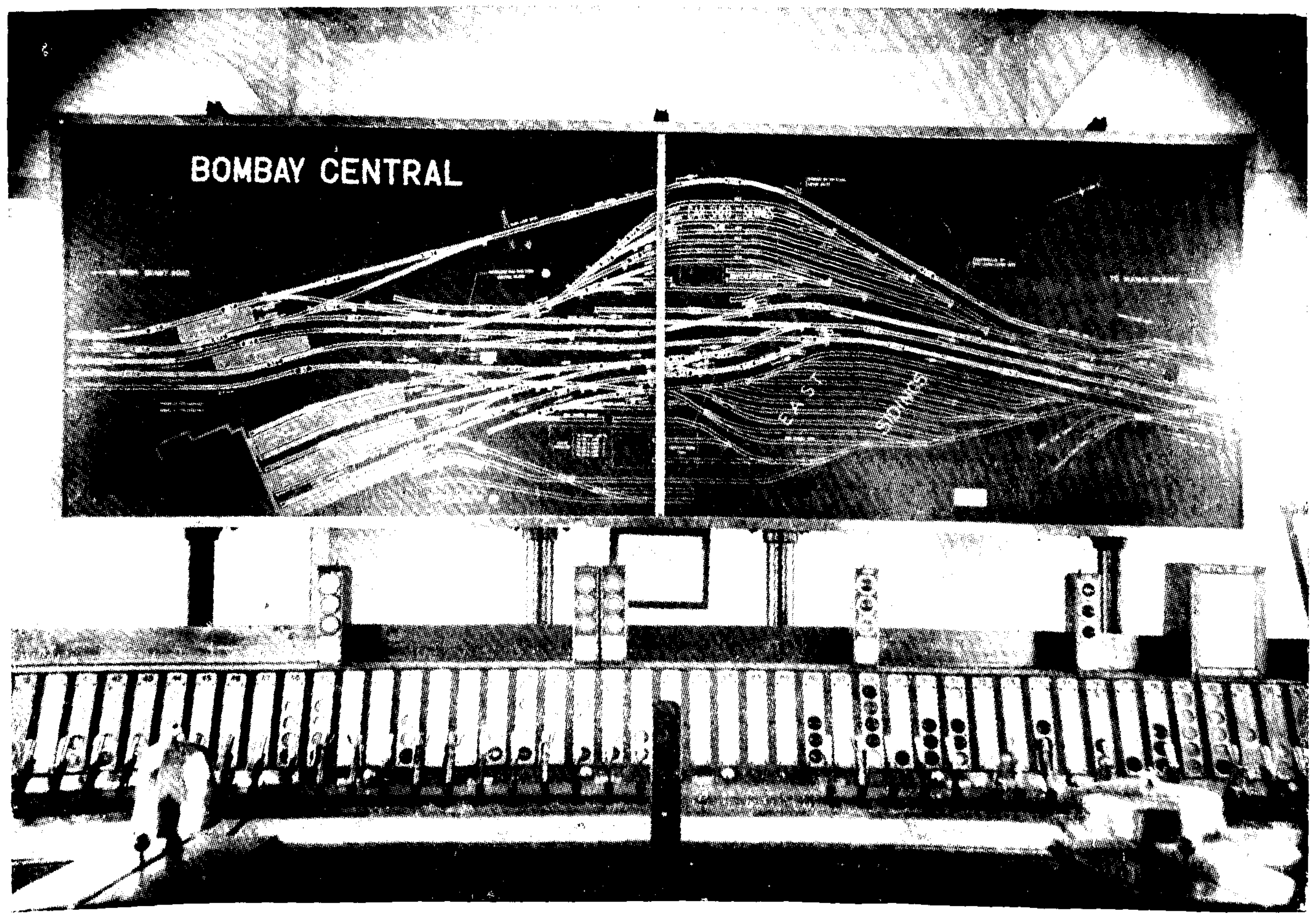
THE ANNUAL SUBSCRIPTION RATE IS RS. 2/- (Inland) & Rs. 4/- (Overseas) BY POST

79, JAYPRAKASHNAGAR, GOREGAON, BOMBAY.

bulbs are placed. In the early diagrams they were illuminated when the track was unoccupied and extinguished when otherwise. The passage of a train could therefore be clearly followed on the diagram.

At first lamps were not used at all. The repeater relays, required for the interlocking circuits in the cabin operated from the track circuits outside the cabin, were placed behind the diagram and each relay had a painted flag which showed through an aperture on the diagram. When the track was occupied, a red flag was displayed and when clear is changed to white. The flag was attached to a spindle worked by the relay armature. The first diagrams using lamps were built on the strip light principle. Instead of the track circuit being painted on the diagram, with a central hole for the electric bulb, the whole track was cut out in the form of a strip. The track number or letter was also cut out and fixed in the centre. A sheet of frosted glass was placed at the back of the diagram. Each track was illuminated by several bulbs, so as to produce even illumination. When no train was in the area the whole of the tracks were illuminated. A variation of the strip type is the oblong indication already mentioned. Here an oblong slot is used with the track circuit letter cut out in the form of a stencil fixed in the middle. One or two lamps are used for illumination. Other types of diagrams are of the all steel type having tracks and signals painted on a steel panel with a matt black surface. Two spotlight type indications are provided for each track circuit.

Present day practice favours the normally extinguished diagram, the bulb illuminated by track occupancy. This method is very advantageous where the signal cabin supply is from batteries, small flash lamp type bulbs being used. In large diagrams, normally illuminated, a considerable amount of heat is radiated which sometimes causes cracked glasses. Continual observation of train movement causes eye strain for the signalmen on account of the brilliance produced by all tracks being normally illuminated. In some cases, a red light is used instead of a white one and the indication is certainly arresting. The first track circuit shown on the diagram

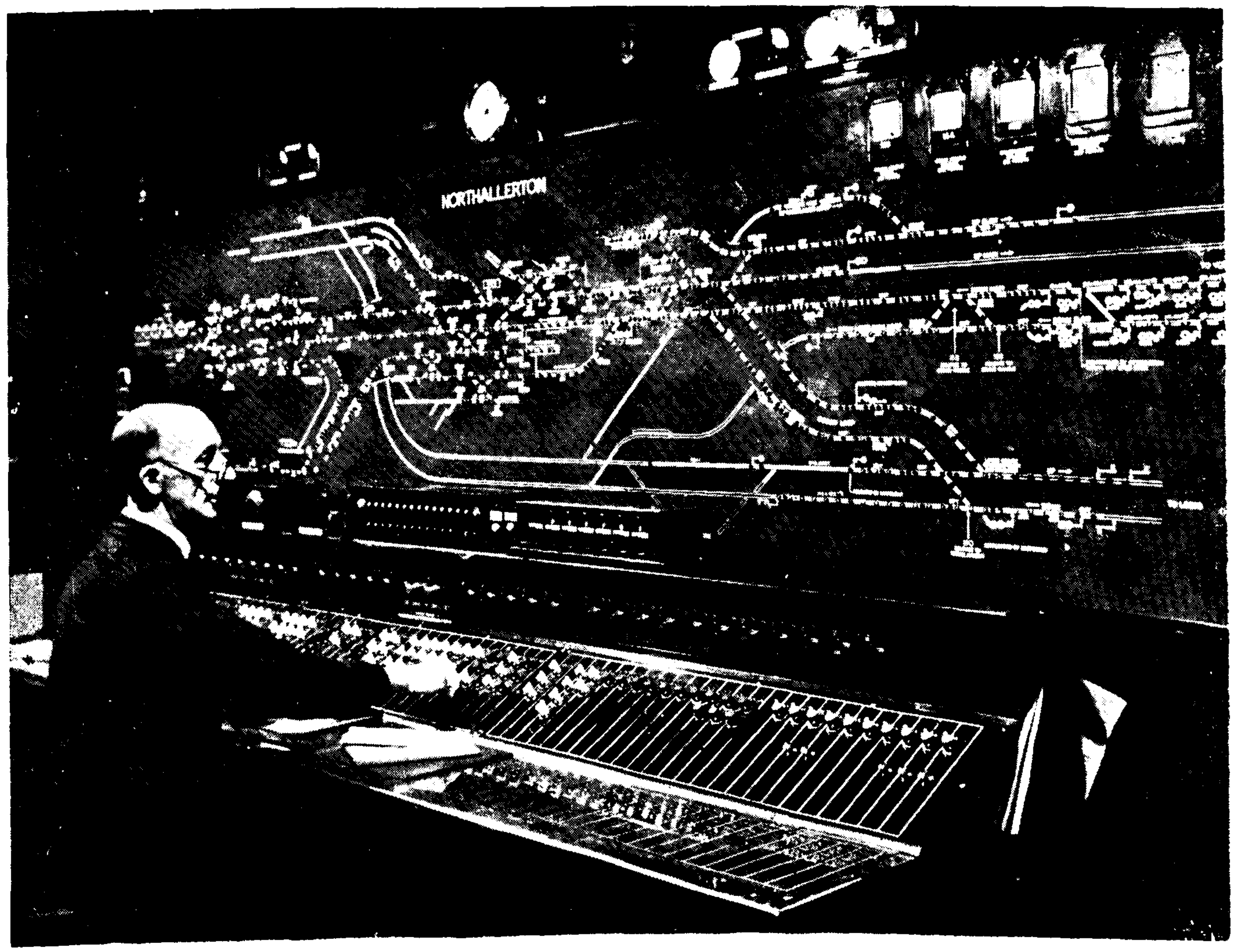


Illuminated diagram covered with non-reflecting glass.

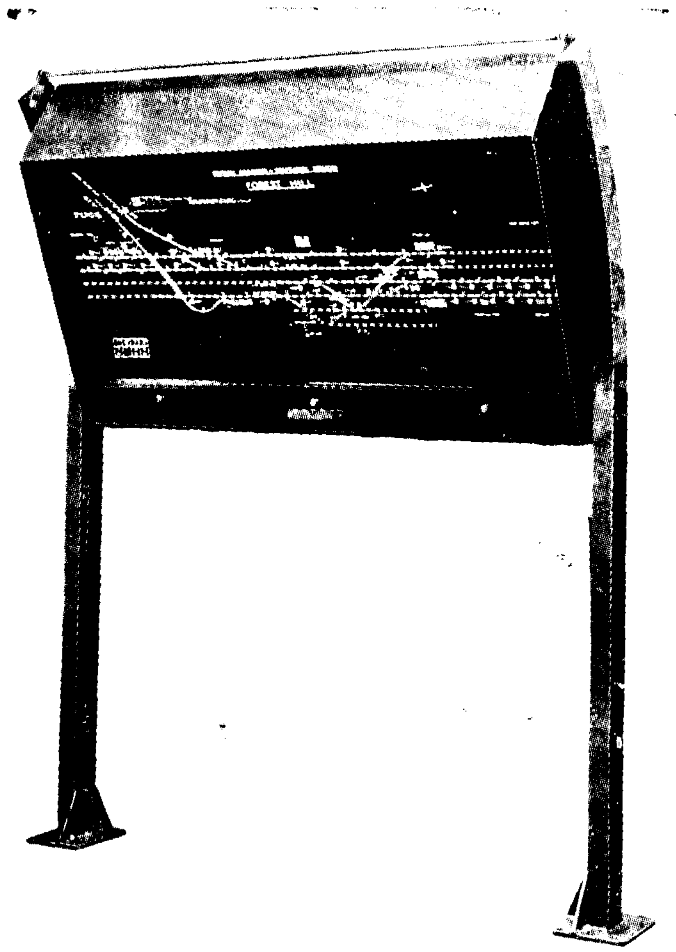
in the approach direction may be made to operate in conjunction with a buzzer so that the signalman is informed of the approach of a train should the indication on the diagram have escaped his notice due to being busy with other duties.

Illuminated diagrams are made of different materials according to taste or the climate in which they are to be used. When the plan is painted on sheet steel it is suitable for some countries but definitely not suitable in sandy places where high winds are experienced. The track plan is quickly rubbed away by the blasting effect of wind. A favourite type of diagram has the case of wood while the plan is painted on thick drawing paper. It is mounted between a sheet of clear and a sheet of frosted glass. Usually the front is hinged to permit lamp replacements and the lamps themselves are placed inside tin masks to prevent light leakage from one track to another. The clear glass, however, picks up reflection and a recent development has been to use an acid washed glass which is non-reflecting. Some railways use black poster paper for illuminated diagrams. The tracks are depicted in Chinese white while signals, track circuits etc. are in colour. This type of diagram is considered to be as distinct as the white type, if not more so, and is more restful to the signalman's eyes particularly in a tropical country where intense glare is encountered.

The development of power operation for signals and points and the introduction of track circuits enabled larger areas to be controlled from a central cabin. The first power frame generally followed the lines of their mechanical predecessors. The points and signals were operated by means of levers assembled in a frame with mechanical interlocking between them to prevent



Relay interlocking at Northallerton, North Eastern Region, British Railways, using thumb type switches on separate panel. (Photograph by courtesy of Westinghouse Brake & Signal Co. Ltd.)



Curved illuminated diagram made of plastic material as installed at Forest Hill, British Railways. (Photograph by courtesy of Westinghouse Brake & Signal Co. Ltd.)

conflicting movements being set up. These levers served to open and close contacts controlling circuits operating the various signal and point controls. As there is no physical connection between the levers and the functions they operate, the former are reproduced in miniature form and have a length of from four to six inches.

The levers are used to operate contacts and they are mounted in a frame to ensure rigidity and to enable the mechanical locking between them to be fitted. In recent years a system known as relay interlocking has been introduced where the power frame has been dispensed with and the levers have been replaced by switches often mounted on the illuminated diagram itself. These switches control interlocking relays which take the place of the circuit controllers formerly operated by the levers in the power frame. These interlocking relays control the various points and signal circuits and also perform the necessary interlocking features to prevent conflicting movements being established.

In these cases the illuminated diagram takes the form of a panel of suitable material. The tracks are represented by xylonite strips divided in accordance with the track circuit divisions. Signal switches are generally capable of movements through 90° standing at right angles to the line with the signal " ON ". The switch is turned to point along the line, in the direction of travel, to make the signal show " Clear ". A red pea lamp in the centre of the switch is illuminated when the signal is at red. On the clearing of the signal the red lamp is extinguished and a green pea bulb at the side of the switch lights up for either the yellow or green aspect of the signal. Track circuit indications are also given by pea lamps which are illuminated when the section is occupied. The signal numbers, track circuit numbers and any other necessary information are painted on the panel in white. On some systems the point switches are mounted on the diagram near where the points are drawn or fixed on the plan and have two positions, normal to the left and reverse to the right the total angle of movement being 90°. Point indication is accomplished by two pea lamps at the point location on the panel.

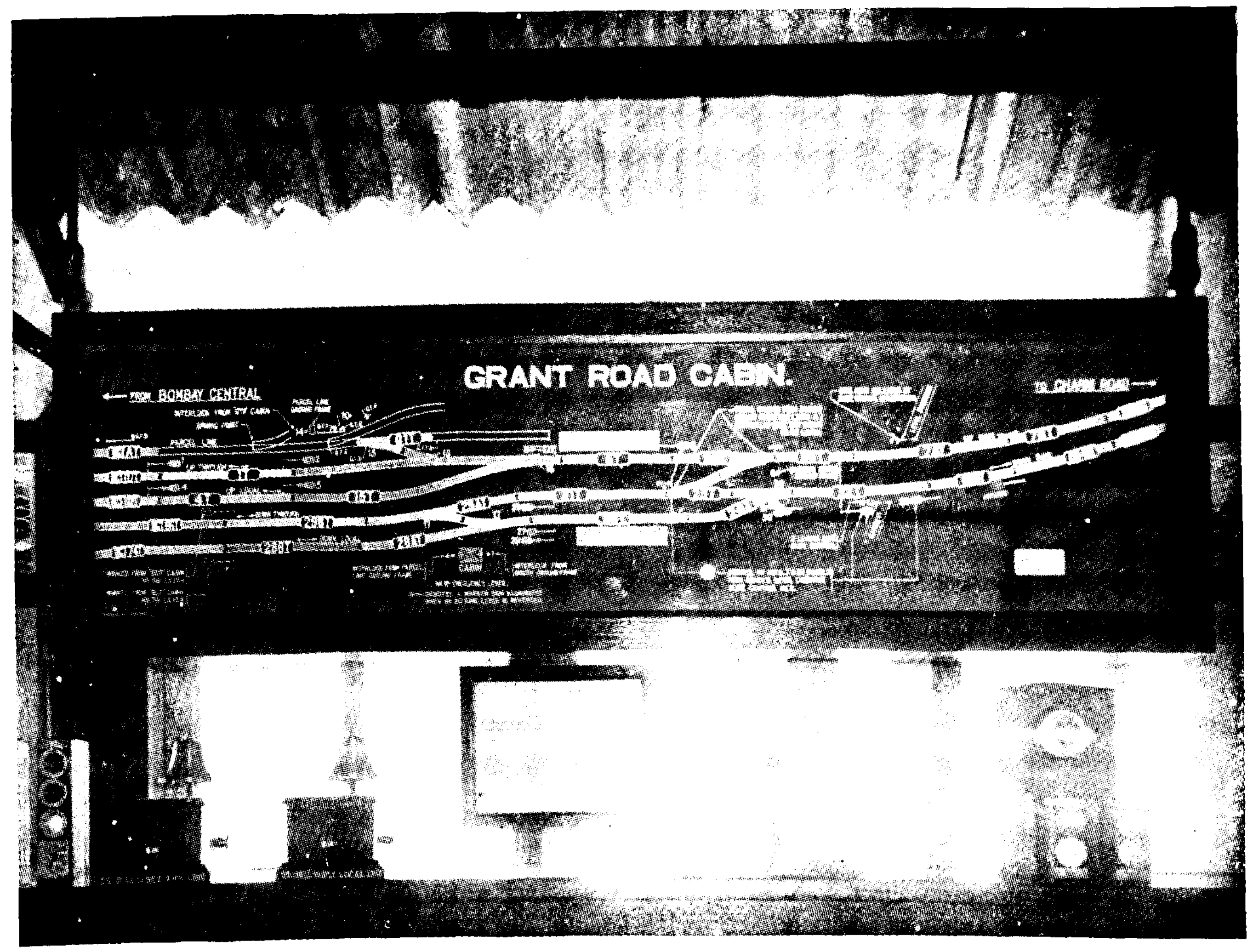
In the system known as route relay interlocking signal switches are provided but where a signal reads more than one way there is a separate switch for each route. The reversing of a switch operate the points in the route as required and, when the movements are completed, the signal clears. The replacing of the signal switch does not, however, replace all points back normal.

The convenience of a relay interlocking plant is that it takes up much less space in the signal cabin than would be required in the case of a power frame. A panel only twelve feet long can be worked by one operator whereas a power frame, for a similar installation, would require a space about 36 feet and several operators. As the lever contacts are replaced by relays more space would be required in the relay room but as this need not necessarily be placed under the signal cabin ample space can generally be found for it elsewhere. Some railways favour the retention of the illuminated diagram in its original form the point and signal switches being mounted on a small desk underneath. Installations of this type are in operation on the north eastern region of British Railways particularly at Northallerton and Hull Paragon. Here the diagram is of the metal faced type with telephone type visuals inserted in the tracks to show occupancy.

The installation at York, opened in 1951, is the largest relay interlocking scheme in the world. It is based on the same principle as Hull Paragon except that, on the operation of a route setting switch, the route so set up is immediately shown on the diagram by a line of white lights. The occupancy of the route and its respective track circuits is indicated by red lights mingled with the white. The indication of the route set up by the white light display is of immense assistance to the operating staff since it enables mistakes to be immediately rectified.

While on leave in the U. K. in 1950, the writer had the privilege of being invited to a demonstration of a new type of illuminated diagram which was held in the development section of a well known signalling company. This type of diagram has been designed not only to overcome the difficulties arising from reflection, where a large area of glass is involved, but also to endeavour to make the signalman's observation of the diagram more comfortable. With the use of power and relay interlockings the area under the signalman's control has increased enormously which means that the size of the illuminated diagram has correspondingly increased. The signalman has to spend considerable time looking up at a diagram at an inconvenient angle, atiring process.

With the object of overcoming the disadvantages of earlier systems, the new design is such as to eliminate all reflection and at the same time increase the visibility of the track plan and its associated indications. The new diagram is of curved, transparent plastic sheet, internally illuminated, on which the tracks, signals, numbers, etc. appear with great visibility. This portion of it remains unchanged. Placed at the back of this sheet is another representation of the track layout but designed so as to indicate track circuit occupancy and other movements associated with traffic conditions. The sheet is illuminated at the bottom edge by strip lighting and modern



Illuminated diagram in Indian Railway Signal Box.

The Influence of the Driving and Carrying Wheel Diameter on the Design, Performance and Behaviour of a Locomotive

By M. S. Surma

THE diameter, whether of driving or of carrying wheels is an important factor in the design of a locomotive. In the case of carrying wheels a large diameter (as nearly equal to that of driving wheel as possible) is always favoured, but in the case of driving wheels a compromise is necessary.

DRIVING WHEEL DIAMETER

Earlier locomotives were fitted with relatively large driving wheels. In the history of locomotive practice, driving wheels of as big a diameter as 9 ft. have appeared and this diameter is possibly a limit which has never been crossed. The reason for the adoption of such a large driving wheel in those days could apparently be :—

(i) To achieve higher train speed for given driving wheel R. P. M.

(ii) To have less wear and tear due to decreased rotational speed of the journal.

At a later stage certain investigators conducted experiments on the steam cycle efficiency and Professor Goss published the data collected by him in his book " Performance of Locomotives ". He states that whenever the speed of rotation of the driving wheels exceeds, what he terms as " critical speed ", a loss of efficiency occurs. This " critical speed ", he fixed, at 200 R. P. M. of the driving wheel.

In those days the locomotives were fitted with 'D' slide valves and Stephenson link motions. The cause of such a low "critical speed" was undoubtedly a low steam cycle efficiency, on account of wire drawing and bach pressure, both of which would still be greater if small driving wheels were fitted. If, therefore, at normal operational speeds, this " critical speed " was not to be exceeded to, the driving wheels had to be made very big.

As the time passed on, the need for drawing heavier loads grew more and more and boiler, on account of its relatively small size became a limiting factor in so far as an adequate steam supply to the cylinders was concerned. Necessity usually arose to employ double engines on stiff gradients, and some times in the wet weather, even to assist the engine to start with the train. To cope with this demand, the power of the engine and consequently the capacity of the boiler had to raised, but the presence of the large driving wheels brought in certain complications, such as,

(i) As the moving dimensions set a limit on the height of a locomotive, the diameter of the boiler could not be increased.

(ii) Any increased in the length of the boiler to raise its capacity meant the introduction of an additional axle in the wheel base.

(iii) If this additional axle was to be a carrying axle, the problem of adequate adhesive weight was to be faced and if it were to be a coupled axle, the question of length of the coupled wheel base would crop up.

The length of the coupled wheel base is one of the most important factors in the design of a locomotive, as it affects its stability to a very great extent. It is not in the scope of this short note to discuss fully its influence on the behaviour of a locomotive, but will be discussed to an extent of its relationship with the diameter of the driving wheel.

A locomotive consists of a number of trucks, main and auxiliaries. The main truck has all the coupled wheels grouped together in one frame, with all the axles parallel to each other, and is called coupled wheel base as well.

One fundamental thing in the design of a truck whether main or auxiliary (a truck consisting of carrying axles) is, that all the axles grouped together in one frame, should radiate from the centre of the curve, the loco negotiates. Any axle does not satisfy this condition affects the stability of the locomotive adversely.

It is, however, difficult to achieve this object absolutely, but the condition can be improved, if the coupled wheel base is reduced to a minimum possible length, by closer spacing of the coupled wheels. A reduction in the diameter of the driving wheel steel helps to achieve this object. It may be mentioned here that it helps in efficient functioning of the end trucks controls, and reduces the friction moment at the coupled wheel treads.

In the modern days, on account of the introduction of improved valve gears, which are well known for their efficiency of steam distribution, the "critical speed", once fixed at 200 R. P. M. has shot up, in the case of,

(i) Walscheart gear to 300 R. P. M.

(ii) Cam operated gears to 360 R. P. M.

The introduction of these efficient gears has enabled the designer to employ comparatively smaller driving wheels, so necessary for the safe operation of high speed locomotives.

Another very important factor in the determination of the driving wheel diameter, is flange rail contact, a study of which reveals that there is a definite relationship between the wheel diameter, wheel base, angularity of the wheel with respect to rail and the slope of the wheel flange for safe operation. This can be verified geomatrically. As the slope of the flange at the gauge face is a fixed thing, a limitation is imposed on the wheel diameter in a particular wheel base.

A full discussion of this subject will be found in "NOTES ON WHEEL FLANGE PROFILE" by Mr. R. G. da Costa.

In the following paras, some merits and demerits of the smaller wheel are discussed briefly.

(i) From the following well known formula it is seen that tractive effort of a locomotive is increased with smaller wheel.

Tractive effort is equal to $\dfrac{P\ d^2\ S\ N}{2\ D}$

Where, P is MEP/ sq. in.

d is the cylinder diameter in inches.

S is the piston stroke in inches.

N is the number of cylinders.

D is the driving wheel diameter in inches.

(ii) The distance between the centre of gravity of the suspended masses and the coupled wheel centre line is increased which results in lower flange impacts on the rail.

(iii) As the spacing of the wheels can be closer, the length between the leading coupled wheel and the front truck centre is increased which improves guiding.

(iv) The vertical distance between the coupled wheel centre and the bogie wheel centre is reduced (in the case of a bogie) reducing the swing of the bogie pivot pin.

(v) Comparatively lesser space is available for placing the counter balance weights and sometimes difficulty is felt even to balance the revolving masses, which results in "underbalancing" and is very injurious to the locomotive as well as track.

(vi) As the engine R.P.M. increases, for a given train speed, the unbalanced vertical component of radial force, which changes its direction very rapidly, becomes greater and gives a higher blow to the rail. All other things being the same, the "critical speed", when the wheel is lifted clear off the rails, on account of this unbalanced force, whether due to "underbalancing" or "overbalancing", is decreased. This will be clear from the following.

Let,

D be the driving wheel diameter, in ft.

W be the static wheel load, in lbs.

M be the balanced reciprocating or unbalanced revolving masses, in lbs.

b be the force due to gravity,

r be the crank radius in ft.

n be the number of driving wheel rev. /sec.

Now the single wheel hammerblow is given as,

$$\frac{M}{g} (2\ \Pi\ n)^2\ r \quad \ldots\ldots\ldots\ldots (1)$$

The wheel will be lifted clear off the rail

When,

$$\frac{M}{g} (2\ \Pi\ n)^2\ r = W \quad \ldots\ldots\ldots\ldots (2)$$

Circumference of the driving wheel = II D Ft.

Let the "critical speed" be S ft./sec.

Number of the revolutions which the wheel will make to cover distance S = S/IID ....(3)

Substituting (3) for n in (1) we get,

$$\frac{M}{g} (2\ \Pi\ S/\Pi D)^2\ r = W \quad \ldots\ldots\ldots\ldots (4)$$

$$\frac{M}{g}\ r\ 4\ S^2/D^2 = W$$

$$S = \sqrt{\frac{g\ D^2\ W}{4\ M\ r}} \quad \ldots\ldots\ldots\ldots (5)$$

But in these days, when the heavier locomotives with as light motion parts as possible, are used, it has been found that the locomotives are not very sensitive to the action of unbalanced reciprocating masses. Therefore the tendency is to balance a smaller percentage of the reciprocating masses. It has resulted in smaller hammer blow and higher "critical speed".

(vii) The impulse of the blow transmitted to the rail, at low joints is higher. This has been dealt with on page 7.

If, therefore, higher train speed is desired, with due considerations for safety and efficiency of performance, the diameter of the driving wheel should be so proportioned as to get better results from the locomotive as a power unit and high speed vehicle.

CARRYING WHEEL DIAMETER

The carrying axles not only carry some of the weight of the locomotives but function as the guiding trucks as well, thus helping the locomotives in curving and reducing the intensity of the lateral forces through the control mechanism provided on them. If the diameter of these wheels is smaller than that of the driving wheels, the control mechanism will be away from the centre line of the driving wheels, which will result in inducing excessive "rolling", when in action and the swing of the bogie pin—in the case of a bogie—will be greater. The designer, therefore, aims at making the carrying wheels as big as possible, within the constructional limits, so as to bring the control mechanism as near the plane of the coupled wheel centres as possible. It constrains the suspended masses to roll about an axis very near the coupled wheel centre line. The impulse at the hub of the driving wheel is, therefore, reduced.

Another advantage of the bigger carrying wheel is that the wave length of the sinous motion of the truck is increased. In the case of a single axle truck the length of the wave will be,

$$2\ \Pi \sqrt{\frac{D}{2} \times \frac{b}{t}} \quad \ldots\ldots\ldots\ldots (6)$$

and in case of double axle truck,

$$2\ \Pi \sqrt{\frac{D}{2} \times \frac{b}{t}} \times \sqrt{\frac{b^2\quad c^2}{b^2}} \quad \ldots\ldots (7)$$

Where,

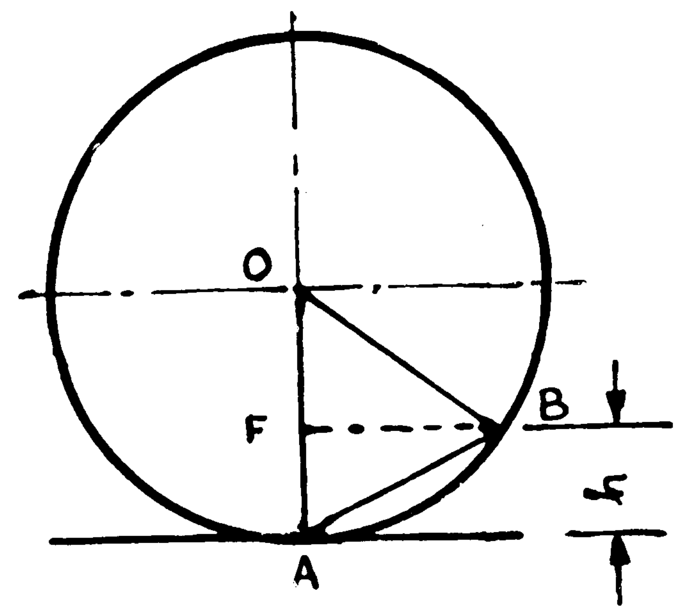
b is ½ the track gauge at tread contacts,

c is ½ the wheel base

t is coning of the tyre

GENERAL

The impulse of the blow which a wheel transmits to the rail, while passing over a low joint or any other vertical irregularity of track, is greater with a smaller wheel as will be seen from the following,



Let,

m be the unsprung mass of the wheel,

v be the speed at which it is travelling,

h be the height of obstruction on the road,

When running over a perfect track, the motion is at right angles to OA, but when the wheel is to encounter a low joint, the motion becomes at right angles to OB.

Now for the wheel to completely cross the obstruction, h, its periphey has to travel through the distance BA.

Let the time taken to travel this distance be, t,

Arc BA = chord BA = BF app.

In the triangle OBF,

$$BF = \sqrt{(OB)^2 - (OF)^2}$$

$$= \sqrt{(D/2)^2 - (D/2 - h)^2}$$

$$2 = \sqrt{Dh - h^2} \quad \ldots\ldots\ldots\ldots (8)$$

$$t = \sqrt{\frac{Dh - h^2}{v}} \quad \ldots\ldots\ldots\ldots (9)$$

In crossing this obstruction the wheel rotates about the instantaneous centre B, and if the mass of the wheel, neglecting the weight of the axle box and the springs etc., is considered as concentrated at O, the centrifugal force will be,

$$\frac{2\ m\ v^2}{D} \quad \ldots\ldots\ldots\ldots (10)$$

The impulse of the blow is equal to,
Force × the time for which it acts.

$$\text{i. e. } \frac{2\ m\ v^2\ t}{D} \quad \ldots\ldots\ldots\ldots (11)$$

Substituting (9) for t in (11) we get,

$$\frac{2\ m\ v^2}{D} \times \frac{\sqrt{Dh - h^2}}{v} = \frac{2mv\sqrt{Dh - h^2}}{D}$$

$$= 2\ m\ v \sqrt{\frac{Dh - h^2}{D2}}$$

$$= 2\ m\ v \sqrt{\frac{Dh}{D2} - \frac{h^2}{D^2}} \quad \ldots\ldots\ldots\ldots (12)$$

As h^2/D^2 is very small it can be neglected and the equation is reduced to,

$$2\ m\ v \sqrt{\frac{h}{D}} \quad \ldots\ldots\ldots\ldots (13)$$

CONCLUSIONS

It may be concluded from the foregoing, that the main factors which govern the determining of the diameter of the driving wheel are :—

(i) Driving wheel R. P. M. for a given operational speed and

(ii) Stability of the locomotive as a high speed vehicle.

As has been shown before that a smaller wheel contributes to the stability of a locomotive, its size should be so proportioned as not to affect the steam cycle efficiency adversely.

In India, where the maximum operational speed is not more than 65 miles hour, and Walscheart valve gear with long travel piston valves is in use, the driving wheel R. P. M. of 5 can be allowed. This means that a driving wheel diameter of 5′-7″ is a good compromise.

The diameter of the auxiliary or the carrying truck wheels, for better results, may be as big as possible within the constructional limits.

For our high speed locomotives on broad gauge the combination of 5′-7″ diameter driving wheel and 3′-7″ diameter carrying wheels have been employed with good results.

INTRODUCTION OF METRIC SYSTEM ON RAILWAYS

The Indian Railways are likely to be among the first in the country to make a beginning with the metric system of weights and measures, the introduction of which has in principle been accepted by the Government of India. The Railways are understood to be planning fore a 15-year period of "co-existence" between the present foot-pound system and new metric system. This period of 15 years is likely to be marked out into three five-year periods, during the last of which the switch-over to the metric system will be completed.

A measure of the collossal task which the Railways face in the change-over to the metric system may be had from the fact that for locomotives alone there are about 12,00,000 drawings in use for various components. Similarly, there is a very large number of drawings for passenger coahaes and wagons on the line.

Specially difficult is the task which about 50 workshops under the Indian Railways will face. Change-over here will be more complicated than in production units, because workshops have to attend to their repair work of a very large variety in types and designs of locomotives wagons, coaches, etc.

Advantage of spreading the period of "co-existence" between the two systems over 15 years is that none of the existing machines will have to be scrapped, as most of the present machines would have come to the end of their useful life by the time the 15-year period is over.

Among the numerous steps which the Railways will have to take will be the subtitution of mile pillars along 35,000 miles of railway lines by kilometre poles, change of number-plates on telegraph posts from the mile to the kilometre unit, issue of revised time and fare tables based on the kilometre and the new decimalised currency, preparation of new tariffs for general goods and coaching traffic, printing of tickets according to the new systems of weights, measures and currency etc.

Thousands of forms, registers and other records where units of weights, measures or currency are indicated will have to be modified to conform to the new systems. The Railways have already been asked to arrange for the training of staff which will be needed to assist in a smooth change-over. While it is difficult to indicate the total cost of the change-over on the Railways, a rough estimate places this in the neighbourhood of one crore of Rupees.

RAILWAY OFFICIALS' GAZETTE

SHRI K. RAMACHANDRAN, CME, EASTERN RAILWAY

WHENEVER I meet a technical workman in the workshops of the Indian railways my mind turns to the thought of Sri Ramachandran, M. E., A. M. I. (Loco) E., now Chief Mechanical Engineer of the Eastern Railway, Calcutta.

The reason why I connect him with the technical men is that it was solely due to his efforts and far-sighted vision that it was possible to formulate some system in the method of training workmen and classify them into unskilled, semi-skilled and skilled divisions, thus affording recognition and status to railway workmen.

Perhaps it may not be readily recalled that one of the effects of the Central Pay Commission so far as the Railways were concerned was the setting up in the year 1948 of a Trade Testing Tribunal to study the question of different classifications and evolve a method of trade testing. This job had to be tackled with expedition and precision.

Sri Ramachandran was placed at the head of this Tribunal and much credit goes to him for giving us a ready reckoner for classifying the numerous railway workmen. It was not a easy job for no material was available, nor was there a system which could be taken as a basis. Practices in different railways were poles asunder. Touring all over the workshops in the four corners of the country, confabulating, discussing, dissecting and eliminating unnecessary details Sri Ramachandran devoted his talents to the job with the keen and sharp brain that he possesses.

To say that Ramachandran is an adept in his profession is perhaps to under-estimate his skill, capacity, ability and vision. He is one of the few officers in the

Shri K. Ramachandran.

mechanical engineering cadre who has risen from the lowest ranks. He entered railway service in 1925 on the Bengal-Nagpur Railway as an apprentice and was in the subordinate establishment till 1930. From a Loco Probationer he became an assistant Loco and Carriage Supdt. and went to the continent in 1934 for higher professional training. He became Dist. Loco & Carriage Supdt. 1942. The partition of the country saw him raised to a special job as Supdt., (Equipment) and later on as Chief Mechanical Engineer with the Railway Board. Again a spell of special duty with the Trade Testing Tribunal and then be joined the Eastern Railway in 1948 as its Chief Mechanical Engineer where he still continues.

His rounds of inspection in the workshops are always looked forward to with enthusiasm by the workmen as they somehow feel that their fate is safe in the dispensation of their Chief whom they could approach at any hour and speak freely and frankly.

It is pleasing to talk to Ramachandran. His decisions are firm and he has a resolute will. His convictions are strong and he wants *sanctity* of orders and decisions maintained.

Grey haired, tall and hefty walks with a swing or springs forward—a characteristic of unbounded enthusiasm and activity. At the desk in office he does not miss the minutest details even and takes pleasure in studying, maps, drawings, sketches and diagrams.

He has a noted Tennis player as his son Sri Krishnan whose name is familiar to sportsmen. Krishnan has annexed trophies galore and has played in International championships.

" Does Ramachandran lay claim to being *religious?* " I was once asked and although I did not readily proffer an answer I took care to verify the fact and found that although he does not lay pretensions to being religious he does not discard it in his day to day life. He is of the opinion that religion is a personal thing and should be practised intimately in one's own way. " Was he fatalistic?" Another question followed. " No," was the answer, but that did not convey the meaning that he was prone to pooh-pooh fate. He simply left things to take their own course, without the muchado of a bravado. That was all.

Born in 1903 Sri Ramachandran is fiftythree years of age and within the next two years of his stay with the Indian Railways, who knows he may not be destined to play a definite role in the vast development of the Indian Railways in the Second Five Year Plan?

FRENCH RAILWAY ENGINEERING NOTES SECTION

Development of the Railway Rolling Stock Industry in France

WHEN one speaks of the railway rolling stock industry in France, the subject must be considered by taking into account the technical development achieved over a period of more than a century rather than developments during the past fifty years. This development, moreover, is not only marked by sensational performances but also by quality, that is to say by the reduction to an extreme limit of the dead weight of rail vehicles.

The dead weight is the strength of rolling stock, its resistance to the effects of dislocation caused by vibration and oscillation in running; it is, in short, the security of human life on rails. However, the dead weight also bears a relation to the comfort of the passenger. In consequence, quality is reached by compromising between two extreme solutions: on one side we find too much dead weight for operating purposes and not sufficient to provide a margin of security on the other side. The compromise in question has progressed with the times together with the improvement achieved in the quality of steel and other metals used in the manufacture of rolling stock and by using a combination of the various solutions which have presented themselves in answer to conditions encountered under different circumstances.

STEAM TRACTION

Even as long ago as 1827, the shortage of coal supplies in France inspired Marc SEGUIN to invent the fire-tube boiler thereby making better use of the steam-generating capacity of boilers. By the use of this device, a solution was found to one problem in the field of achieving quality in railway rolling stock as is illustrated by the fact that the Seguin locomotive with its 25 boiler tubes developed 22 h. p. for a total weight of 4T. 25 which was 5 times more than the first British locomotive weighing 4 or 5 tons and developing hardly 4 or 5 h. p. This method was used for the first time in France.

Still with the same idea in mind of reducing coal consumption, a series of French improvements brought about increases in the power of locomotives. In 1858, GIFFARD invented the steam injector for feeding the boiler. In 1873, MALLET discovered the principle of the double expansion of steam by the compound expansion arrangement from a small cylinder to a larger one. Then in 1900, superheating, which prevented losses from condensation was used for the first time and this resulted in a 20% saving of coal. In 1929, the French engineer, CHAPELON, of the S. N. C. F., obtained increases of power in the region of 40% through improving the efficiency of steam locomotives by the use of a better steam channel layout, a higher superheating temperature and an improved double-chimney education with a minimum back-pressure.

So we see how the relation between the power of locomotives and their total weight—that is to say their " power-to-weight " ratio which in a manner of speaking determines the efficiency of a railway steam traction machine—has been progressively increased. This ratio which was 6 in 1829, 12 in 1849, increased to 16 in 1864, 17 in 1876, 20 in 1891, 23 in 1910, 28 in 1931 and has now reached 36 with modern high-efficiency machines and even 43 with 480 P and 464 locomotives of the S.N.C.F. which develop a power of 4000 h.p. In 1946, the 484-AL locomotive which was put into service by the S.N.C.F., developed a cylinder power of as much as 5000 h.p. and now holds the power record for Europe. Although there are locomotives in America which outstrip the performance of European machines, this can be explained by the fact that American track can carry an axle-load of 30 tons whilst in France the limit is only 23 tons.

To obtain such power, it has been found necessary not only to increase the test pressure of boilers upto a figure of 20 psi but also to enlarge the fire-grate surfaces, which, when they measure more than 4 sq. meters, have to be mechanically fired because the fireman would not be physically strong enough to maintain normal firing. Incidentally, mechanical firing has the advantage of enabling coal with a low coking value to be burnt owing to the fact that finely granulated coal is used and this is consumed not only on the fire grate but also during its passage into the fire-box.

To attain high speeds exceeding 100 km/h, (62 m.p.h.), steam locomotives must be extremely well balanced and highly stable. This can be achieved by means of a well-designed axle arrangement with a leading-bogie which guides only and also by virtue of a high suspended weight to total weight ratio. All the rotating moving parts are minutely balanced with counter-weights on the driving wheels; parts moving alternatively are also counter-balanced although it is more difficult to arrange this. Finally, motion caused by the track is overcome by means of gravity or springs on the swing-bars of the bogies and the pony trucks.

ELECTRIC TRACTION

The desire to husband the small coal resources in France and to avoid as much as possible the importation of foreign coal by making use of the hydraulic wealth of French mountain ranges had led to the discovery of a number of alternatives to the use of steam rail traction.

(a) Direct Current

Of relatively recent invention, the electric locomotive is only now beginning to pass through the various technical stages leading towards the improvement of its efficiency. Without going into details of the first practical applications, dating back to 1900 at Chamonix, Versailles and Juvisy, the first main line machines dating from 1922 were confined to two types : one of the partial bearing weight type with 4 axle motors and 2 carrying bogies (2-D-2) for high-speed trains developing 3400 h.p. for a total weight of 140 tons (power-to-weight ratio of 24) and the other of the total bearing weight type with 2 bogie motors (B-B) on 2 axles developing 1800 h.p. for a total weight of 80 tons (power-to-weight ratio of 23) for slower and lighter trains. These locomotives operate on 1500 volt direct current.

After the liberation of France, the electrification of the South-Eastern region led to the improvement of the two foregoing types of electric locomotives the power-to-weight ratio of which was raised to 27 and 26 respectively. Moreover, for operating over difficult sections of the line (such as that between Brive and Montauban), a new total bearing weight type of locomotive was introduced with 2 motor bogies each driving 3 axles (C-C) of which the power-to-weight ratio reached 30.

Since 1950, the former 2-D-2 and B-B types have again been improved and now develop 4900 h. p. and 2850 h. p. raising the power-to-weight ratios to 33 and 30 respectively, while the weight per horsepower has been reduced, particularly in the case of the B-B types from 12 kilos to less than 7 kilos.

Furthermore, a new trend is developing to replace the 2-D-2 partial bearing weight machines on high speed trains, *(with the object of reducing weight)*, with B-B total bearing weight machines developing 4000 h. p. for a weight of only 80 tons (power-to-weight ratio 50), capable of hauling 150 ton trains at 140 km/h (87 m.p.h) on the flat and at 90 km/h (56 m.p.h.) on 1 in 125 gradients.

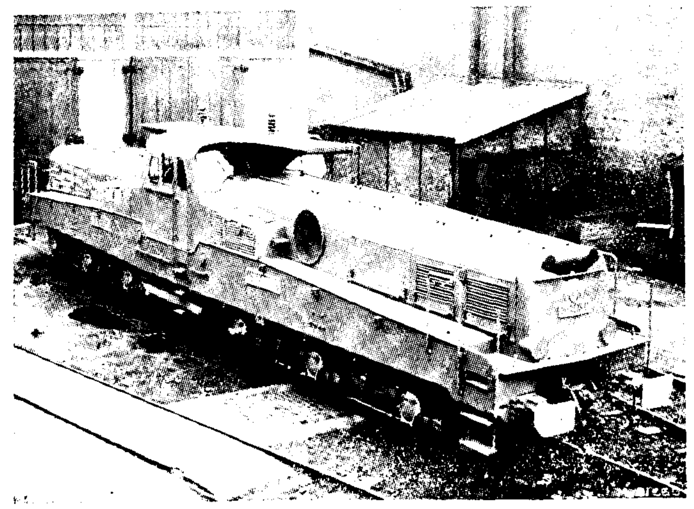
Finally, two types of total bearing weight machines remain in service – the C-C's and the B-B's. In fact, on the 21st February, 1954, a series C-C locomotive hauling 3 carriages beat the world speed record on rails by attaining 243 km/h (151 m. p. h.) between Dijon and Beaune. This maximum speed was limited not by the stability of the machine, but by the rotation speed of the motors which could not exceed 2600 revolutions per minute. At about this time, the French National Railways were completing the trials of two prototype B-B's for high speed traffic and it was thought fitting that they should be tested in turn to establish comparative performances between the B-B type and the C-C type, changing at the same time the transmission gear ratio of the latter. These tests were, in fact, carried out on the 28th/29th March, 1955 on the Arcachon-Dax line between Morcenx and Lamothe; the performances of these two locomotives were found to be practically the same and a new world speed record on rails of 331 km/h (205 m. p. h.) was established.

(b) Single-phase Current

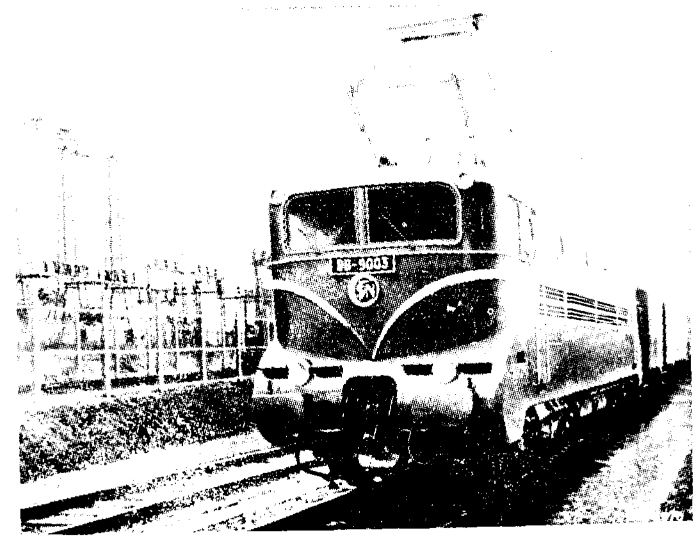
However, the 1500 volt d. c. locomotives now have a new competitor in the field of electric traction – the single-phase 50-cycle (i. e. industrial frequency) locomotive.

In point of fact, single-phase current working enables high tension energy to be fed to the locomotive in a very simple way and to be transformed in the machine itself.

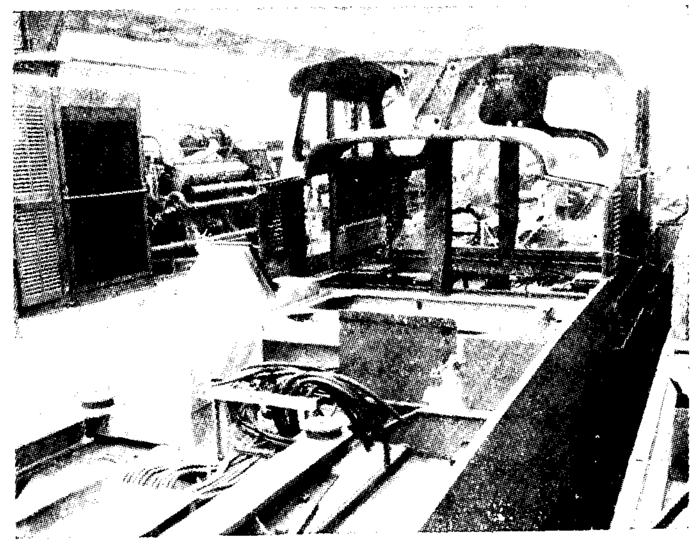
This system has the advantage of reducing very considerably the cost of static equipment. Whilst with



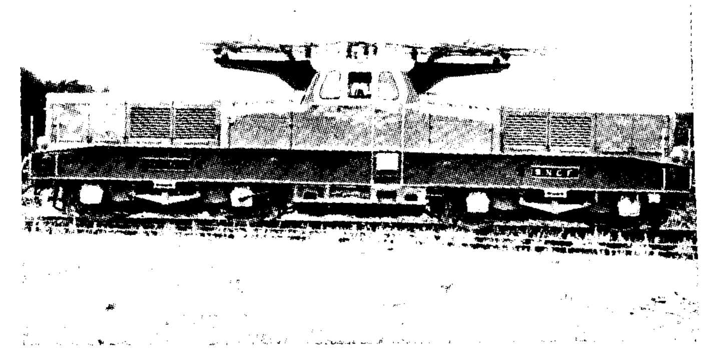
Electric locomotive (mono-phase current 25,000 volts-50 periods)



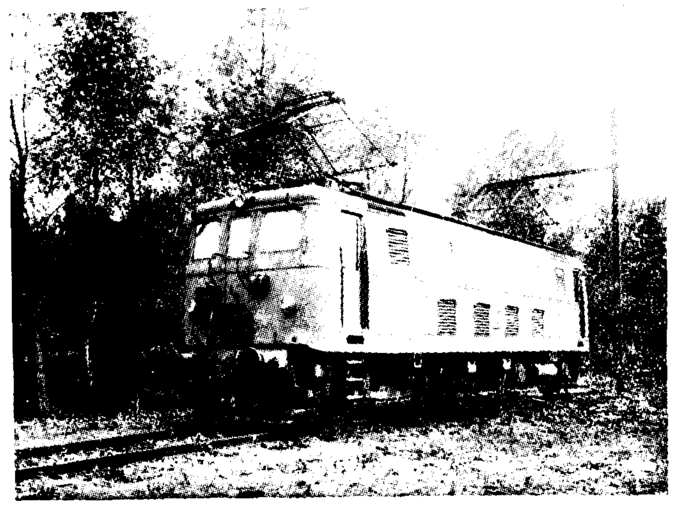
High speed BB Locomotive utilised by the French Railways on the Paris — Lyons line (continuous current — 80 tons — 99 m. p. h. 4800 h. p.)



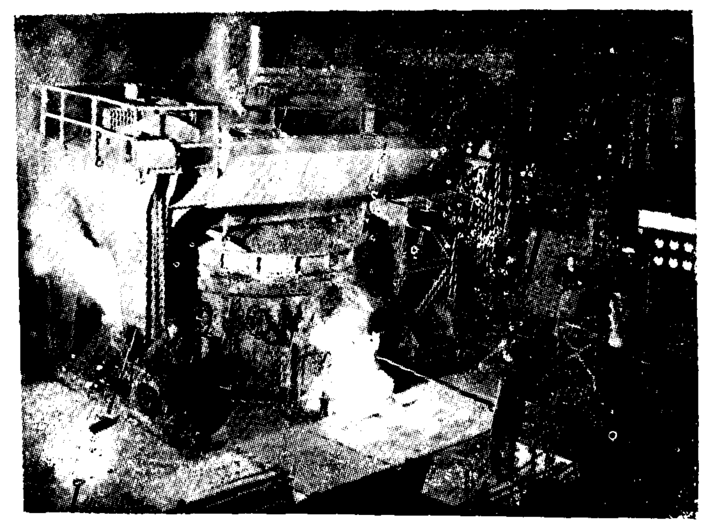
Another view of the CC type locomotive (mono-phase current 25,000 volts 50 periods)



BB Locomotive (mono-phase current 25,000 volts — 50 periods) utilised by National French Railways between Valenciennes and Thionville.



BB Locomotive delivered to Algerian Railways (Continuous current 3000 volts 1800 H.P. 65 to 74 miles per hour)



A view of the furnace.

direct current, the distances between the supply points to the lines are generally somewhere between 10 and 30 kilometres (6 and 18 miles) apart, these distances are increased to between 50 and 70 kilometres (31 and 44 miles) when single-phase current is employed. Moreover, the cross-section of the supply line (contact wire and essential feeders) can be reduced appreciably.

Until 1948, however, it had not been possible to build locomotives to operate on 50-cycle industrial frequency current. At that time, the first experiments were begun on the 78 kilometres (48 miles) single line between Aix-les-Bains and la Roche-sur-Foron using a current of 20,000 volts on the catenary. The principal French electric locomotive builders then produced prototypes of the C-C and B-B type locomotives with a power of 3000 h. p. on the driving wheels.

These first experiments were sufficiently conclusive to enable more general electrification using the 50-cycle single-phase system to be planned in 1951 for lines not yet electrified. The line chosen for the first application of this system on a large scale was the line from Valenciennes to Thionville and Apach which is used for carrying coal from the North to the mineral region in the East and which handles some of the heaviest freight traffic dealt with on the S. N. C. F. network. The problem was to haul 1350 ton mineral and coke trains over a line with 1 in 100 gradients. It was a particularly difficult project because 120 ton d. c. locomotives with motors on 6 axles are capable of hauling 1200 tons only over gradients of 1 in 100.

The first deliveries of a series of 4 types of single-phase locomotives are available for this programme. The first type, a B-B, employs the "ignitron" rectifier system in which a principal transformer reduces the 25,000 volt H. T. line current to a 50-cycle current variable between 0–750 volts. The alternating current is rectified in the ignitrons and becomes a pseudo-direct current variable between 0–750 volts, feeding in parallel the 4 traction motors.

The second type, another B-B, but employing the "direct motor" system, begins by transforming the 25,000 volts 50-cycle single-phase catenary current into alternating current variable between 0–300 volts and at a constant frequency of 50-cycles, directly feeding the 4 traction motors in parallel.

A third type, a C-C, known as a "mono-three phase converter" locomotive, transforms the 25,000 volt 50-cycle single-phase catenary current into 1000 volt 50-cycle single-phase current, then a phase converter converts it from single-phase to triple-phase current and a frequency converter converts the three-phase 50-cycle current into variable frequency three-phase current (from 0 to 135 cycles per second) and this variable frequency current feeds in parallel the 5 "induction" type traction motors.

Finally, a fourth type, also a C-C, known as a "mono-direct rotary converter" locomotive transforms the 25,000 volt, 50-cycle single-phase current into 3000 volt, 50-cycle single-phase current which feeds a synchronous motor which feeds in turn 2 main generators, each producing direct current of a variable voltage between 0—700 volts. Each of these generators feeds in parallel 3 traction motors working on direct current variable between 0—700 volts.

The C-C locomotives are intended for hauling very heavy trains (2400 tons on 1 in 166 gradients) and the B-B locomotives for other trains running at speeds of 100—120 km/h (62—75 m.p.h.) The initial tests were most encouraging and the loads which it was estimated could be handled when starting on gradients or on curves can be increased without difficulty.

After the completion of the Valenciennes-Thionville electrification system, a second section will extend as far as Lille on the one hand and Metz on the other; following this, electrification will be further extended to Strasbourg and Basle.

It can therefore be said that technical progress in the field of electric traction is making further great strides in France.

DIESEL TRACTION

After steam and electricity, a third type of rail traction was also engaging the attention of railway engineers before war broke out; that of thermal motors and particularly Diesel motors.

In spite of its undeniable advantages from the aspect of thermal and mechanical efficiency, this type of motor lacks flexibility and is not adaptable to overloading and low running speeds. This necessitates the fitting of a transmission with variable gearing between the main shaft and the axles which increases the weight of the Diesel locomotive and, on main line traffic, reduces its "power to weight" ratio below that of its counterparts in steam and electric traction. It is therefore in the field of study of economy compatible with length of service that research has been carried out in order to perfect the two essential components—the motor and the transmission—and it is in this field that technical progress can be measured.

(a) Railway Diesel Motors

The very first railway Diesel motors of the fixed position type were too heavy, running as they did, at only 400—500 r.p.m. They could only be adapted for traction purposes when the running speed was increased to 700 r.p.m.

Hence, it was first in 1933 that the French Railways experimented with 500—700 h. p. Diesel locomotives having electric transmission and 4 driving axles: these were used for shunting and freight work. About the same time, a 750 h.p. machine for light express trains was tested in Algeria. However, to distribute the weight between the axles and to keep within the 18 ton load limit for the driving axle, taking into consideration the strength of the truck, it was found necessary to fit these machines with carrying axles. This gave rise to the 2-C-2 arrangement which was a feature of the Diesel locomotive of that time.

It was also in 1933 that fast Diesel motors running at 1500 r. p. m. first began to appear and these were consequently much lighter than the former type. They were used mainly in railcars which pay for themselves more quickly and which have a shorter length of service than ordinary types of locomotives for which the slow running motor at least had the advantage of possessing a remarkable resistance to wear and tear. In consequence, the distance covered by the latter between the periods of overhaul of the principal components very quickly reached 500,000 kilometres (310,000 miles) which, for a general purpose locomotive, showed a very high annual mileage approaching that of an electric locomotive. To quote an example: the 4000 h. p. Diesel-Electric high speed locomotives (130 km/h - 81 m. p. h.) built by Fives-Lille and Marine Homecourt, tested on the Paris - Lyon line in 1938 for eventual use on the Trans-Siberian Railway which was very much in the news at the time of Colonial Exhibition in Paris, are still in service between Avignon and Nice. These machines which were the most powerful Diesel locomotives in the world at that time, consist of two 2-C-2 units, each unit being equipped with a 2000 h. p. Sulzer motor or two supercharged 1000 h. p. M. A. N. motors running at 700 r. p. m. These locomotives weigh 226 tons.

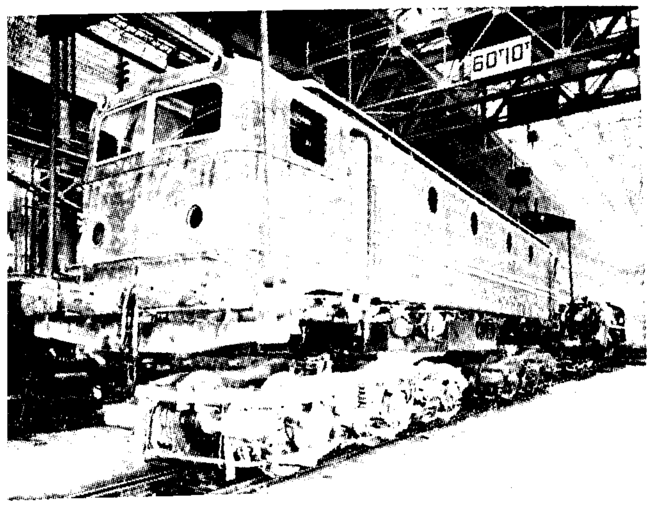
In the meantime, both types of motors have been developed: slow-running motors have had their specific power considerably increased by improved supercharging, whilst fast-running motors have been improved in the same way and have acquired qualities of resistance to wear and tear and a reputation for long service which was previously lacking. French manufacturers now build 900 - 1200 h. p. motors running at 1500 r. p. m. which can operate for 5000 hours without an overhaul, which is not so very far from the results previously quoted. These engines are manufactured by "Societe Alsacienne De Constructions Machaniques" (M. G. O. Engines)

(b) Transmission

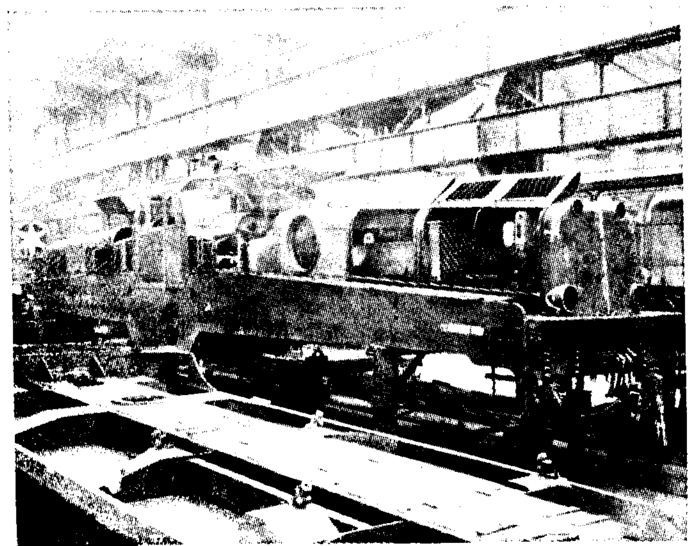
Transmission systems most commonly found in railway practice today fall into the following categories :- machanical, electrical, hydromechanical and even hydraulic.

The mechanical transmission system is the one most generally adopted on railcars. It includes a clutch and a gearbox of the automobile type. It is found on railcars of up to 500 h. p. and on light railway motor - tractors of up to 200 h. p. This system has the advantage of producing the high total efficiency of 80–85%, but it has the inconvenience that it is not possible to make use of the full power of the motor over the whole range of running speeds. Thus, the clutch makes it difficult to get a heavy train into motion; the considerable inertia of turning bodies is adverse to the synchronisation of the gear box and finally there is the sudden cutting of the motive effort during gear changing which gives rise to jolts and the risk of broken couplings on steep gradients. However, on locomotives and on higher powered machines of up to 800 h. p. it has been found possible to fit mechanical transmission with two-gear trains and 8 synchronised speeds. Up to a power of 400 h. p., two series of 8 speeds are used and for 600/840 h. p. machines, six series of 8 speeds.

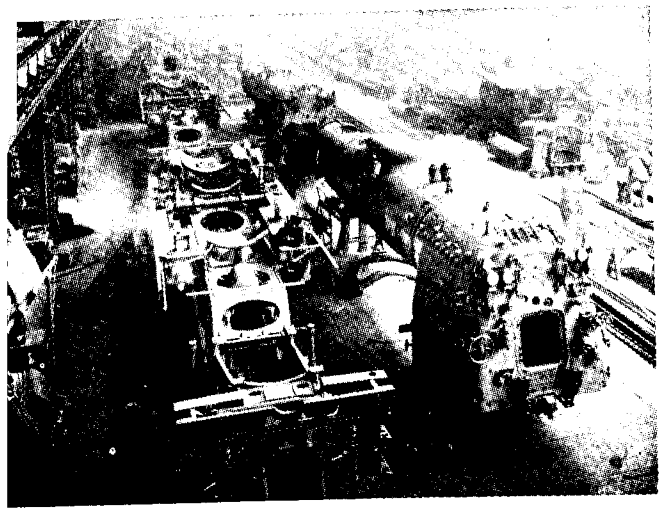
However, electrical transmission is much more flexible and easier to operate. On the other hand, it is heavy and it was costly at the outset. Today, the improvements and the simplifications which have been introduced by French manufacturers make this type of transmission competitive when the power involved exceeds 400 h.p. The generating set consists of the Diesel motor and the main generator (to which, at the same time, an auxiliary generator is coupled through the Diesel motor for charging the accumulator and exciting the main generator) which drives one or several traction motors and, at about the same efficiency (slightly lower than that of mechanical transmission - 80%), enables the full power of the Diesel to be employed over a very wide range of the series of speeds. such a type of transmission has, moreover, the advantage of being particularly well adapted to the operation of locomotives in multiple units, that is to say, coupled together and



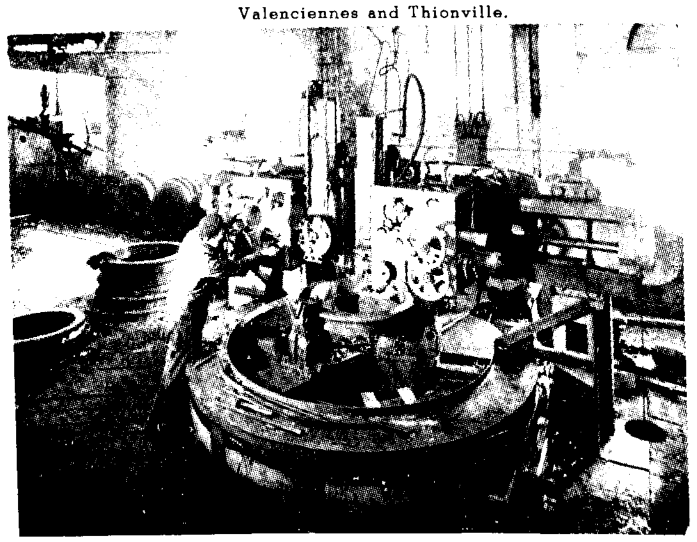
CC Electric locomotive (1500 Volts continuous current)
World speed record.



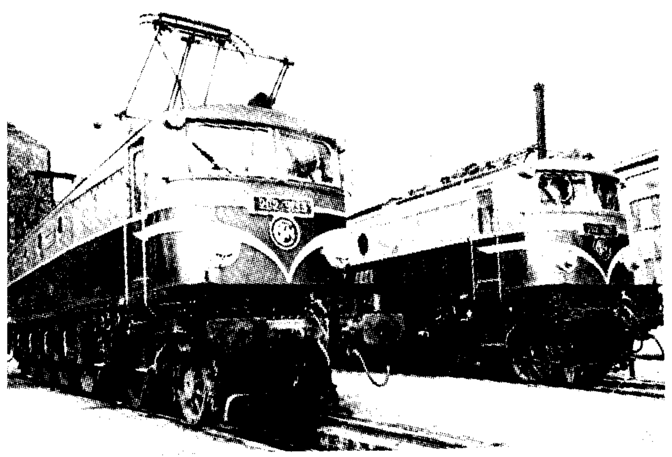
Assembly of a CC type locomotive (mono-phase current 25000 volts, 50 periods with mono-continuous convertor set). Such a locomotive is utilised by the French Railways between Valenciennes and Thionville.



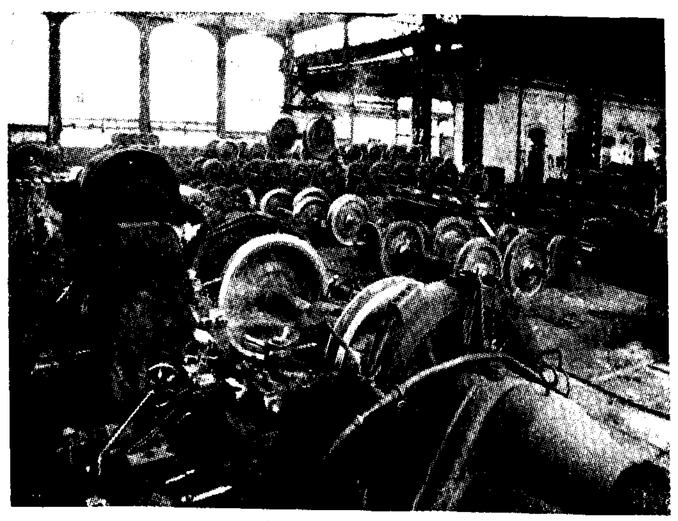
Steam boilers workshop for steam locomotives.



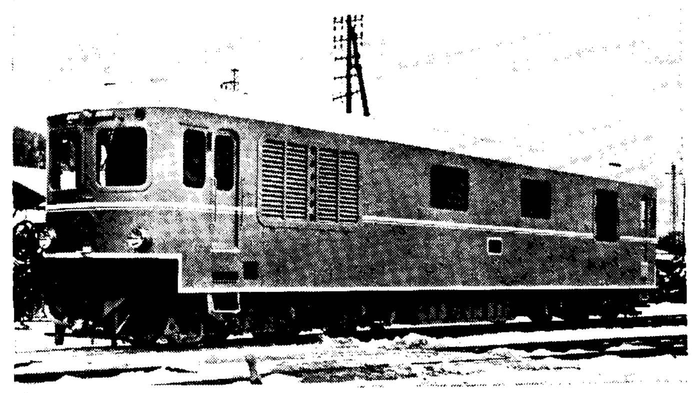
A view of the Tyre's tooling.



2-D-2 electric locomotive (1500 volts-continuous current)

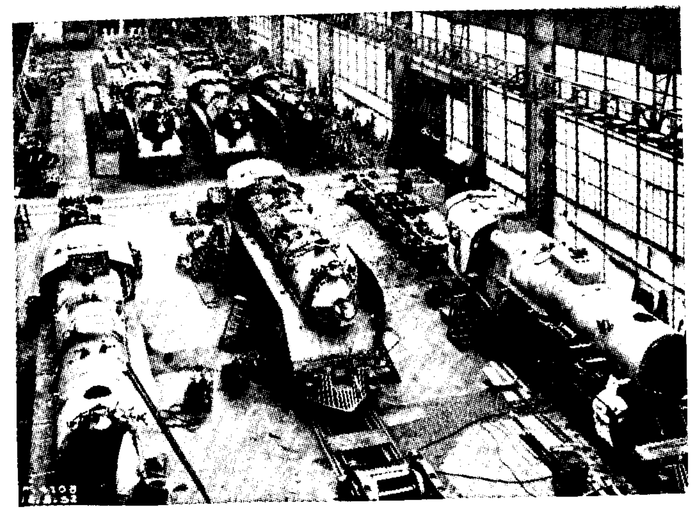


A view of the wheel shop.

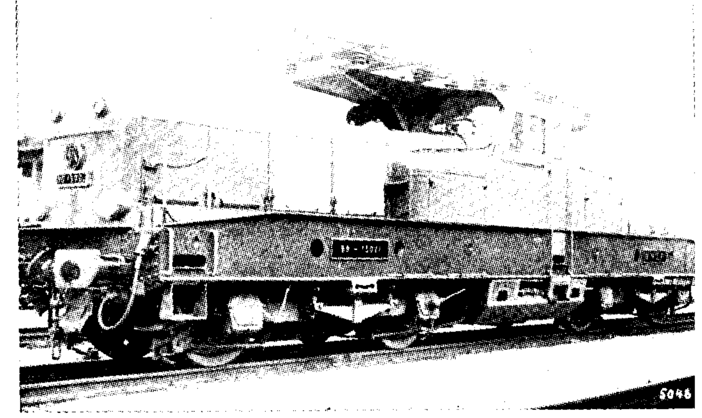


CC Electric diesel locomotive (1000 H. P.) utilised in Algeria.

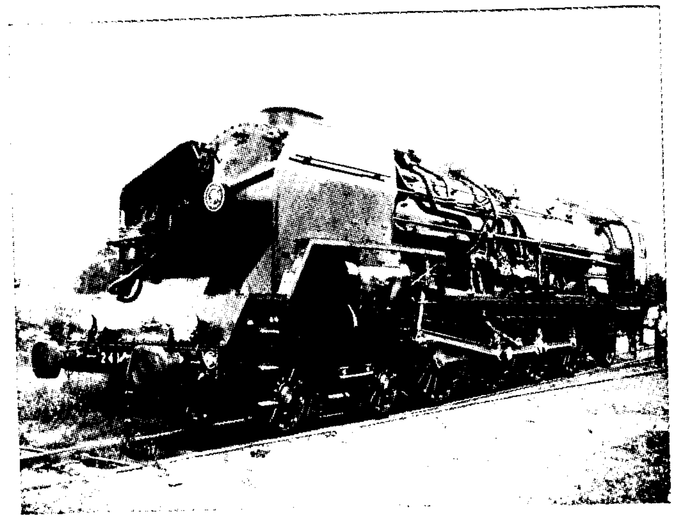
BB Type Electric Diesel locomotive in use in Madagascar.



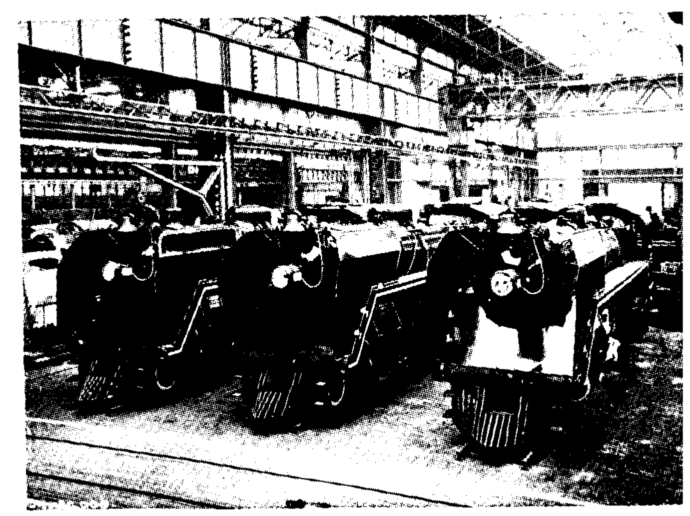
Assembling of Steam locomotives in a Workshop in France.



BB Type locomotive in service on the Valenciennes-Thionville line.



Close up view of a Steam Locomotive built
in French Workshops.



Steam Locomotives built in France for Brazil.

under the control of a single driver. It therefore enables the adherent weight of a locomotive to be doubled by the adjunction of a weighted motor-truck.

Although the electrical transmission system is the one most usually adopted over 500 h. p., one does occasionally come across not only purely mechanical transmissions as have just been described, but also mechanical transmissions together with hydraulic couplers known as the hydromechanical system. Couplers of this type are one of the components in purely hydraulic transmission, a new type of transmission developed over the past ten years or so. These couplers consist of two crown wheels each shaped like a hollow half-torus, fitted face to face with each other, revolving in an oil box. The driving crown, rigidly locked to the Diesel, acts as the centrifugal pump. The driven crown, rigidly locked to the shaft which transmits the movement to the axles, acts as a turbine. The oil, put into motion by the movement of the driving crown, circulates in the blading under the effect of centrifugal force and transmits the motion to the driven crown. This device amounts to an automatic clutch capable of supporting with impunity the protracted slipping encountered in the starting of heavy trains. The only friction, in fact, is that of the oil against the casing which is easily dissipated in the form of heat, without wear or tear of components. Apart from the couplers, the hydromechanical transmission is fitted with an 8 speed gear box driving the bogie axles through a universal joint and worm.

At the present time, the French National Railways employ about forty 400 h. p. locomotives fitted with a supercharged Diesel motor and a hydro-dynamic gear box with a couple converter, for composite passenger and goods trains over lines carrying light traffic. 300 700 h. p. locomotives of a similar type in so far as transmission is concerned are also used in the Cameroons and French West Africa.

(c) The real Diesel Locomotive

It was for station shunting operations that Diesel traction engines were first used, in the form of light railway motor tractors having only 2 axles if the required power lay between approximately 25 and 200 h. p. However, to shunt heavy goods trains over the humps in marshalling yards—an operation requiring heavy continuous effort at a speed of 2 m. p. h.—the French National Railways use 500 h. p. locomotives with 3 coupled axles, connected to a weighted motor-truck carrying just the traction motors fed by the generating set on the locomotive. This arrangement provides a unit with a substantial adherent weight (108 tons) capable of handling trains weighing 2500 tons.

The Diesel locomotive has also made its appearance for main line traffic. It is being developed principally in the United States to compete with electric traction because economic conditions (abundance of crude oil) are more favourable there than in Europe. On finds 4000-5000 h. p. trains driven by machines with full electric transmission made up of 2—6 units each developing 1500—2400 h. p., coupled together and under the control of a driver in the leading unit. In France, the development of electric traction has impeded the use of powerful Diesel locomotives on main lines. So far, the French Railways have adopted the policy of operating 600 h. p. machines built by the Etablissements BRISSONNEAU with a single Diesel motor—d. c. generator unit feeding traction motors on 4 axles grouped on 2 bogies. These machines are intended for branch lines and station shunting.

On parallel lines however, two series of powerful machines are going to be put into service in France, preparing the way for the dieselization of non-electrified lines.

(a) On the one hand, a series of 20 Diesel-electric locomotives (2 bogies with 3 axle motors on each) built by the Compagnie des Ateliers & Forges de la Loire. These machines, fitted with a slow-running 2000 h. p. Sulzer motor and weighing 120 tons, are intended for hauling heavy goods trains over the non-electrified section of the Grande Ceinture Nord de Paris line; latter on, they could be used for main line goods trains with a speed of 150 km/h (93 m. p. h.) by changing the gear ratio.

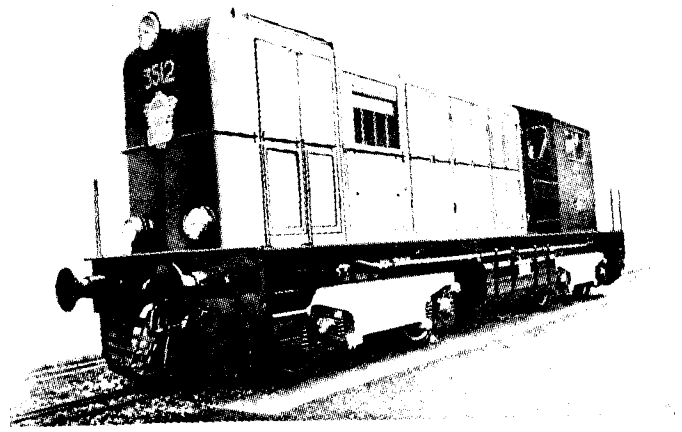
(b) On the other hand, a series of 15 general purpose 1800 -2200 h. p. locomotives fitted with 2 fast-running M. G. O. motors of the Societe Alsacienne de Constructions Mecaniques and ordered from the Societe Alsthom.

Dieselization has made much progress in North Africa: begun just after the last war by the acquisition of 65 American locomotives which replaced the 200 less powerful and already old steam locomotives, it was quickly extended by the use of French motive power stock. In this way, all the metric-gauge railway systems which are so important in these regions are now operated with French motive power stock:—50 Alsthom 600 h. p. locomotives in Tunisia, 10 Alsthom-de Dietrich 1000 h. p. locomotives and a certain number of railcars in Algeria. On normal gauge lines, de Dietrich have also supplied 5, 1400 h. p. express loco-

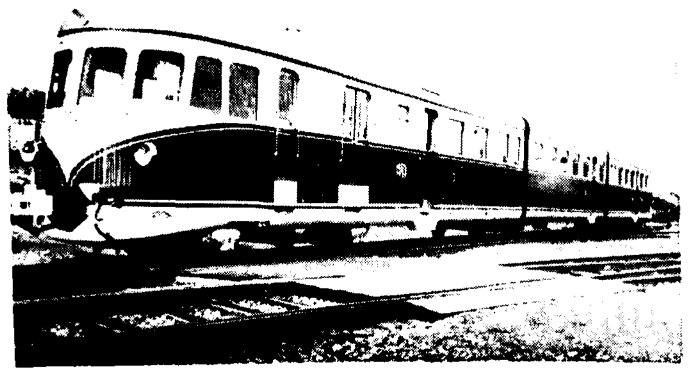
motives for the Algiers-Oran line, while the Moroccan Railways, which already have 15 Batignolles 450 h. p. machines, will soon be operating 4 fast de luxe 2400 h. p. trains built be de Dietrich-Alsthom fitted with fast running motors, on the Casablanca-Oran express service.

Finally, Diesel traction is also developing rapidly in Madagascar, French West Africa and French Equatorial Africa and will prepare the way for the total abolition of steam traction in the very near future. The motive power stock will then consist of 75 Alsthom 600-900 h. p. machines 20 Fives-Lille 1000 h. p. locomotives, 8 Compagnie des Ateliers & Forges de la Loire 800 h p. locomotives, 17 Renault 840 h. p. locomotives, 3 Coferna 750 h. p. locomotives and 18 American 675 or 1350 h. p. locomotives, making a total of 141 machines of which 123 are French built (54 fitted with slow running motors and 69 with fast running motors). It should be mentioned at this stage that the air absorbed by the Diesel engine and the different electrical units, including the traction motors, is taken from inside the body of the locomotive into which it enters through openings positioned about 4 metres (13 feet) above ground level. Therefore this air contains only a small quantity of dust. Additional precautions are taken if desert regions have to be crossed where strong sand storms are encountered: the body of the locomotive is supplied by air cleaned by double filtering-centrifugal filter with blower and final filter with filtering tissue. The traction motors are fitted, on the output side with ducts bringing the air back into the body, so that the motors have no direct opening under the body and behave, in so far as dust and sand are concerned, as completely enclosed motors. Other difficulties have also been overcome such as, for example, the performance of electrical equipment and wiring under tropical conditions, operating over water-logged land, traffic on light lines with ballast furrowed by tornadoes etc.

Assembling plant for CC locomotives.



BB, 68T electric diesel locomotive delivered to Pakistan Railways.



Another type of diesel locomotive.

A view of Autorail.

A third class passenger coach in service on the French Union Railways.

Over the past 5 years, French industry has exported in light railway motor-tractors :- 80 units to overseas territories and 15 to foreign countries, these units varying in power between 80 and 150 h.p ; and in Diesel locomotives :- 210 units from 400 to 2400 h. p. to overseas territories and 160 from 500 to 850 h. p. to foreign countries (Holland, Luxembourg, Pakistan, Cuba, Ethiopia). Furthermore, 87 locomotives from 900 to 1200 h. p. are in the process of being built for Holland, Spain, Ecuador and Burma. These 247 locomotives exported abroad were built by the following firms : Alsthom (164 machines), Societe des Forges & Ateliers du Creusot, Brissonneau etc.

The question now to be answered is what does the future hold for the Diesel locomotive.

So long as the problem involves on the one hand, moderate speeds, shunting, railway services over branch lines or networks in Africa or the Far East and on the other hand, powers below 1000 h. p., in the case of narrow gauge lines or a maximum axle-load not exceeding 10—11 tons, the Diesel locomotive, in spite of its relatively heavy weight, is likely to meet operational requirements.

In the case of standard-gauge lines, however, which require increasingly high powers and where, in Europe, the stability of the track will not bear an axle load exceeding 20 tons (in the United States it is 30 tons), one can hardly count upon exceeding more than 2000 h. p. per unit. In spite of the progress made in the sphere of Diesel motors and the increase in the supercharging factor one is always confronted, as things stand at present, with difficulties in respect of transmission to the axles of powers exceeding 2000 h. p. over a Wide range of speeds.

Recourse must therefore continue to be made to the solution offered by multiple Diesel units until progress makes another method practical. In so far as the choice between Diesel traction and Electric traction is concerned, the deciding factors will be maintenance costs and the respective prices of the two types of energy employed.

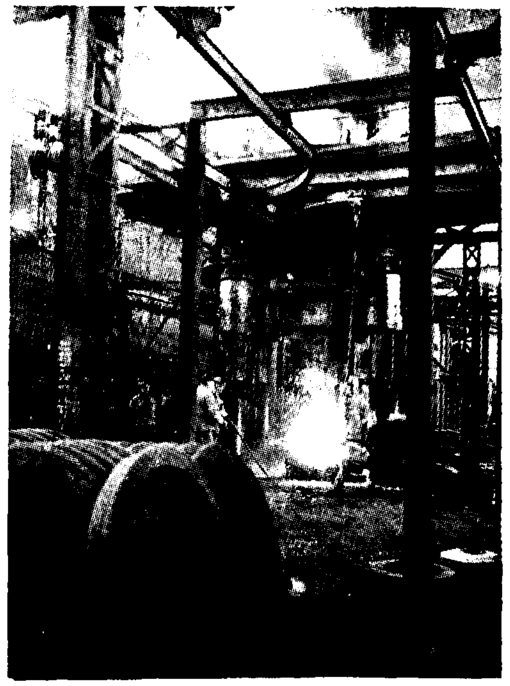
(d) Railcars

It was in 1930, in order to combat road competition, that railcars were first introduced into France, firstly, in the form of small light-weight machines running on pneumatic tyres—the Micheline type of vehicle—followed by machines of a more specific railway character—spacious, luxurious, rapid and designed for use on lines carrying heavy traffic. The progress made was surprising. Both power and size increased simultaneously to such a point that the vehicles had to be either run in pairs or coupled up in units which we now call " railcar trailer sets." The production of fast-running 1500 r. p. m. Diesel engines about 1933 which were consequently lighter those used in locomotives, brought about this rapid development.

Railcars, were introduced to bring down the initial cost of rail vehicles. The factors which governed the production of this type of motive vehicle were, therefore, lightness and strength from the very start. The recent 600 h. p. type of railcar used by the French National Railways, of which the tare does not exceed 41 tons with a $12\frac{1}{2}$ ton motor can be quoted as an example of lightness. Railcars can be classified into three categories :— (a) 80—200 h. p. machines with 2 axles able to attain 100 km/h (62 m. p. h.), used for branch line traffic; (b) 200—600 h. p. machines with 2 bogies able to attain 120 km/h (75 m. p. h.) and capable of hauling bogie trailers, used for medium traffic and finally, (c) machines of a power of up to 1000 h. p. capable of exceeding 140 km/h (87 m. p. h.), made up of one or several bodies, often forming a part of multiple trailer car sets coupled together, used for express services between important centres.

In view of the fact that railcars were introduced to bring down the prime cost of rail vehicles, lightness, together with strength have been the determining factor in their construction from the time they were first put into service. In practice, a given power corresponds to a maximum load limit in order to obtain the required performance. A power varying between 6—10 h. p. per ton must be allowed according to the type of service on which the vehicles will operate. Two types of vehicles introduced by the French National Railways may be quoted as examples of lightness : in the first place, the 600 h. p. railcar, the tare of which is less than 41 tons should be mentioned. If the weight of $12\frac{1}{2}$ tons representing the motor equipments is deducted, one is left with a 2-bogie vehicle nearly 28 metres (90 feet) long which weighs only $28\frac{1}{2}$ tons (this can be compared with the lightest main line coaching stock 23m. 5 (77 feet) long and, because of the use of stainless steel in their construction, weighing only 30 tons). In the second place, the small 2 axle trailer for use with the 150 h. p.

railcar and which has an overall length of 11 metres (36 feet) and weighs only 6 tons, should be considered.



A view of Tyres forging section.

Mechanical transmission is normally employed on railcars in preference to electrical transmission; this is because mechanical transmission is hardly ever fitted to vehicles with a power of more than 500 h. p. and the power of railcars rarely exceeds that figure. The recent 600 h. p. type used by the French National Railways, to which references has just been made, equipped with 2 motors of 300 h. p., is fitted with mechanical transmission. It is a 2-bogie machine capable of attaining 140 km/h (87 m. p. h.) when running by itself and 60 km/h (37 m. p. h.) when hauling by 3 trailers with bogies up gradients of 1 in 66. Although it is 28 metres (90 feet) long, the body of the railcar is constructed from bent or pressed elements not more than 3 m.m. (1/8th inch) thick.

The framework of the body is built up, according to circumstances, from 2 lateral girders forming the sides braced by the chassis and the roofing, or alternatively, from tubular girder work. The components used to build the framework are made of steel, some of stainless steel or even aluminium alloys. To reduce weight, the outer casing forms an integral part of the framework. The various elements are welded together. A wide range of materials is used for internal fittings—aluminium alloys, plastics, plywoods without counting the new materials which serve for sound proofing and heat-insulation. For heating, use is made either of exhaust gases or of water used for cooling the motors. The railcar bogies are double-sprung to achieve smooth running: the first group of springs is positioned between the axle boxes and the bogie-chassis and the second group, between the bogie chassis and the railcar body.

The trailer-car set fitted with thermal motors is an offshoot of the railcar and is an intermediary between the railcar and the ordinary train. The very first of these units were operated in France as long ago as 1934 by the former Chemin de Fer du Nord and consisted of two motive vehicles with Diesel motors and electric transmission with a trailer-car between them. The composition of this set was invariable and it was capable of attaining 140 km/h (87 m. p. h.). At the present time, the French National Railways operate similar long-distance units but these can be made up in different ways by using a motive vehicle fitted with a single 800 h. p. motor and hydromechanical transmission, together with a trailer equipped with a bar, 56 seats and space for 2000 kilos (2 tons) of baggage. These units can be coupled together or operated with two motive vehicles. Furthermore, 2400 h. p. units with electrical transmission will be put into service on the normal gauge network in north Africa in 1956.

In view of the difficult gradients encountered and the light-weight equipment generally employed on colonial metric-gauge lines, the railcar is quite frequently the only possible solution for operating passenger services. Many 300 h. p. railcars and a few 600 h. p. ones are in service at the present time in North Africa, French West Africa and French Equatorial Africa.

Generally speaking, it can be said that the development of the railcar in both quantity and quality has been continuous. 30% of the passenger traffic handled by the French National Railways is carried in railcars at the present time. As this type of vehicle pays for itself much more quickly than the Diesel locomotive, the vehicles can be replaced at frequent intervals. Many new, more powerful, lighter and less cumbersome motors appear on the market every day as well as better transmission systems particularly so, since in this case, the question of getting heavy loads into motion (as is the case with Diesel locomotives) does not arise. In the field of plastics, one can foresee the production of materials likely to reduce the weight of the body and improve its sound-proofing and insulation against changes of temperature.

In connection with rail-road competition, railway rolling stock still has some trump cards to play.

PASSENGER CARRIAGES

All that has been said previously concerning the weight of the railcar and its sturdiness, in regard to the construction of the body, applies even more to the railway carriage because the weight of the equipment no longer has to be taken into consideration. This is another reason why the comfort of the passenger, perfect suspension, sound-proofing and especially good lighting and heating is being studied to an even greater extent.

In so far as good suspension and sound proofing are concerned, it should be remembered that, thanks to Michelin, as far back as 1930, France led the way in the sphere of pneumatic tyres for rail vehicles, which were used on small ultra-light machines for branch lines at that time. This was the birth of the railcar which was then called a "Micheline". There are vehicles in service at the present time which run on special wheels fitted with Michelin tyres.

This gave rise to the idea of using pneumatic tyres on actual passenger carriages as the system has the principal advantage of considerably reducing noise and jolts which in turn, led to the construction of three sets of 6 carriages for service on the fast running morning and evening trains between Paris and the East of France. These trains are hauled by 460 steam locomotives of a relatively old type with large driving wheels and these have been summarily stream-lined and converted to oil-burning.

These carriages had to be designed lighter than was usual because the rail-type pneumatic tyre cannot bear a load of more than 1 ton. Hence, the use of the 2 5-axle bogies per carriage and a tare not exceeding 17 tons and going even as low as 14 tons for the lightest carriages. As wheels fitted with pneumatic tyres eliminate heavy jolts and noise, certain body components can be designed on a less generous basis and economy can be effected in sound-proofing which generally involves increasing the weight of the vehicle. The metal frame work has been built with special materials: high resistance ribbed stainless steel, aluminium alloy and seam-welded soft ribbed steel. The locomotive and tender weigh more than the 6 carriages put together. Metal shoes on each bogie are in permanent contact with the track to short-circuit the two rails—this is essential to ensure the operation of the automatic block signalling. The bursting of a tyre releases a valve which sets off, by electric contact, an audible warning in the brake van and lights an indicator in the carriage involved. Bursts are rare, the pneumatic tyres having an average life of 65.000 kms. (40,000 miles). The advantage gained by silence and lightening of weight is slightly counterbalanced by a small increase of resistance to motion.

Among the other items affecting comfort, the question of lighting followed by that of heating are the most important.

In the case of lighting, the method of employing independent equipment has been found to be the best. It consists of a dynamo driven by an axle and which recharges a set of accumulators which feed the lamps. The normal current is 24 volts and this figure goes up to 72 volts in the latest generously equipped carriages.

However, the accumulators are heavy, large and expensive and the solution offered by fluorescent lighting is now being adopted. This system required alternating current in the first place. The previous type of dynamo was therefore fitted with extra rings to enable a rotary converter to be employed for supplying 80-cycle per minute alternating current which was raised in voltage by a static transformer. However it was later discovered that direct current could be employed. At a current of 72 volts, kept rigidly constant by means of special stabilizing units, it can be used for feeding fluorescent lamps which obviates the need of having rotary converter equipment.

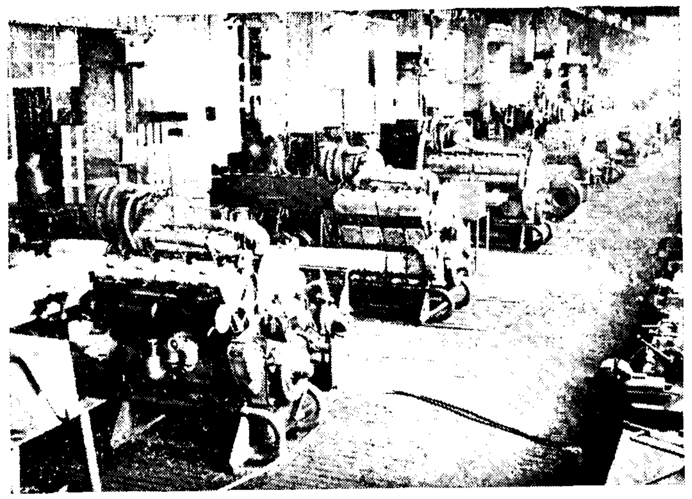
In so far as heating is concerned, this is not independent like the lighting, but is general and depend on a source of energy supplied either by the steam locomotive, by a special boiler in the case of the Diesel locomotive or by the current in the catenary, picked up by the electric locomotive. In modern carriages, the hot air system of heating known as the "thermostatic controlled forced air heating system" is used. A steam air-heater and an electric air-heater are jointly housed in a heat-insulated compartment under each carriage. Cold air from outside, drawn in through a filter by a fan, is first driven on to the heaters and then forced along insulated hot-air ducts to the outlets which supply hot air to the compartments and the corridors. The heating system functions automatically and maintains the temperature at about 22°C. (72°F.).

The forced air heating system which, moreover, has the advantage of well ventilating the carriages, will replace radiators to a much greater extent in future.

Tests of French High-Speed Diesel Engine

Results of 100-hr. type tests, and others to determine consumptions and torques

THE most notable of the post-war quick-running railway oil engines of French origin is the M G O or Grosshans, engine, sponsored by the Mariep-Grosshans-Ollier group, and made by the Soc. Alsacienne be Constructions Mecaniques at its Mulhouse works. Described in its initial form in the issue of July 1953, of Diesel Railway Traction the first of these engines was put into an old diesel shunting locomotive of the S. N. C. F. for trial purposes. Detail modifications in design and material have been made since that time, and the engine is now installed, or is being installed, in express train sets, in heavy shunting and branch line locomotives, and in main-line locomotives of the French National Railways; and it is also used by Alsthom for its standard locomotives in Holland, Madagascar, Spain, and other countries.



Series of 8V and 12V engines under construction at the Mulhouse works of the Soc. Alsacienne

As is common with railway oil engines built in France, the MGO engine has been subjected to the type tests of the S. N. C. F., and details of the performance of the V12SHR engine are given in the second part of this article. But a brief recapitulation of the leading features of the design may be made first.

There are seven models in the present range, all of the V type with a 60 deg. angle between the banks, and extending in output from 400 to 1,200 b. h. p., and with a large degree of standardisation of wearing parts throughout the seven models. Compared with the

TABLE I—CHARACTERISTICS OF MGO ENGINES

Model		V8	V8S	V12	V12S	V12SH	V12SHR	V16SHR
No. of cyls. at 60 V.		8	8	12	12	12	12	16
Cyl. bore	m.m.	175	175	175	175	175	175	175
Stroke:								
master rod	m.m.	180	180	180	180	180	180	180
artic. rod	m.m.	192	192	192	192	192	192	192
Cyl. volume	litres	36	36	54	54	54	54	72
Speed	r.p.m.	1,500	1,500	1,500	1,500	1,500	1,500	1,500
B.H.P.		400	500	600	750	825	925	1,200
Dry weight	lb.	6,200	6,600	8,600	9,500	9,500	10,000	13,100
Weight	lb. per b.h.p.	15.5	13.2	14.3	12.7	11.5	11.0	11.0
Piston speed:								
1st bank	ft. per min.	1,770	1,770	1,770	1,770	1,770	1,770	1,770
2nd bank	ft. per min.	1,890	1,890	1,890	1,890	1,890	1,890	1,890
B.M.P.[1]	lb. per sq. in.	96½	120	96½	120	133	149	145
Overall length	in.	60	71	79	88	88	95	124
,, width	in.	51¾	52	56	56	56	57½	56
,, height	in.	62	69½	62	69½	69½	72	80½

[1] Averaged over the two banks

earlier engines, the cylinder diameter has been increased from 165 mm. to 175 mm. In the pressure-charged engines this has led to no increase in output; but the naturally-aspirated engines give about 14 per cent. more output than formerly. But the 165 mm. engine was offered only in three models, viz. V-8, V-12 and V-12 pressure-charged, the extension to seven models following the modifications to the original design.

GENERAL PARTICULARS

Table I gives the leading particulars of the seven current models, and fro n it will be appreciated the four basic variations, namely naturally-aspirated, pressure-charged, highly pressure-charged, and highly pressure-charged with intercooling. All have 175 mm. dia. cylinders; but as the nickel-chrome steel rods of

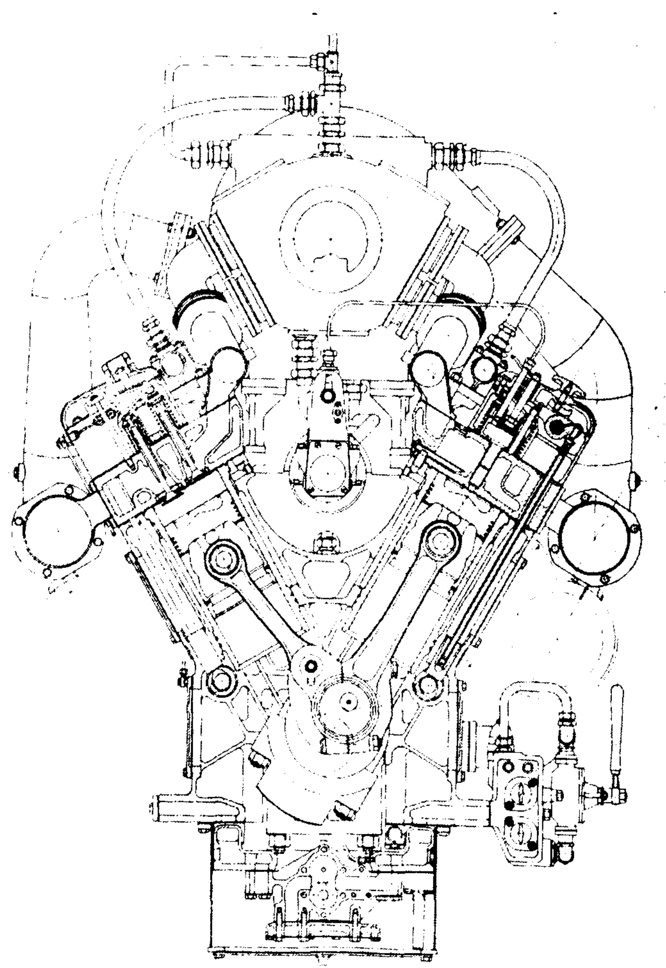


Fig. 1.—Cross section of the M.G.O., or Grosshans, V-engine with 60-degree angle between the cylinder banks. This view shows the pressure-charged engine which develops a maximum of 62½ b.h.p. per cylinder at 1500 r.p.m.

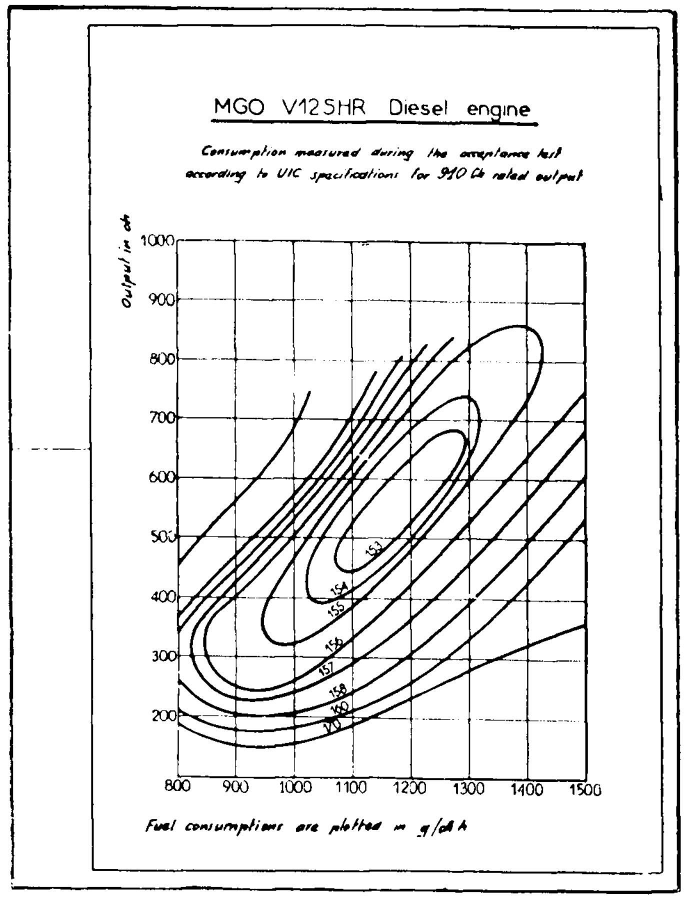


Fig. 2—Fuel consumption loops of M.G.O. type V12SHR intercooled of 910/930 b.h.p.

opposite cylinders are articulated together, the strokes are different, being 180 mm. for one bank (main rod) and 192 mm. for the other (articulated rod), that is, a difference of 7 per cent. The stroke-to-bore ratio thus is very low, only 1.03 to 1 for one bank and 1.1 to 1 for the other bank. This helps to give a rather sturdier structure of the crankcase-cylinder block, and the feature was adopted because it was considered that thermal fatigue and mechanical fatigue of the principal constituents do not depend on the rotational speed but on the piston speed. Specific dry weight varies from 11 to 15½ lb. per b. h. p.

Cast steel construction has been adopted for the present models, with a single casting for all models, covering both cylinder banks and the crankcase down to well below shaft centre line and cast at the Soc. Alsacienne steel foundry at the Mulhouse works. The cylinder heads are individual castings with two inlet and two exhaust valves each. Injection is direct through a central multi-hole nozzle, with a combustion chamber formed by symmetrical dishing of the piston crown.

Considerable attention has been given to the cooling of the injectors and cylinders heads, and of the upper part of the liners. The cross-sectional drawing shows that a syphon arrangement has been adopted for the upper part of the liner, and that the water from here, under high-speed flow, is led up into the cylinder head and then nozzled to give a jet flow first against the injector.

All crankshafts are one-piece nickel-chrome-molydenum steel forgings, induction-hardened, and supported on underslung main bearings of the Glacier interchangeable precision type with copper-lead lined steel shells. There is no adjustment of the bearings, which are simply replaced by new shells when wear limits are reached. A feature of the main shaft is that full output can be taken off either end. The master connecting rod big end is in two halves serrated together and bolted, so that each rod and its piston assembly can be withdrawn with greater ease through its corresponding cylinder liner.

Other constituents are of conventional type, and include aluminium-silicon alloy pistons, gear-drive to the two camshafts at the sides of the crankcase and to the fuel injection pumps in the neck of the V, wet liners of iron with a nickel content chrome-faced renewable valve seats for inlet and exhaust valves, and Brown Boveri pressure-charger. Four pressure and two scraper rings are carried by each piston, and the top pressure ring is chrome plated. Normally the fuel injection pumps are of Precision-Mecanique make and of conventional arrangement.

TEST SUMMARY AND ENGINE DATA

The engine submitted for the S. N. C. F. type tests was a V 12SHR model, that is a 12-cylinder type, highly-pressured charged and with intercooling Nominal output of this model is considered as 925 b.h.p. at 1,500 r.p.m., but in the type tests was set for 910 b.h.p.

These type tests extend over 100 hr. and are made up of: *(a)* 80 hr. continuous full load and speed, i. e. 910 b.h.p. at 1,500 r.p.m. *(b)* a 10 per cent, overload test at full speed, i. e. 1,000 b.h.p. at 1,500 r.p.m., for 45 min., followed by 10 per cent. overload at 10 per cent. overspeed (1,000 b. h. p. at 1,650 r. p. m.) for 15 min.; *(c)* a 10-hr. test under partial loads, decreasing in three stages corresponding to speeds of 1,250, 1,000 and 850 r.p.m., and *(d)* nine hours under an alternating load test, the alternations being six minutes under full load and power followed by four minutes at idling. In the case of this M. G. O. engine this 100-hr. test was followed immediately by a 75-min. test at 825 b. h. p. with the intercooling circuit cut out. In the actual tests there were two interruptions of ¼ hr. at the 27th and 44th hours of the 80-hr. test under *(a)* for adjustment of the valves of No. 3 cylinder; and a gap of 20 min. between tests *(b)* and *(c)* to take the oil level and replace an exhaust valve spring on No. 10 cylinder.

Prior to the type tests, others have been run to check the fuel consumption, torque, b. h. p. and speed, and from these the fuel consumption loops given in Fig. 2 have been drawn up. Some of the relevant data are included in Table II.

In the type of engine submitted to these tests and the 100-hr. type tests the following data are considered as normal: starting torque at 5 deg. C. 200 m.kg. firing speed at 5 deg. C. 50 r. p. m. minimum; resisting torque at firing speed at 5 deg. C. 160 m. kg.; quantity of heat dissipated by cooling water at top power and speed 265,000 k. cal./hr. with normal water outlet

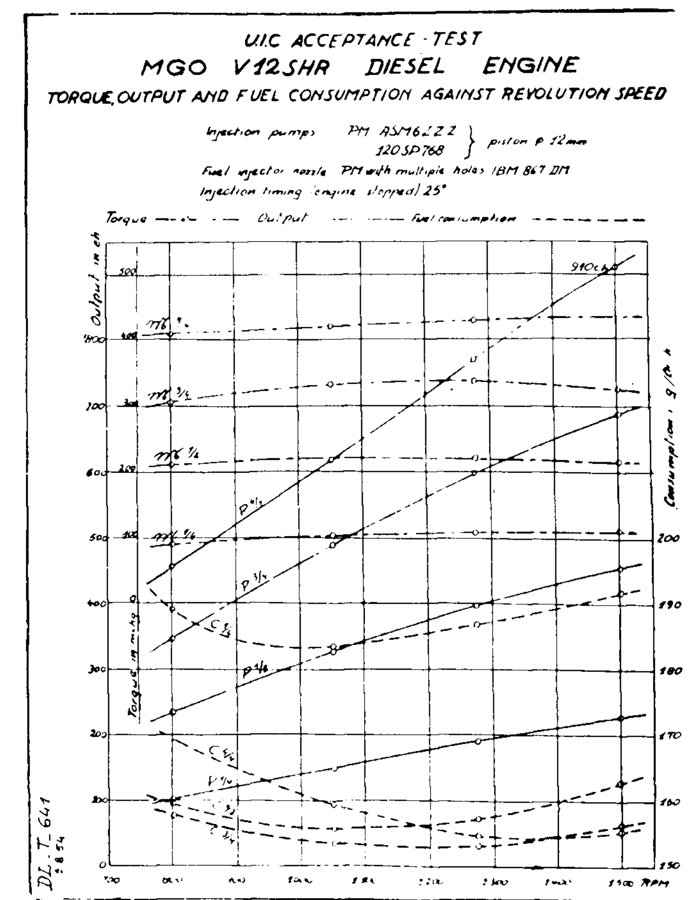
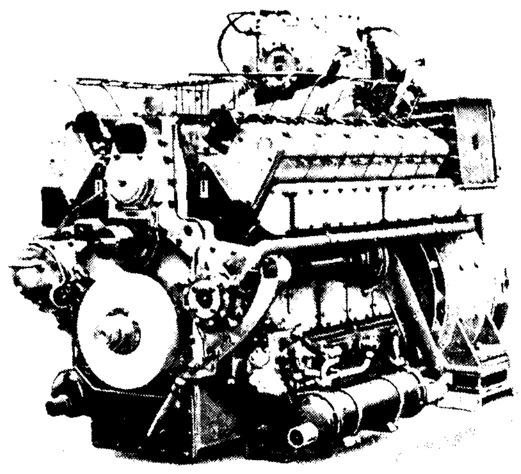


Fig. 3.—B.h.p., torque and specific fuel consumption curves against a base of variable speed

temperature of 80 deg. C., maximum temperature permissible 90 deg. C.; quantity of heat dissipated by engine lubricating oil at top power and speed 28,000 k. cal./hr; normal oil temperature 80 deg. C., maximum admissible temperature 92 deg. C. measured at cooler exit; lubricating oil consumption at top power and speed 2.7 kg. per hr.; oil pump capacity at 1,500 r. p. m. engine speed 120 litres per min.; nominal lubricating oil pressure at normal temperature and 1,500 r. p. m. engine speed measured at the relief valve 4 kg. per sq. cm. The fuel injectors, of

TABLE II—READINGS FROM POWER, TORQUE AND CONSUMPTION TESTS

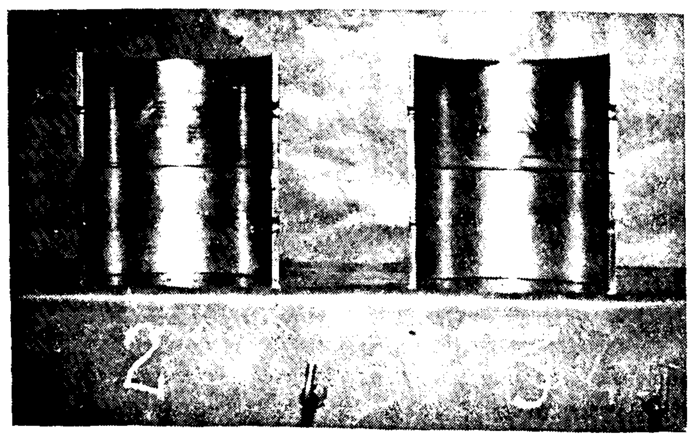
Hours of Running	R. P. M.	Output Figures: Weight on brake	Engine torque m.kg.	B. H. P.	Fuel cons. gr./b.h.p./hr.
1.0	1,500	60.70	434.7	910.5	155.1 154.9
	1,275	60.40	432.5	770.1	154.5 154.5
	1,050	58.90	421.8	618.4	159.3 159.3
	800	56.75	406.4	454.0	169.4 169.4
0.75	1,500	45.50	325.4	682.5	156.5 156.2
	1,275	46.80	335.1	596.7	153.6 153.2
	1,050	46.50	332.9	488.2	152.9 152.9
	800	42.80	306.5	342.4	158.5 157.2
0.50	1,500	30.33	217.2	454.9	162.7 162.7
	1,275	30.80	220.5	392.7	157.3 158.0
	1,050	30.80	220.5	323.4	155.6 155.6
	800	29.40	210.5	235.2	159.5
0.25	1,500	15.17	108.6	227.6	191.3 192.1
	1,275	15.00	107.4	191.2	185.0 188.5
	1,050	14.20	101.7	149.1	182.0 184.5
	800	12.60	90.2	100.8	189.5 188.3



M.G.O. 12-cylinder pressure-charged and intercooled engine of 910/930 b.h.p. at 1,500 r.p.m.

Precision-Mecanique make, are set to open at 200 kg. per sq. cm. pressure, and the injection begins 25 degs. before top dead centre. In regard to valve timing, the inlet valve opens 75 deg. before t. d. c. and closes 36 deg. after b. d. c.; the exhaust valve opens 36 deg. before b. d. c. and closes 75 deg. after t. d. c. There is thus a valve overlap of 150 deg. when both inlet and exhaust valves are open together, during which there is through scavenging.

The weight of the engine dry is 4,530 kg. (10,000 lb., or 11 lb. per b. h. p. against an output of 910 b. h. p.); the contained water weighs 120 kg. and the contained oil 100 kg. The heaviest single piece is the crankcase-cylinder block frame, complete with



State of Glacier precision bearings of connecting rod big-ends after 280 hr. of running including the 80-hr. full-load full-speed test described in this article on the M.G.O. 12-cylinder intercooled engine of 910 b.h.p.

bearing caps, which weighs 1,300 kg.; after that, the heaviest pieces to be handled in the course of repair are the B. B. C. pressure-charger group of type VTR 250, weighing 305 kg., and then one cylinder head complete with rockers, valves, etc, weighing 42 kg.

Under top output and speed, that is 910/930 b. h. p. at 1,500 r. p. m., the pressure of the exhaust before the pressure-charger turbine is 380 mm. of water; the air pressure in the intake manifold 470 mm., the speed of the turbo-blower group 22,000 r. p. m., the exhaust temperature at the exhaust manifold 420 deg. C. and at the turbine inlet 520 deg. C. The intercooler is proportioned to give an intake air temperature of 45 deg. C. to 50 deg. C., and the heat absorbed by the cooling water in the intercooler is calculated to 43,000 k. cal. per hr.

HEAT BALANCE

The heat balance calculated for this engine from the various tests is interesting. It comprices; power 39.7 per cent.; loss in exhaust 26.8 per cent.; loss to cooling water 17.9 per cent.; loss in intercooler 2.85 per cent.; loss to lubricating oil 1.75 per cent.; loss by radiation 11.0 per cent. The last figure may seem high, but is counted as the difference between all the other items and the heat in the fuel at 155.5 gr. per b. h. p. hr. specific fuel consumption with fuel of 10.255 k. cal. per kg. heat content. The value of 155.5 gr. per. b. h. p. hr. was the average of the 80-hr. run at 910 b. h. p. 1,500 r. p. m. The fuel itself was gas-oil of Antar brand, with a cetane number of 60 and a sulphur content of 0.15 per cent. The lubricating oil used was Shell Rotella T. 30; its general viscosity was 62 to 65 centistokes at 50 deg. C. and 11.4 to 11.8 centistokes at 100 deg. F.

TEST MEASUREMENTS

The measurements taken and observations made each hour during the 80-hr. run were: engine r. p. m.; weight on the Froude hydraulic brake; b. h. p.; specific fuel consumption; lubricating oil pressure at the big ends; lubricating oil pressure before and after the filter; weight of any oil added during the preceding hour; oil temperature in the crankcase before and after the cooler; cooling water temperature at engine entry and exit; pressure and temperature of the combustion air before the blower, after the blower, and after the intercooler; water temperature in the intercooler; pressure-charger r. p. m.; pressure of exhaust gas before the turbine, and back pressure; exhaust temperatures at the branches of all 12 cylinders; exhaust temperatures at turbine inlet and turbine outlet.

Space does not allow of reproduction of the entire test results, but Table III gives the readings for every tenth hour of the 80-hr. continuous run, and a selection of the other tests covering overload, over-speed partial loads, etc. A feature was the regularity of the results. The b. h. p. readings, for example, showed 910.5 b. h. p. (metric) for 74 of the 80 readings, the other six—from 21 to 26 hours—varying from 903.7 to 906.7 b. h. p.; at the 27th hour a short stop was made to adjust the valves of one cylinder. Specific fuel consumption was 155.5 gr. per b. h. p. hr. at 28 of the hourly measurements, and the extremes at other hours were 158.5 gr. and 155 gr.; over the last 20 hr. of the test the specific consumption lay entirely between 155 and 156 gr. b. h. p. hr.

Similarly with the exhaust temperatures as measured in the branches; there was no tendency to increased values as the test proceeded, and for any one cylinder the only marked variation was at No. 3 cylinder for the hours from 21 to 26, which led to the adjustment of the valves of that cylinder at the 27th hour. There were noticeable variations between one cylinder and another, No. 1, 3, 6 and 9 being cooler than the others at 400/420 deg. C.; No. 5 cylinders showed 460/480 deg. C., and the remainder were lower. During the 80 hr. run a total of 159/160 kg. of lubricating oil was added to the crankcase, the last addition of 9.2 kg. being made at the 79th hour.

STATE OF ENGINE

The complete tests were made under the direction of four engineers of the French National Railways, and with the permanent presence at the test bank of one or other

Pistons of Nos. 4 and 5 master rods of the M.G.O. type V12SHR intercooled engine after 280 hr. of running, including the 80-hr. full-load full-speed test; cylinder dia. is 175 mm.

TABLE III—TEST RESULTS OF M.G.O. 910 B.H.P. FOUR-STROKE ENGINE

Test	Hours of Running	R.P.M.	POWER: Weight on brake kg.	Engine torque m. kg.	B.H.P.	Fuel cons. gr. per b.h.p. hr.	OIL: Pressure, kg. per sq. cm.: Master rod end	Artic. rod end	Entry to cooler	Filter: Entry	Filter: Exit	Weight added to crank case kg.	Temperature, deg. C.: Crank-case
Continuous Full Load	0	1,500	60.7	434.6	910.5	156	3.5	3.5	1.9	4.2	3.5	...	85
	10	1,500	60.7	434.6	910.5	156	3.6	3.5	1.9	4.1	3.5	17.085	85
	20	1,500	60.7	434.6	910.5	156.5	3.5	3.5	1.9	4.1	3.5	27.074	86
	30	1,500	60.7	434.6	910.5	155.5	3.3	3.2	1.6	3.8	3.3	27.139	77
	40	1,500	60.7	434.6	910.5	155.5	3.4	3.2	1.6	3.8	3.2	18.09	78
	50	1,500	60.7	434.6	910.5	155.5	3.4	3.2	1.6	3.8	3.2	18.093	78
	60	1,500	60.7	434.6	910.5	155	3.3	3.2	1.6	3.8	3.2	15.915	78
	70	1,500	60.7	434.6	910.5	155	3.4	3.2	1.6	3.8	3.2	17.973	78
	80	1,500	60.7	434.6	910.5	155.5	3.3	3.2	1.6	3.8	3.2	18.279	77
10% overload	¾	1,500	66.7	477.6	1,000	156	3.3	3.2	1.65	3.8	3.2	—	78
10% over speed	¼	1,650	60.6	433.9	1,000	157.5	3.5	3.4	1.95	4.2	3.5	5.772	77
Partial Loads	2	1,250	54.0	386.6	675	153	3.0	2.9	1.25	3.4	2.8	—	78
	2	1,250	34.0	243.4	425	157.5	3.1	3.0	1.25	3.5	3.0	—	72
	2	1,000	44.0	315.0	440	155	2.6	2.5	0.8	2.8	2.5	—	77
	4	850	36.5	261.3	310.2	156	2.5	2.5	c.65	2.6	2.4	—	77

Test	Hours of Running	OIL: Temperature, deg. C.: Cooler Entry	Cooler Exit	Cooler Diff.	WATER: Temperature, deg. C.: Entry	Exit	Diff.	AIR: Pressure, mm. Hg: Athmos Turbine entry	Depression blower entry	After blower	After intercooler	AIR: Temperature, deg. C.: Thermo dry	Thermo wet	Diff.	Blower entry	After blower	After intercooler	WATER: Water in intercooler
Continuous Full Load	0	69	51	18	74	80	6	736	115	469	459	31.6	22	9.6	35.2	100	50	40
	10	67.5	55	12.5	73	80	7	736	—115	474	457	29.6	22.4	7.2	29.5	96.5	47	40
	20	68	56	12	73	79	6	735	—114	472	458	32.2	23	9.2	28.5	102	50	40
	30	77.5	65	12.5	74.5	80	5.5	734.3	—115	477	460	33	23.2	9.8	31	99	48.5	40
	40	78	66	12	74	80	6	737.5	—114	475	460	27.8	19.4	8.4	28	96	48.5	40
	50	78	66	12	74	80	6	737	—115	487	470	28.4	19	9.4	29	97	48	40
	60	78	66	12	76	80	4	737	—114	487	470	26.4	19	7.4	24	92	48	40
	70	78	67	11	74	80	6	738	—115	490	475	27.4	19.1	8.3	28	96.5	50.5	45
	80	77.5	65.5	12	74	80	6	739	—114	489	475	24.4	17.6	6.8	27	93	49	45
10% overload	¾	78	67	11	74	80	6	739	—130	575	559	24	17.4	6.6	28	103.5	52	45
10% over speed	¼	77.5	67	10.5	74	80	6	739	—147	577	559	26.5	19	7.5	27.5	103.5	53.5	45
Partial Loads	2	73	67	11	75	80	5	739	—62	302	295	26.2	18.8	7.4	26	68	44	45
	2	73.5	65	8.5	76	80	4	738	—35	154	144	25.4	18.2	7.2	24	46	42	45
	2	78	67	11	74	79	5	738	—32	160	153	25.2	18.6	6.6	25	49	42	45
	4	78	72	6	76	80	4	738	—20	87	83	27.0	19.2	7.8	29	42.5	42	45

Test	Hours of Running	Turbo-Blower r.p.m.	EXHAUST: Press. before turbine: cyls. 7, 8, 9 mm. Hg.	cyls. 10, 11, 12 mm.Hg.	Back press. after turbine mm. water	Temperature, deg. C.: Cylinders 1	2	3	4	5	6
Continuous Full Load	0	21,600	370	*346	—30	420	465	410	470	485	440
	10	22,000	365	346	—33	419	452	409	462	476	429
	20	22,100	365	349	—31	429	463	409	469	482	435
	30	22,100	365	345	—33	418	450	415	462	478	431
	40	21,900	370	347	—34	419	450	418	460	470	426
	50	22,100	367	349	—32	409	451	409	459	470	428
	60	22,100	371	349	—31	409	445	400	450	461	419
	70	22,000	382	340	—27	418	451	409	458	472	422
	80	22,000	379	334	—25	417	449	409	451	471	424

Test	Hours of Running	GAS: Temperature, deg. C.: Cylinders 7	8	9	10	11	12	Before turbine: cyls. 1, 2, 3	cyls. 4, 5, 6	cyls. 7, 8, 9	cyls. 10, 11, 12	After turbine	Remarks
Continuous Full Load	0	445	445	440	470	480	450	540	560	535	540	430	
	10	438	440	428	460	465	441	530	549	539	529	428	
	20	441	440	432	460	472	450	546	559	545	537	434	
	30	432	439	430	460	461	448	531	555	539	539	429	†
	40	430	432	425	459	460	440	533	549	535	521	425	
	50	430	435	421	460	452	438	533	541	531	520	421	‡
	60	429	430	418	449	450	430	521	532	527	511	416	
	70	430	434	422	455	459	435	530	542	532	520	422	
	80	429	434	418	470	440	433	530	539	530	529	422	§

* In mm. H_2O. † 15 min. stop at 27 hr. for valve adjustment of No. 3 cylinder
‡ 15 min. H.O. stop at 43 hr. for adjustment of rockers No. 3 cylinder
§ Exhaust invisible throughout the 80 hr.

(Continued on page 72)

Manufacture of Railway Iron Fittings in France

WHEN a foreign visitor comes to the French Ardennes having in view business transactions in Railway iron fittings what does he expect to find here but the usual scenery of an industrial country: chimney stads smoke black sky, a gloomy dark atmosphere.

He is ready to retrace his steps thinking that he took the wrong road when he finds himself in a beautiful green country, when he sees rivers and torrents winding their course amongst old heavily treed mountains. He, nevertheless, looks for the factories he has come to see, and suddenly he sees them, hidden in a scenery which surprises him and is, for his eyes, an unexpected enchantment.

Why is nature so intimately blended here with the industry? It is because, in the Ardennes, nature gave birth to industry.

A very long while ago, men discovered the need to manufacture iron implements. They found in our country both the ore and the fuel, this fuel was the trees of our forests, the ore was there, just by scratching the ground, in the limited quantities sufficient for their needs.

Our iron industry was born then, and its continuous growth was due to the lucky fact that coal and iron mines were in the immediate vicinity.

The very first railways made use of the Ardennes' iron forging and stamping industry for their fittings. Thus, being specialized in these forged fittings manufacture, the industry followed the growth of the railroads adapting itself to its ever increasing need.

This industry supplies all the French Railways' fittings and its exports towards foreign countries are increasing yearly.

The end of the last world war with the necessity of a total reconstruction of the French Railway system, demanded an ever increasing production. Individually our factories, which are small and medium size, were unable to answer to these enormous needs. But these needs had to be met and the only solution to this problem was the creation of the COMPTOIR DES FERRURES. This company studied a global working plan, and, specializing

(Continued from page 71)

of three representatives of the Bureau Veritas. Before the tests the engine measurements were carefully checked, and all parts subject to wear were accurately measured. After all tests and the preceding running were finished, after a total of 280 hr. under all kinds of loads, the engine was taken down and all parts examined minutely and the condition noted; and sets of moving parts were finely weighed to show tolerances and the matching of parts.

As an example of the standard of manufacture, the weights of the connecting rods may be taken. Without the bearings, the weights of the six master rods varied only from 14.743 kg. to 14.875 kg.; and of the six articulated rods from 2.560 kg. to 2.590 kg. The pistons, without rings, gudgeons or circlips, varied in weight between 7.135 kg. and 7.164 kg. for those attached to the master rods, and between 7.043 kg. and 7.052 kg. for those attached to the articulated rods.

Examination of the dismantled parts showed the following results: crankshaft—good state, examined through a metalloscope and found to be without fault; camshafts good state; timing gear train one pinion in the left-hand camshaft drive was found to have a small piece broken from one tooth, otherwise all wheels were in good state and without wear; main bearings—good state, a few light cracks; big-end bearings—three fine cracks in bearing of No. 5 rod, everything otherwise in good state; small end bearings—no comment; articulated rod sockets no comment; connecting rods—without defect; cylinder blocks very good fit of liners, without any defect apparent; pistons—light deposit of friable carbon on the crowns, but quite normal considering the 280 hr. of operation; piston rings—good state, good fit, good appearance of grooves, no ring gummed; gudgeon pins—good state; articulation pins in connecting rods—good state; cylinder heads—light deposit of friable carbon on undersides; valves—some marking on one of the exhaust valves on No. 10 cylinder as a result of one of the springs breaking, all other valves were without defect; valve seats—all without defect; injectors—light deposit round the heads, pulverisation normal; push rods and rocker and tappet gear—slight deformation in No. 3 inlet rocker, otherwise everything satisfactory; oil pumps and water pumps—good state.

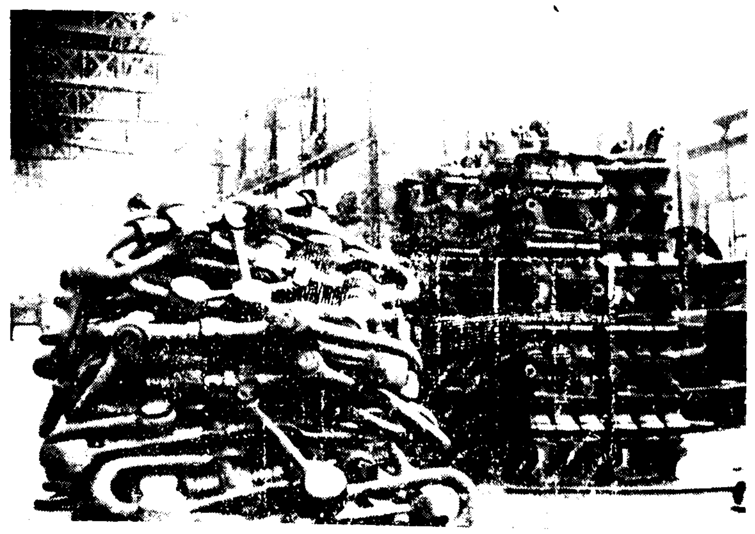
(By courtesy of Diesel Railway Traction) each plant in the manufacture of the kind of fittings best adapted to its possibilities, got the result it looked for: Heavier production, reduction of the manufacturing costs.

The COMPTOIR DES FERRURES associated factories employing more than 2000 workmen have been now organized for ten years and they deliver fittings to most of the whole world's railways.

Amongst the COMPTOIR DES FERRURES Foreign Customers, India occupies the very first place For Years, fittings used in the manufacture of MC, MOX, O, CR Wagons and carriages have been supplied by us and our workmen know them just as well as they know the fittings supplied to the French Railways (S. N. C. F.). Tens of thousands of pieces, from the cotter Pin (W20) of but a few ounces weight to the heavy and strong draw hooks (W445) have been made in our works. I. R. S. Inspecting Officers visit us almost weekly and their presence there does not surprise more than the calls of the French Railways Inspecting Agents.

By the use of a complete and modern range of forging hammer and presses and drop stamps, our equipment for heat treatment ensures for our customers a full guarantee of a manufacture fulfilling their requirements.

Our mechanical and chemical laboratories, equipped with the most modern apparatus are constantly checking



Screw—Couplings W A 1 and Scroll Irons W 768/792 ready for shipment.

the quality of the various steels. It is at the disposal of all Inspecting Officers for any test they wish to make.

As our factories are all specialized we are able to insure deliveries required by our customers. Large orders are shared among several works in order to avoid any shipping delays even in the case of difficulties in one particular factory.

The COMPTOIR DES FERRURES keeps a complete watch over the manufacture and it is its duty to see that promised deliveries are made in due time.

The COMPTOIR DES FERRURES makes forgings and stampings for all the rolling stock made in Europe for, India (France, Belgium, Austria, Holland, England.) We feel sure that our knowledge of the Indian market in these lines and our producing capacities will enable us to become a supplier of the Indian States Railways. We shall always be happy to study and answer all inquiries.

Our works manufacture also all stampings, forgings and ironwork used in various industries (mines, marine work, motorcars) and in particular galvanized or non-galvanized pieces used in Railways electrification and in the telegraphic and telephone services.

CONSTRUCTION OF RAILWAY LINES

THE contractors A. DEHE & Co. have for a long time specialized in railway building. They have unceasingly been planning new methods for renovating the material of the railway lines.

They have constructed an important material for this work which they have mechanized.

They have trained a number of specialists, and acquired a long experience which enables them in setting up and managing such yards.

Some of their achievements are enumerated below:

Clearing away of ballast and sifting

Mechanical loading of sifting debris

Mechanical deposit by mounted elements from 12 to 24 meters

Mechanical laying of the sleepers before laying the long bars

Different materials of mechanical handling

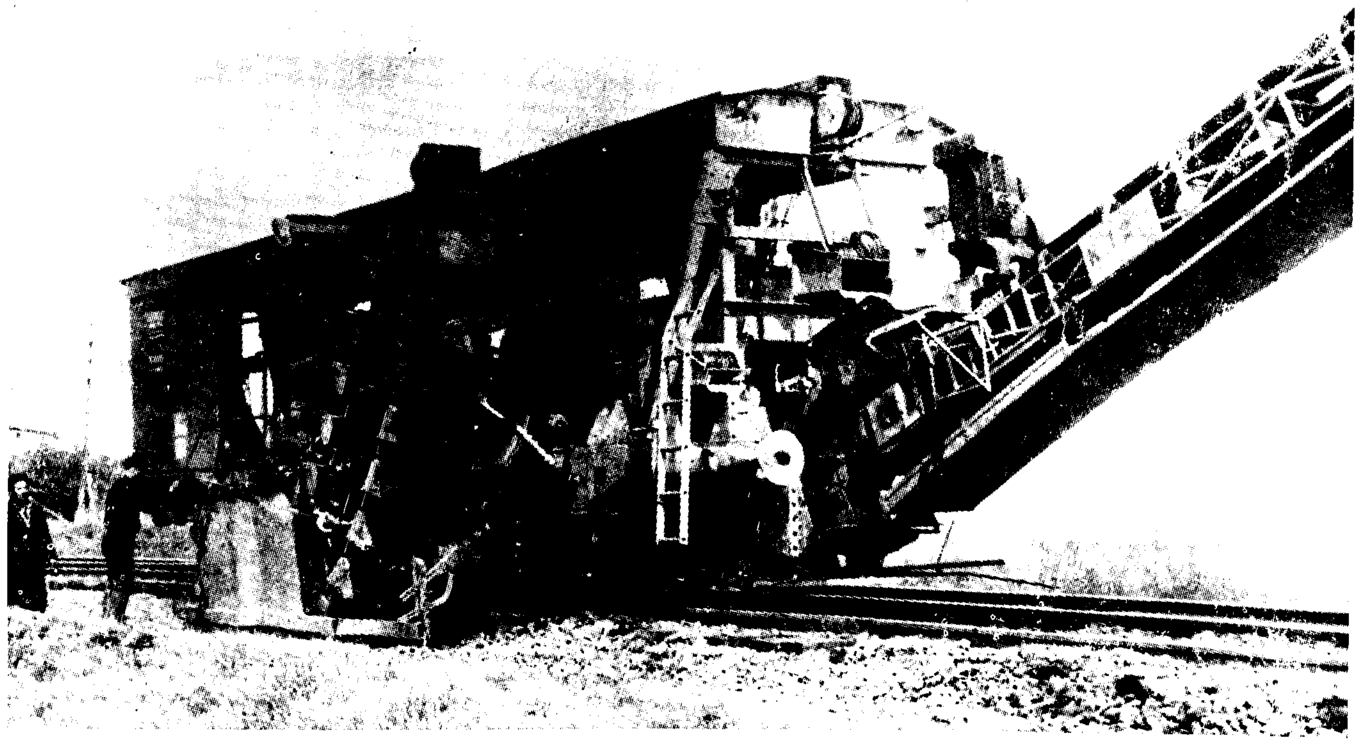
MECHANICAL CLEARING AWAY AND MECHANICAL LOADING

The firm has been carrying out for many years the mechanical clearing away of gauges by means of showel sieves.

Recent improvements have just been realized on these machines which enable them, with an extremely reduced personnel of about 3 specialists, to carry out in full, mechanically, the following operations, viz:

—Clearing away of the gauge.
—Sifting of the ballast in 3 parts, viz: good ballast, fine gravel, debris to throw away.
—Refilling partially of the tracks with the recuperated ballast.
—Deposit of the fine gravel every 5 or 10 meters, runway side or between, at will.
—Reloading of the debris on cars ready to leave or carrying of the debris on the embankment.

The length of the line treated in one day by one of these machines can reach or exceed one kilometer.



MECHANICAL LAYING OF THE TRACKS

The firm carries out also the mechanical renewal of railway lines thanks to a patented material.

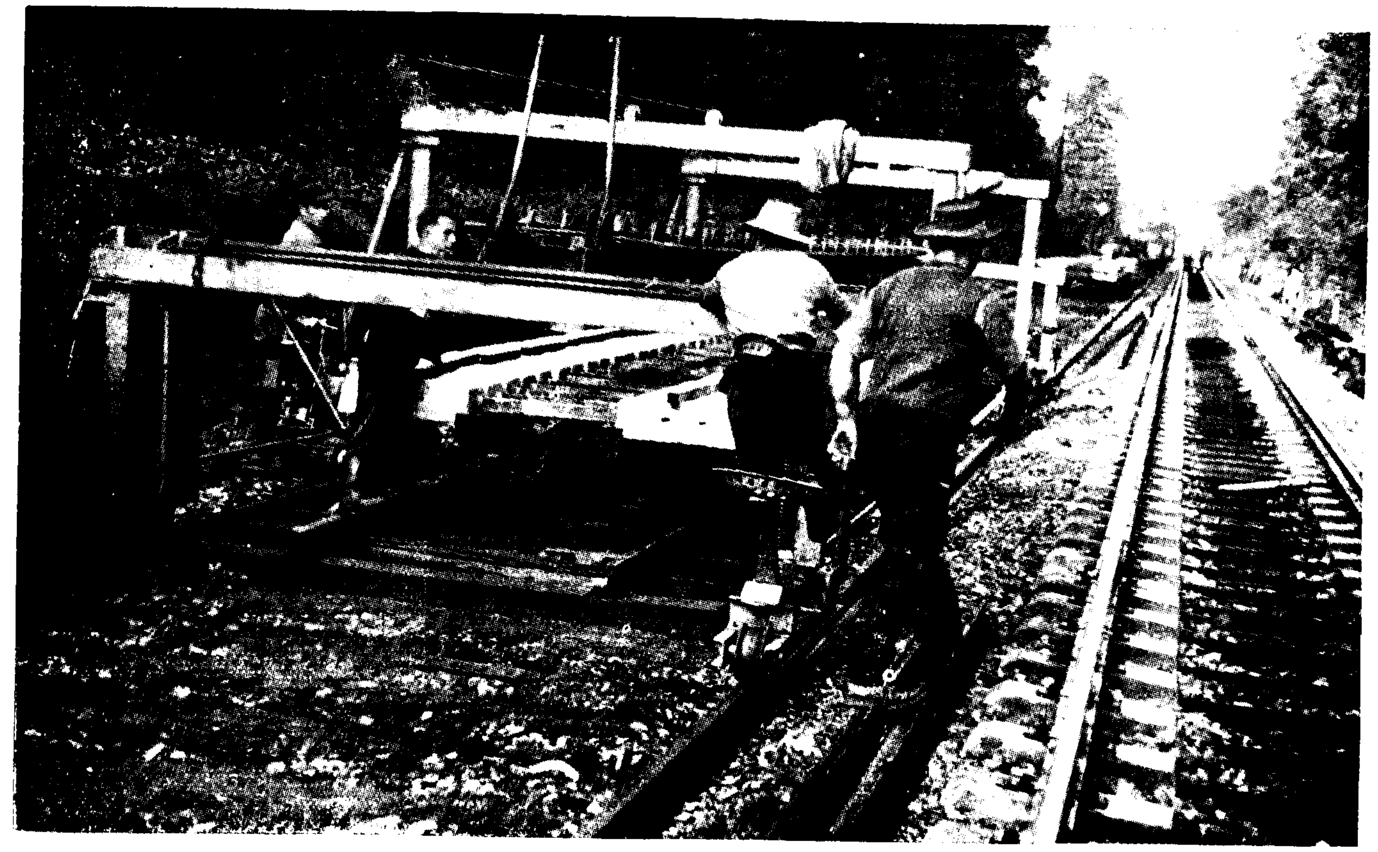
This method consists in :

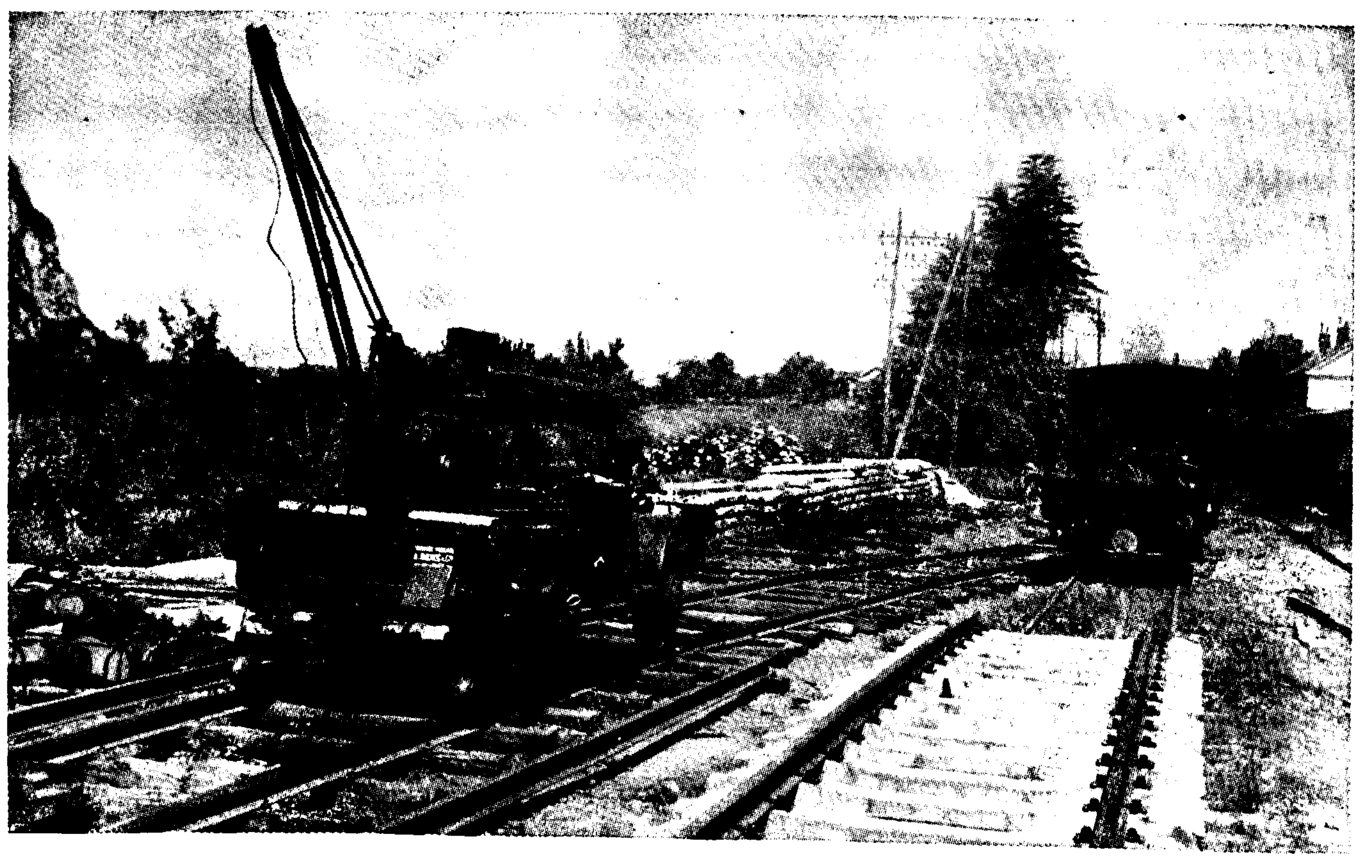
—laying the tracks in a set spot,

to bring on the yard new elements of tracks assembled beforehand,

—taking away the elements displaced which will be taken apart in the yard.

—taking apart the old tracks in a set spot, also.





It is thus possible to treat on kilometer of track per day with this material, and a squad greatly reduced as compared with the manual process.

Advantages of this method

—Great rapidity of carrying out the work,

—Material free from any damage at the time of their unloading on account of narrow space.

—No material is left behind on the spot renewal, thus avoiding losses and accidents.

—Important reduction of workmen squads and of the manual effort required of the men.

—Careful laying of the lines in a fixed yard.

—Also taking apart in fixed yard, thus avoiding all losses of material.

MECHANICAL LAYING OF THE SLEEPERS BEFORE LAYING THE LONG BARS

The laying of tracks of great lengths and the different line elements which accompany this technique in full swing have led the firm DEHE to elaborate new methods of laying and to build a material adapted and patented.

This material enables the taking up and the mechanical handling with a precision requiring only a few, or none at all, manual retouches of the elements particularly heavy of the line (long bars, concrete sleepers).

The different sleeper chassis built by the firm each allow uninterrupted succession of a determined type of sleeper.

THE DIFFERENT IMPLEMENTS AND THE ENDEAVOUR TO REACH PERFECTION

Seeking always the maximum of efficiency and the greatest care in the execution of the work to be done, the firm has attempted to reach these results through the use of special methods and of new outfits which it has adapted to the requirements of the railway line.

We mention among others:

—the harrowing of the substratum before laying the tracks,

—the hardening of platforms with vibrating rollers,

—the use of caterpillars in the laying of lines for quick progress.

—The mechanical handling and reloading of the different elements composing the line (sleepers, rails).

To complete this write-up, it is necessary to mention that this firm has successfully carried out, in the case of the French and foreign systems, as well as in the case of private industrial branch lines, since its creation in 1891, nearly ten thousand kilometers of line renewals (approximately 6213 miles).

DIVISIONAL SYSTEM ON INDIAN RAILWAYS ACHIEVING GREATER EFFICIENCY

The Railway Board has decided to pursue vigorously the question of introducing the divisional system of administration on the Indian Railways, wherever it does not at present exist.

At present in force only on the Eastern and the Northern Railways, the divisional system has in practice been found to be conducive to greater efficiency and better co-ordination at all levels than the other prevailing systems, known as the regional and district systems.

In the Railway Board office the post of Secretary has been upgraded to the same level as in 1951, with powers of co-ordination and over-all administrative supervision. Shri D. C. Baijal, Director, Efficiency Bureau, has taken over as the new Secretary.

A French Technical Development—Electrical Locomotives with High Wheel Adherence

By P. Desrignes, Engineer, Materiel de Traction Electrique (M.T.E.)

BO BO TYPE M.T.E. (1) LOCOMOTIVES

It can be rightly claimed that transport by railway is the most economical means through which heavy tonnages over long distances can be handled quickly and at low cost. This is due, in fact, to an inherent railway feature: the contact of the very hard wheel with a similarly very hard material, namely the rail face, will result only in a very low rolling resistance, which will consequently permit to haul heavy trains with a reduced tractive effort. However, such an advantage because of its very property is presenting a major drawback: the contact of the locomotive wheel with the track is associated with a low friction coefficient. Therefore, should one wish to take advantage of the low rolling resistance as mentioned above and increase unduly the hauled tonnage, it can be expected this will result in *a lack of adhesion* between locomotive and track, causing thus the locomotive *to skid*. It is, therefore, required where railway traction is involved to give special attention to the problem connected with the "rail-grip" of the locomotive wheel. Of course, an alternative would be to increase the locomotive weight with additional wheels when practicable and consistent with the railway track system, but this is a costly solution as it increases both the locomotive cost and the amount of power required to pull this additional load.

Any attempt to increase the load of the wheel on the rail would obviously tend to reducing or even eliminating the carrying axles altogether—since they actually do not assist adhesion—and transferring as far as possible over to the driving axles the very loads they are carrying. Now, such carrying axles, until recently were acting as guiding axles, too, and it is only during the last few years that their omission was found practicable on fast electric "all-service" locomotives, that is, on locomotives suitable for hauling high or medium speed trains. The omission of such axles gave rise to many technical problems connected with stability at high speed. These were successfully solved as evidenced by the fact that on March 29th 1955 the BB 9004 locomotive o M.T.E. design did beat the World speed record on rail when it reached the speed of 206 m.p.h. (331 km/h).

As a result major Railway Companies are no longer placing orders for locomotives including carrying axles and the new designations BB, BBB and CC have been fully substituted for 2 D2, 1 CC1 and 1 D1, formerly used.

However, it must be owned that the omission of carrying axles did not solve adhesion problems altogether. In fact, even on locomotives with complete adherence the satisfactory distribution of the total locomotive weight is involving mechanical and electrical problems, and there is no denying that the specific adhesive potentialities of any given locomotive are closely related to the locomotive type.

MECHANICAL FACTORS

Though stability will not be dealt at length here, it should be emphasized, however, that the installation of 2-axle bogies in BB or BBB type and 3-axle bogies in CC type requires special care either in coupling them together or securing same to the body they carry, or alternatively in combining both systems.

Quite a number of ingenious devices have been used, but full advantage of the locomotive weight shall not be taken unless any such device is not primarily designed to balance to the fullest extent possible the reversing torque which causes the static distribution of load on rail to be modified.

In BB type locomotives designed by M.T.E. such balancing requirements are automatically met—irrespective of the tractive effort involved—through the use of junction links conveniently placed between bogies and body. The reversing torque is thus balanced and the

(1) "M.T.E." stands for "Le Materiel de Traction Electrique", a group including the following Companies:

—Forges & Ateliers de Creusot (Usines Schneider)
—Forges & Ateliers de Constructions Electriques de Jeumont
—Le Meteriel Electrique S.W. (Schneider-Westinghouse).

load on the two axles of one bogie is equally and permanently distributed.

A further factor likely to be responsible for the defective adherence of locomotive wheels lies in the track irregularities (e. g. sleeper depression or defective rail joint will cause dynamical bogie "unloadings" which, though of very short duration, may be, however, conducive to initial "skidding").

In BB locomotives of M. T. E. design such unloading action is defeated by the provision of a highly flexible suspension so designed as to have the bogie frame resting on Pennsylvania type equalizing beams; in addition to this improved feature, various valuable arrangements were incorporated which experience has proved most satisfactory.

ELECTRICAL FACTORS

The type of *motor* has a governing effect on the adhesive properties of any locomotive.

The trend of the characteristic curve tractive effort/speed will permit to appreciate readily the rail gripping capacity of a machine; if such curve tends to "drooping", i. e. if any increase in the speed of the motor bogie will determine a substantial decrease in the tractive effort, wheel skidding is more likely to be defeated than in the reverse case.

Coupling plays also a determining part.

Similarly, of primary importance are such factors as rheostat sensitivity and even shunting variations in d. c. locomotives, or smooth supply voltage progression and freedom from current surges during notch change-overs in a. c. locomotives.

Extensive research work has been carried on by the M. T. E. on such questions.

RESULTS OBTAINED

Adherence coefficients regarded as normal a few years ago only were ranging about 25 % ; peak figures as high as 30 % were recorded at starting: this was obtained with sand spraying and was due to the fact that at low speed adherence coefficients are higher than at high speeds.

M. T. E.'s technical advance had enabled them to build earlier D. C. BB locomotives of 80 ton total weight that compared favourably with 2 D2, 124 ton locomotives; such is the case of 9004 type locomotives (mentioned earlier) for which adherence coefficients as high as 38 to 40% were recorded at starting during recent tests. However, a new technique which has now successfully stood the test of experience in France, namely, the electric traction involving the use of commercial single-phase current, has led M. T. E. to build single-phase current operated locomotives which are now regarded as most outstanding units in that specific field.

The single-phase, 50 cycle, BB Locomotives equipped with ignitrons rectifiers, as now in use on the French State Railways lines, are actually capable of developing high tractive power without any resulting skidding due to their improved mechanical construction and electrical features; such tractive power being actually sustained over long periods at low speed without any detrimental effect on the motor. Such is the starting capacity of these machines under high loads that they can be regarded in that respect as unparalleled units.

The tractive effort at wheel rim as recorded during tests performed on such locomotive reached 41 tons, which represents an aderence coefficient nearing 50 %, the locomotive weighing 84 tons. This is an uncommonly high figure and cannot be claimed by any other traction system. Practically such locomotives will currently start and haul 1600 tons trains on 10 % gradients on the Valenciennes-Thionville line.

They are also capable of reaching speeds as high as 81 m. p. h. and are also hauling fast service trains, but this is beyond the range of this article which was mainly restricted to consideration on wheel adhesion.

The above mentioned figures are fully illustrative of the outstanding results reached in that very field: they are due to most up-to-date mechanical and electrical features that have definitely endowed the M.T.E. locomotives with a rail gripping capacity second to none.

As a result of the above, locomotives are required in less number to produce a similar amount of hauled "tons-miles". The economical significance of this achievement is beyond discussion and it was felt that it was worth while to be reviewed at length in the present article.

ALUMINOTHERMIC WELDING OF RAILS

THE Aluminothermic welding is generally sufficiently well-known and we will not here go into the explanation of the different methods and of their development.

Large progress have been made in 1936 when the "homogeneous smelting welding" brought to light according to the "BOUTET PROCESS", the making of which is very simple, quick and not expensive, and give a resistance equal to the rail's itself.

To obtain such a result the following data were to be worked out:

1. Obtain a high quality steel presenting for each case a composition corresponding to that of the parts to be welded.

2. Adjust an equipment, an operating method and the corresponding details enabling to reach a general effect showing the greatest possible homogeneity.

As early as 1937, the Boutet methods developed rapidly; the publication of the report presented by Mr. Ridet, Chief-Engineer for the East Railway Tracks to the International Railway Meeting that took place in Paris in 1937 (see the December 1936 bulletin of the International Association for Railway meeting) revealed the remarkable characteristics of this welding method.

Let us recall, in particular the comparative chart for hardness measured on the rolling and the chart for impact tests.

The sections welded by means of the Boutet methods referred to as "smelting welding" have nearly always held, with annealed normalization, in the same extent as the non-welded reference sections, and, this being important, without losses.

Another test has brought to light the steadiness of the resulting datas owing to a severe and special check of the production, this being part of the manufacture secrets.

The tests has been made for three weldings on 55 kg. S 39 rails; two sections out of the welded sections were tested by means of successive increasing drops

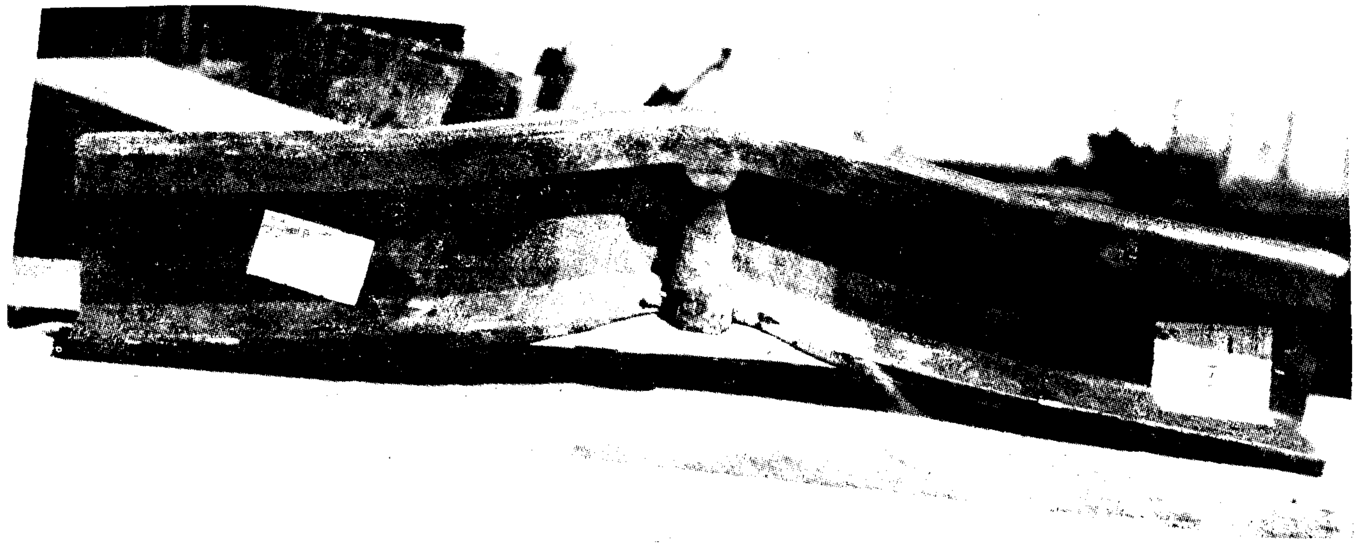


Fig. 1.

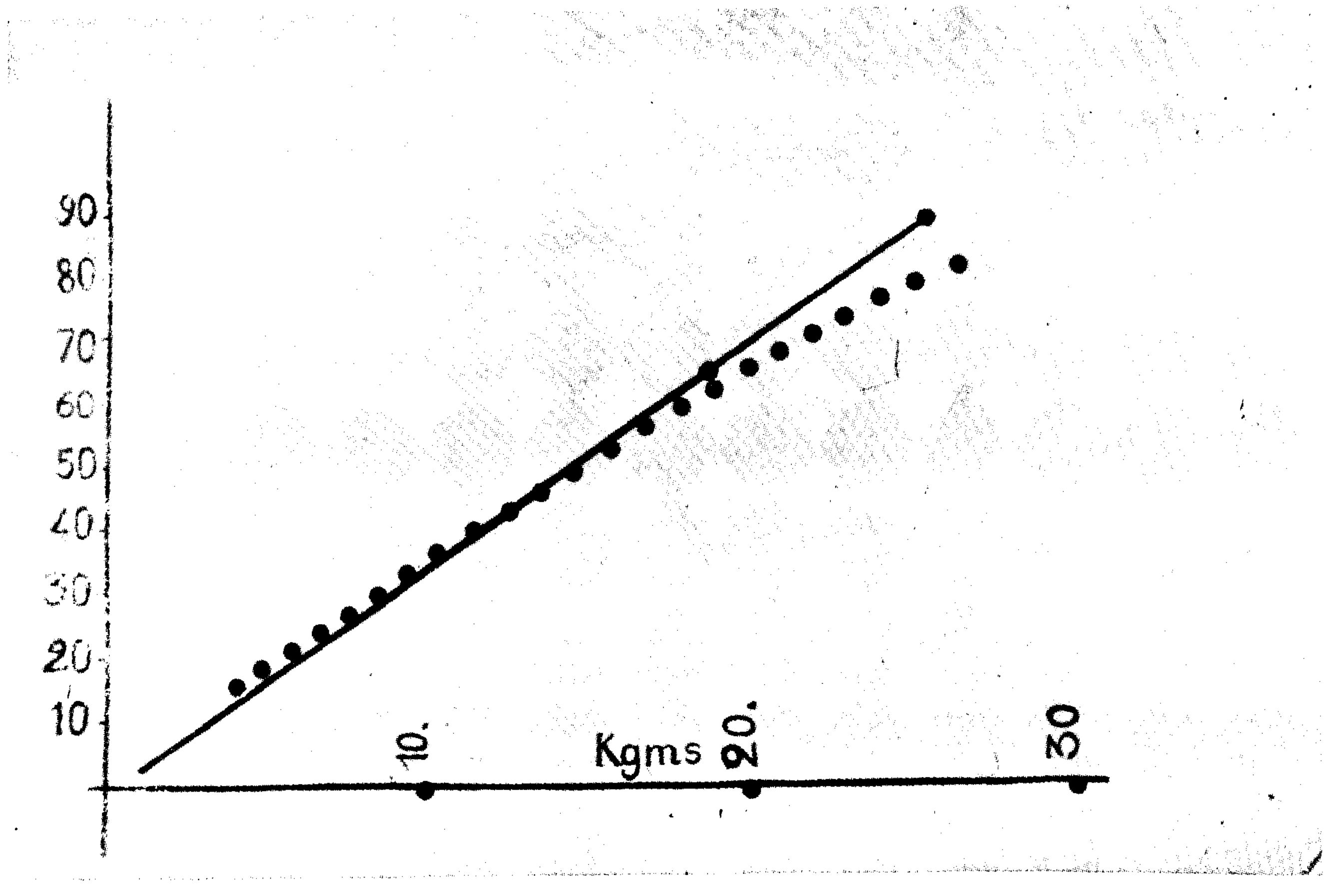


Fig. 2. Abscissa Kilogrammeters applied to the welded section—ordinate sags measured.

from o m, 50 to 4 m. and thereafter from 1 m. till rupture occurred. These ruptures occurred, the one for 12 m., the other for 13 m. The third welding was tested with successive drops of 5 m. 22; rupture occurred for the 18th drop. We have drawn, for these 3 weldings a curve obtained in tracing in abscissa the kilogrammeters applied to the welded section and in ordinate the sags measured along 50 cm. For the two first ones these curves are straight lines, or more exactly one single line; the curve pertaining to the third test,

Fig. 3.

Fig. 4.

shown in dotted line, is but little different from the first straight line.

The homogeneous smelting welding has provided another important advantage:

Simplicity and rapidity in the working, resulting in an important reduction in the cost price.

As early as 1938, the Boutet methods have been applied in addition to the National French Railways, on a large scale to Great-Britain, to the Federal Railroads, to the Loetchberg etc.

The steadiness in the metal hardness should be emphasized, this hardness of the welding metal being always 15 to 20 Brinel points over that of the rail this removing the cup formation hazards, even the welding of hard rails.

But the research departments of the Aluminothermic Company have not been remaining idle in front of the modern railways requirements. They always have kept to two big principles:

Meet, to the greater possible extent, the railroad requirements.

Attempt to increase the metallurgic homogeneity of their weldings in relation with the best economical conditions.

As early as 1949, after many tests made by the Federal Railways had shown the drawbacks resulting from the section change corresponding to the welding rims in relation to the resistance to wear, they adjusted the type B Boutet joint without any rim under the shoe.

The very great resistance pertaining to this joint is brought to light through the documents hereunder listed.

1.—Resistance to the wear test.

Fig. 5. Welding of rails.

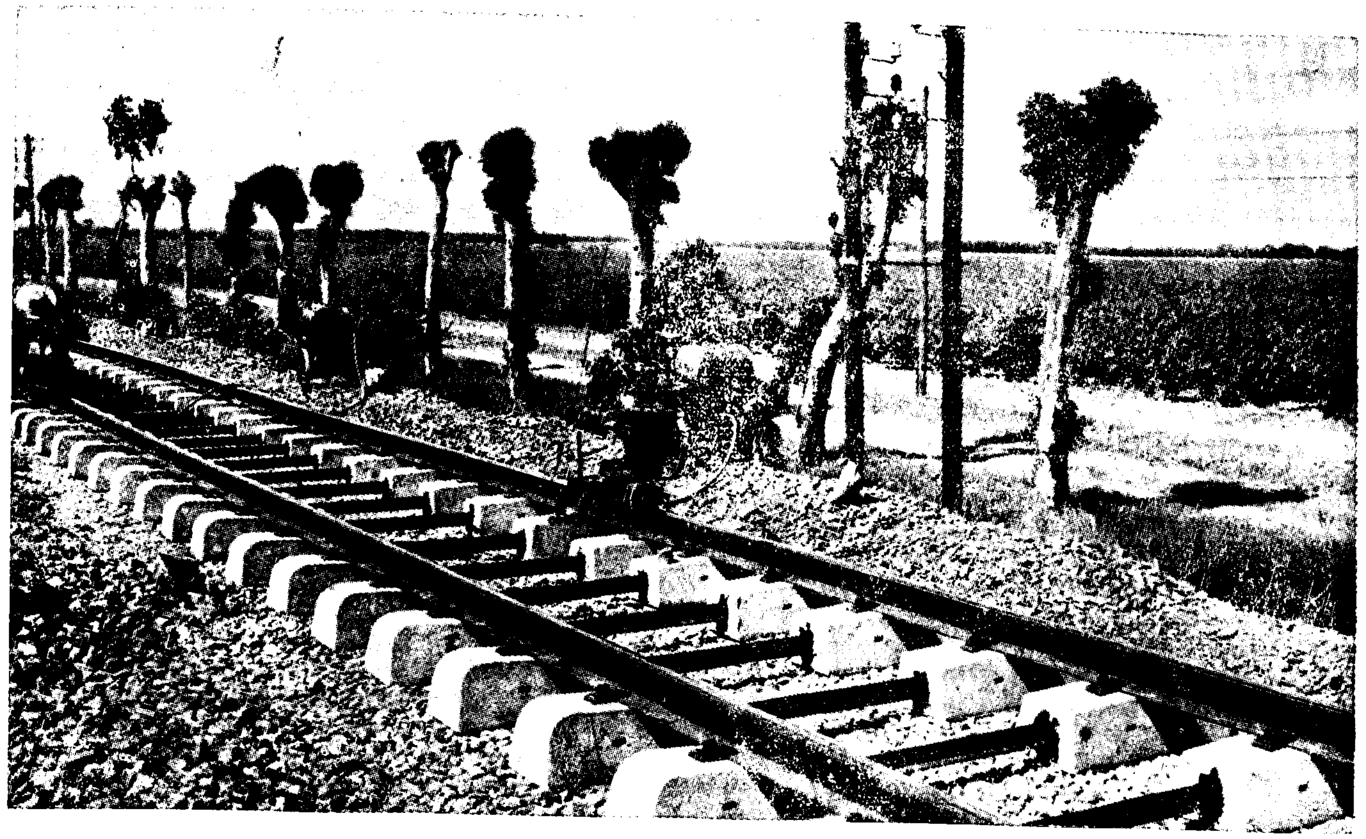


Fig. 6. Welding of rails—Joints in preheating. All material necessary to a Welding is shown. The simplicity of process and material is demonstrated by this photo. 45 Weldings per day were made on this yard.

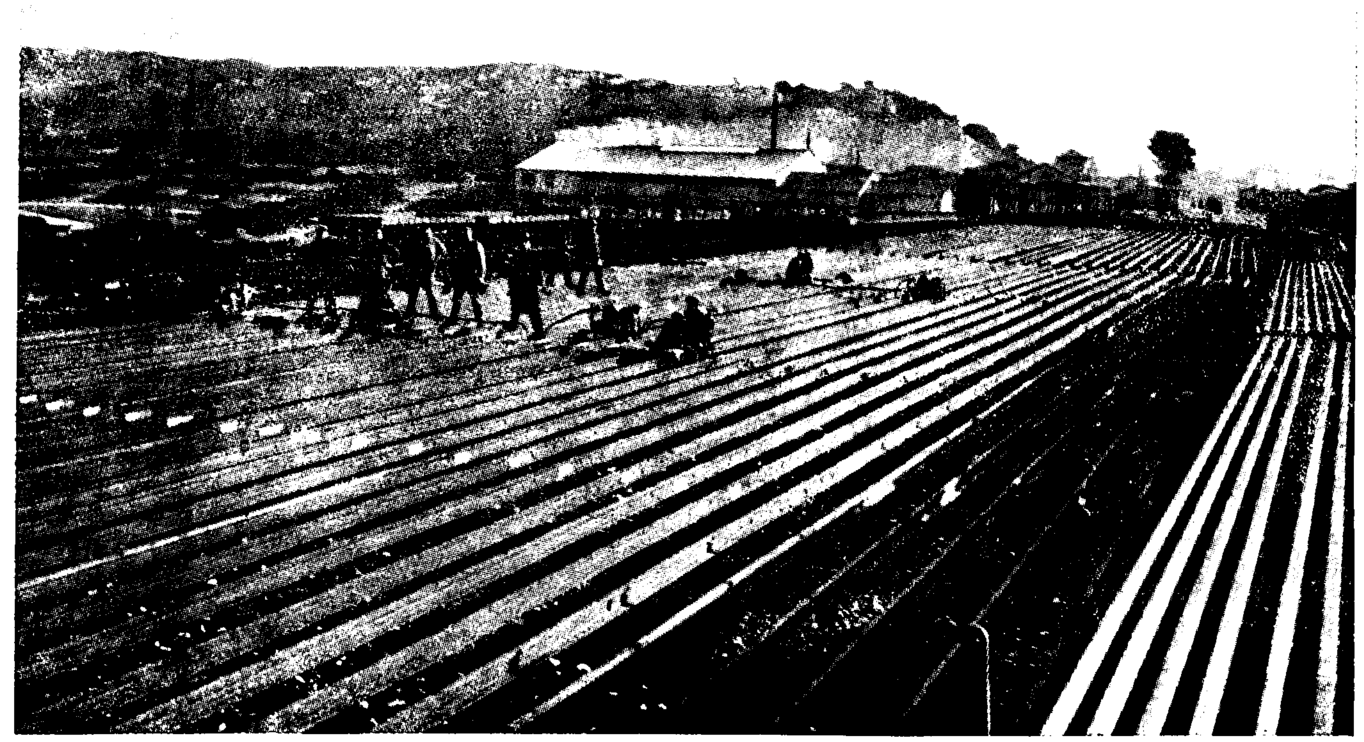


Fig. 7. Welding on a set spot. On this yard RR workmen accomplished 40 weldings per day (rails 72 meters long)

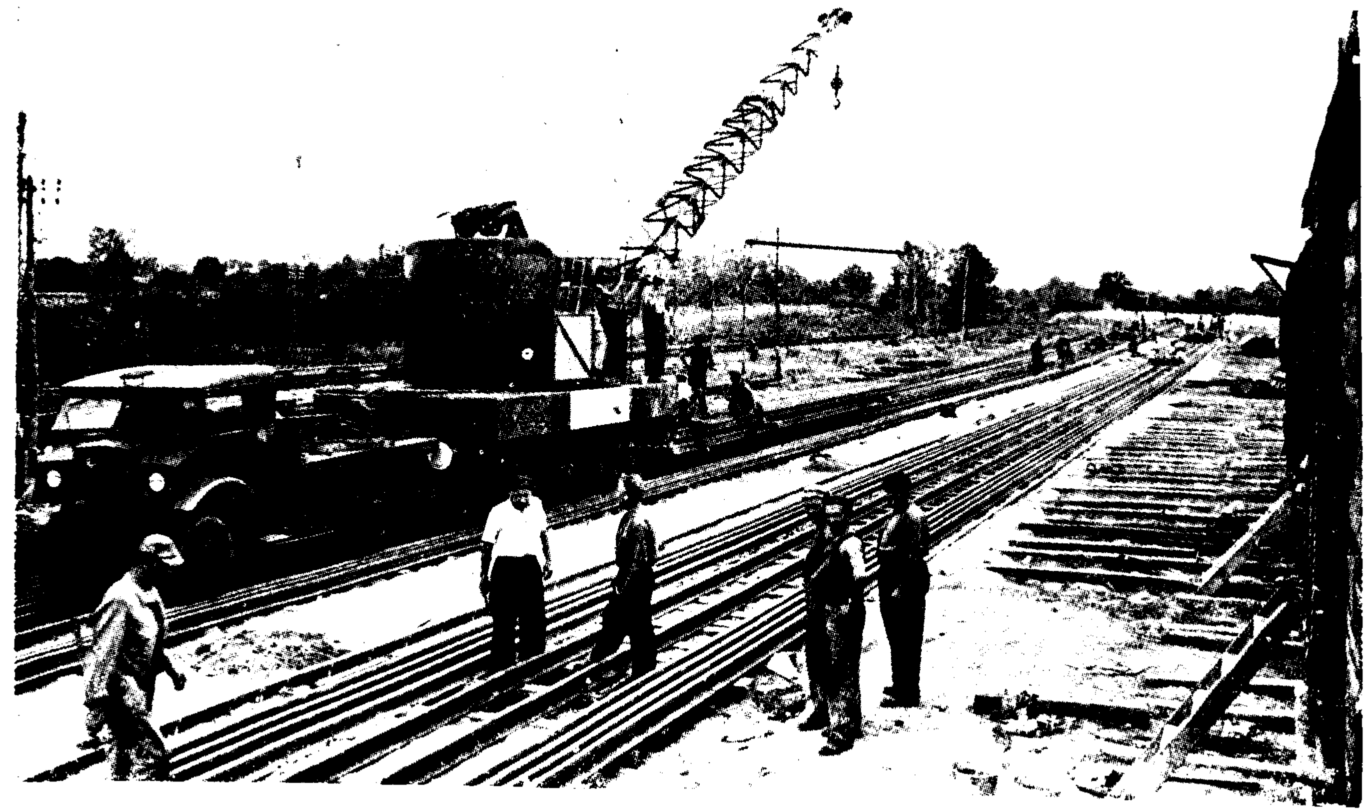


Fig. 8. High efficient set yard—an average 65 weldings per day.

Let us take for bases the conditions in which the wear test was completed by the Empa (Zurich); machine: Amsler; number of pulsations per minute: 350; distance between bearings: 1,2 m.; minimum requested: 1 million of pulsations for 15 Tons.

When the normal Aluminothermic weldings, that is with welding rim under the shoe, did not reach the minimum imposed figure, and the rupture occurred through wear at the shoe location adjacent the rim, between 400,000 and 800,000 pulsations, the type B joint, with no rim under the shoe overreached in a large extent the minimum limit, as shown in the above photograph *(Report of Empa, Zurich)*.

2. Resistance to the impact test.

The resistance of the type B joint to the impact test is also greatly increased.

A welded section tested with energized rolling; the test was interrupted after the 10 meters drop owing to the important sag shown by the section.

Another section tested with energized shoe; the result proved to be the same and the test was interrupted after the 10 meters drop, as for the prior one, owing to the important sag showed by the section.

These tests were officially completed before French and Foreign Railway Engineers.

The great resistance showed by this joint is the result of a greater homogeneity than previously:

Smelting homogeneity revealed through macrographic method, shape homogeneity through removal of hampering change in sections.

The present time results are supposed to be better still as a result of the last improvements realized by the metallurgic homogeneity.

HANDING OVER CEREMONY OF WAGONS AT OKHA

At a simple ceremony at Okha, Mr. Sherman Cooper, United States Ambassador handed over the first lot of 40 Metre Gauge wagons to India on Wednesday, 4th January, 1956. The ceremony was held in a shamiana near the Wagon Assembly Plant at Okha. Among the distinguished guests at the turnover ceremony, were Shri Naik Nimbalker, Minister for Public Works, Bombay Government, Mr. Clifford Wilson, Director of the U. S. Technical Co-operation Mission in India and Shri K. P. Mushran, Member (Staff), Railway Board.

These wagons are out of a lot of 8,730 wagons (4365 Broad Gauge and 4365 Metre Gauge) being made available to India under the Indo-American Technical Cooperation Programme by the United States of America and are being manufactured by the American Car and Foundary Company of New York. The wagons will be assembled at the Railway Assembly Plant at Okha.

Shri O. V. Alagesan, Deputy Minister for Railways accepting the wagons on behalf of the Railway Ministry thanked the Ambassadar for the help extended by the United States Government for the rehabilitation and development of India's premier transportation system.

Mr. Sherman Cooper, speaking on the occasion stated that the United States were glad to have been associated with India in the first years of its great venture in economic development. Continuing, the U. S. Ambassador stated " There is nothing new about American aid to India, just as there is nothing new about American friendship for India. In the days of your freedom struggle, the United States urged Indian independence. Since then the United States had demonstrated its interest that India should succeed in establishing economic independence. There is no doubt that India will succeed, and in your great purposes my country gives its friendship and support. The role of my country has been small in comparison to the great effort of the Indian people and that is as it should be, for it is your country."

Shri M. Ganapati, General Manager, Western Railway, thanked Mr. Sherman Cooper and the U. S. Government for their timely help and the U. S. people for this aid.

Line Inspection & Maintenance Vehicles

From a special French Correspondent

THE considerable development of Railway traffic and expansion of rail routes have made it obligatory for those in charge of maintenance of vehicles to arrange effective supervision and inspection of gauges with greater accuracy.

The Ets. CAMPAGNE (21, rue de la Voute, Paris, France) have specialised for more than fifty years in the construction of Inspection and Maintenance Vehicles which are in great demand by the world's Railways. In particular, their vast experience has enabled the manufacture of :—

1. Light and Fast vehicles for Line Inspection.
2. More heavy duty vehicles for Maintenance & Towing purposes.

These types of vehicles are in use not only over the network of French Railways but all over the world's Railways.

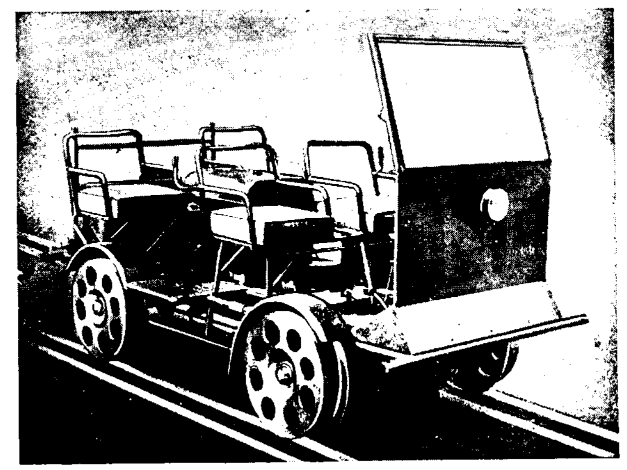


Fig. 1. Motor Lorry 2 to 4 seats—Petrol engine maximum speed 37 m.p.h. easily run off the rails.

LINE INSPECTION CARS

Motor Lorries or light draisines, powered by air or water cooled petrol engines allow the quick carrying of 2 or 4 persons at a speed of about 24 to 37 m. p. h. These vehicles can be easily run off the rails. Thus the users of these vehicles can easily make way for flowing traffic without obstructing them while on their inspection of permanent ways.

More powerful lorries carry 6, 8 or 10 persons with a light tooling equipments required for emergent repairs.

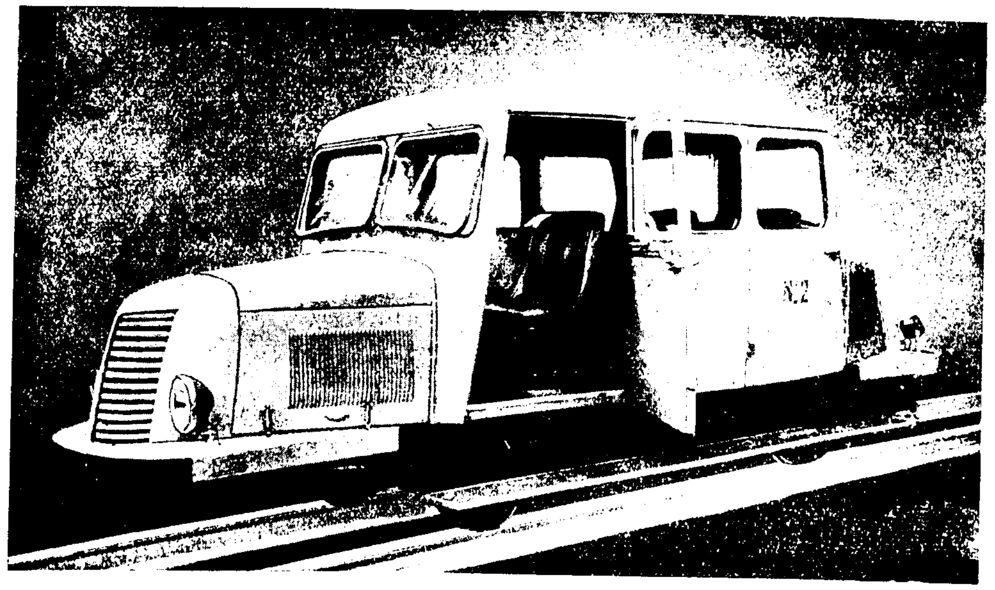


Fig. 2. Line inspection car 6 seats petrol engine maximum speed 37 m. p. h. with easy run off the rails device.

LINE MAINTENANCE TOWING CARS

In order to secure the gauges' regular maintenance, the Ets. Campagne have designed a heavy lorry allowing the carrying of persons and material. An useful load of 2 Tons of material and tools as well as the carrying of 18 to 20 workmen seated in a closed, wide and sufficiently aerated bodywork is possible.

The lorry shown in Fig. 3 corresponds to a vehicle of 7 Tons empty weight and 10 Tons full weight.

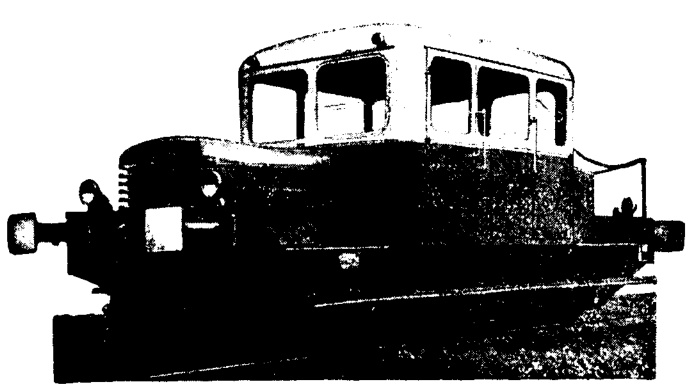


Fig. 3. Maintenance touring car—18-20 seats plus 2 tons useful load—Diesel engine 80 h.p.—Speeds from 3 to 37 m.p.h.—Total weight 10 tons.

Its maximum capacity of horizontal towing is of 40 Tons at a speed of 31 mph and 200 Tons at a low speed.

Thus the maintenance department is equipped with a vehicle which easily meets with their day-to-day requirements for line inspection.

This machine is powered by a 80 HP Diesel Engine (1800 rpm) with a hydraulic engine torque and an empcyclic gear-box.

The driver disposes of 10 speeds scaled from 3 to 37 mph in the forward and reverse transmission; that allows to adopt very accurately the power to resisting torque. The change-over to the various speeds is made in acting upon a pre-selected lever and by compressed air.

The desired speed is always accurately obtained either in changing to a higher gear or to a lower gear. The change of running is also effected by the compressed air.

The pneumatic controls to change speed-gear or increase the speed are supported by mechanical controls in the case of compressed air failure.

Transmission to two axles is made by means of strong double chain adjustable by cable-guides fitted with tensioners.

In addition there is a mechanical handbrake and an air brake on the four wheels.

All controls are reunited on Panel board and have easy access.

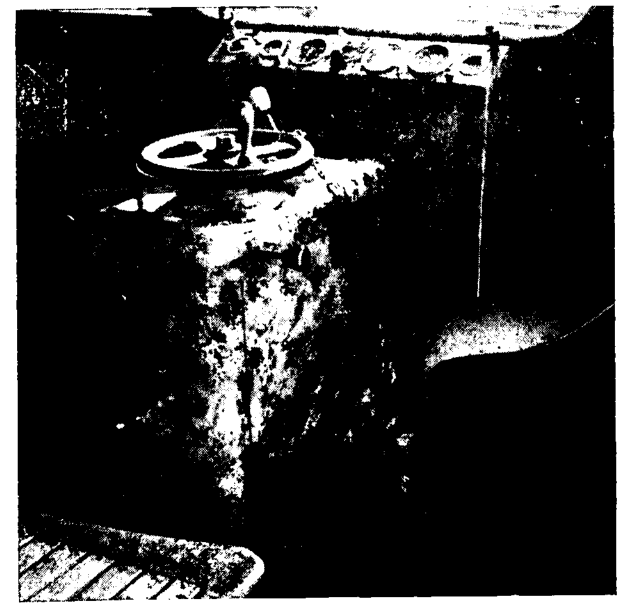


Fig. 4. View of the board control panel of a line maintenance car—In the two directions of the course, the driver disposes with a perfect visibility and with an easy access to double controls.

The driver in front of the panel board has perfect visibility of the gauge together with control devices for surveying the tract.

This railcar is fitted with a coupling similar to the one on coaches in service in addition to a special coupling system for the purpose of towing the diplorries or the triplorries engaged for the purpose of carrying sleepers or rails, for replacement purposes etc.

The bodywork consists of entirely metallic frame with "security windows". The wooden seats comfortably accommodate about 18 persons. The down glass windows secure a sufficient ventilation. A double-deck protects against Sun's heat.

At the front a metallic cowling protects the engine, in addition to securing easy access to all its components.

At the rear a platform is constructed to carry about one ton of material. On the back platform, alongside the bodywork, a box contains all the essential tools and equipments for urgent repairs.

The railcar is also fitted electrical beacons, lanterns and warning devices according to the requirements of the railway regulations. The railcar is a robust machine designed for hard and rough use and is really appreciated by the users on world's railways

In the meantime, the Ets. Campagne are specialising in the design and construction of all types of vehicles for Railways, both petrol and diesel engines of power ranges from 4 to 150 H. P.

PASSENGER AMENITIES

In regard to amenities for passengers, the Railways have a record during the past few years of which any public utility undertaking might be proud. The standard of amenities has gone up noticeably in the Third class and the passenger who now travels third can do so with a sense of dignity and satisfaction that he no longer belongs to the "forgotten class". It is true that over-crowding in trains persists on certain sections. Elimination of over crowding depends on several factors like availability of line capacity, locomotives and coaches. Getting all these is a slow process and according to the present indications, we may have to put up with the discomforts of over-crowding even during the Second Plan period. We have, however, tried to make travel more pleasant in other directions. The introduction of new integral all-steel coaches, has brought in the Third class travel a degree of comfort which can compare very favourably with the lowest class of travel anywhere in the world.

Sleeping berths for Third class passengers seemed a few years ago, something in the realm of dreamworld Introduction of this amenity in November, 1954, has indeed been a revolutionary step.

We are watching the experiment of all-Third class corridor train, which was initiated between Delhi and Howrah last October. It has also been decided to run a fast and fully Air-Conditioned corridor train from next October for First and Third class passengers.

The Reinforced Concrete Sleepers of the Vagneux System

By Paul Maille, Graduated from the Polytechnical School, President and Head Manager of the SATEBA.

THE use of reinforced concrete sleepers inceasingly goes on finding new adepts among the authorities in the field of railway technics. The SOCIETE ANONYME DE TRAVERSES EN BETON ARME SYSTEM VAGNEUX cannot help feeling a certain pride when seeing that the ideas that its founder, Mr. Edmond Vagneux, untirely has put forward and defended since 1914, have made their way and are now adopted in France as well as in other countries.

In fact, no experiment with reinforced concrete sleepers had ever been really successful, no one had led to a real utilization on a large scale, before the task was taken up by Mr. Edmond Vagneux, chief engineer of the department of "Highways and Bridges", later chief engineer of the French Railroads, creator of the system of reinforced concrete sleepers bearing his name.

The penury of wooden sleepers after the world war 1914/1918 had shown with acuteness that it was to the interest of the Railway Companies to multiply their sources of supply of sleepers and to guard against the uncertainties of the wood market by applying to the reinforced concrete. Among the many sleepers that appeared at that time, only the reinforced concrete sleepers of the Vagneux system is still in use, and with success, now for more than 30 years without interruption.

The reinforced concrete sleeper of the VAGNEUX system is well known. It is a composite sleeper, made up of two blocks of reinforced concrete united by a metal cross-beam, either steel beam I section, or a piece of an old rail, or even an old rail relaminated.

Moreover, in 1954 the SOCIETE DE TRAVERSES EN BETON ARME SYSTEM VAGNEUX has taken out a patent for a sleeper of the same type, but with axial fastening device.

This sleeper (Fig. 1), like the reinforced concrete sleeper of the VAGNEUX system manufactured since the beginning, is built up by means of a metallic cross-beam uniting two blocks, or sleeper heads, of reinforced concrete. However, in this sleeper with axial fastenings the cross-beam is a laminated iron with a special bulbous cross-section instead of the beam I PN 80/42.

Besides, the fastenings are situated in the longitudinal axis of the sleeper, two fastenings on each head, placed on each side of the rail.

Like all the VAGNEUX sleepers, these sleepers with axial fastenings can receive any one of the three types of fastening most commonly used at present by the French National Railroads for the equipment of the reinforced concrete sleepers of the Vagneux system, the pre-stressed concrete sleepers and the longitudinal stringers which they utilize:

(a) Fastening consisting of a coach-screw SC, coated with the special Maille putty and screwed into the Thiollier fitting forming nut (Fig. II).

This is the most simple and the most economical fastening device.

The fastening is perfectly adapted to tracks with heavy traffic but with moderate speed.

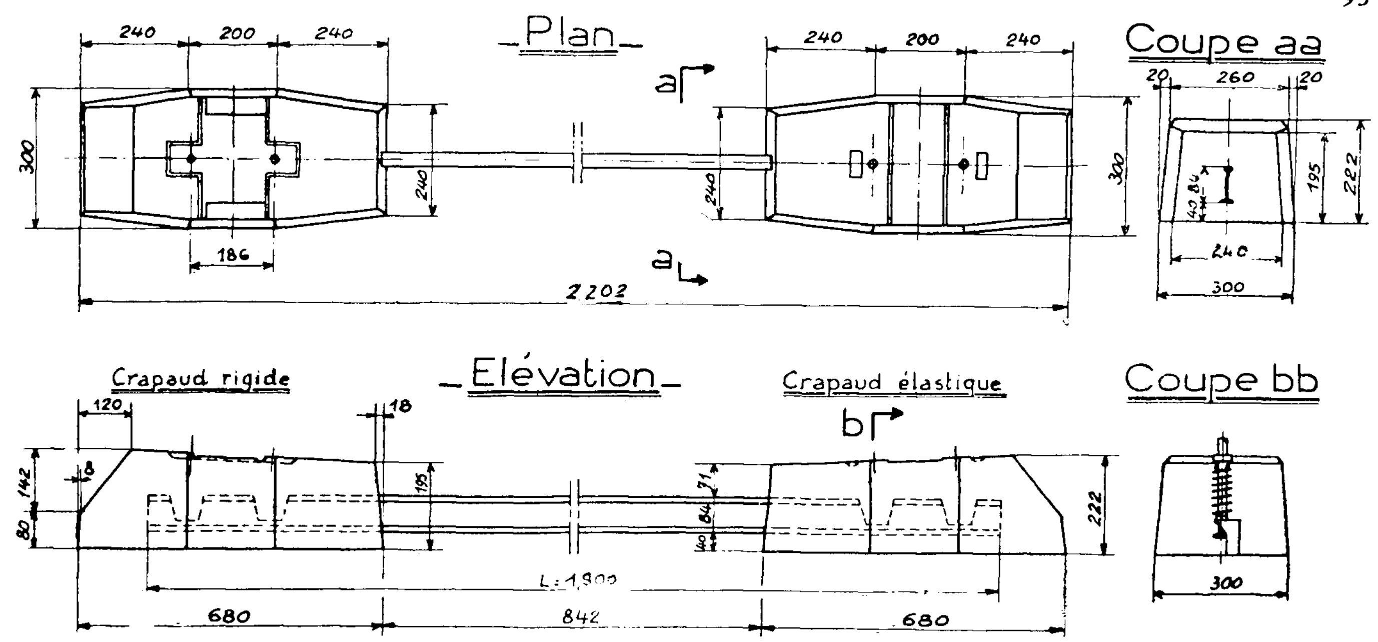


Fig. 1.

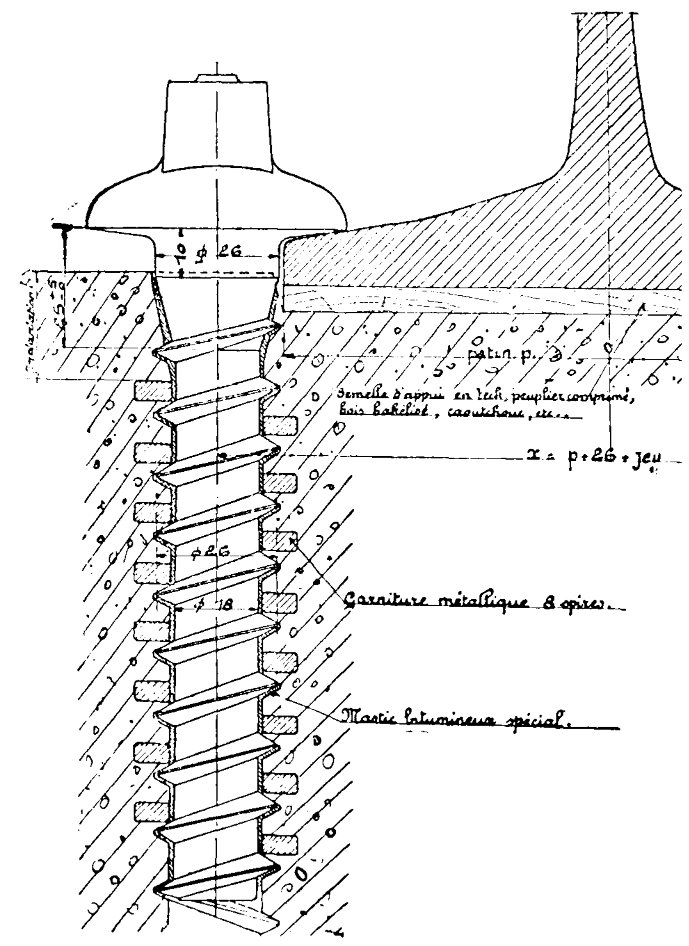


Fig. 2.

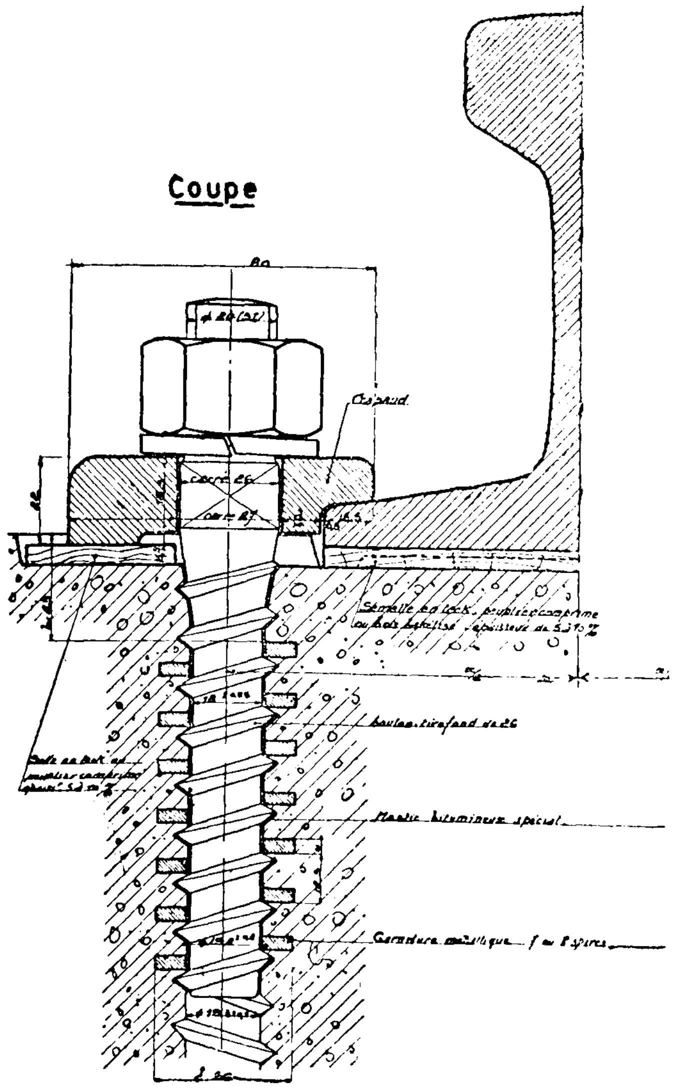


Fig. 3.

(b) Fastening by means of Vagneux bolt coach-screw and rigid clip, with sole-plate of bakelized wood or metal sole-plate (Fig. III). The Vagneux bolt coach-screw is coated with special putty and screwed into the Thiollier fittings forming nut.

The combination of different types of clips permits the realization of various gauges with sleepers of the same drilling between axes of the fastening holes).

(c) Fastening by means of Vagneux bolt coach-screw and elastic clip, with sole-plate of groved rubber. (Fig. IV).

The Vagneux bolt coach-screw is coated with a special putty and screwed into Thiollier fitting forming nut.

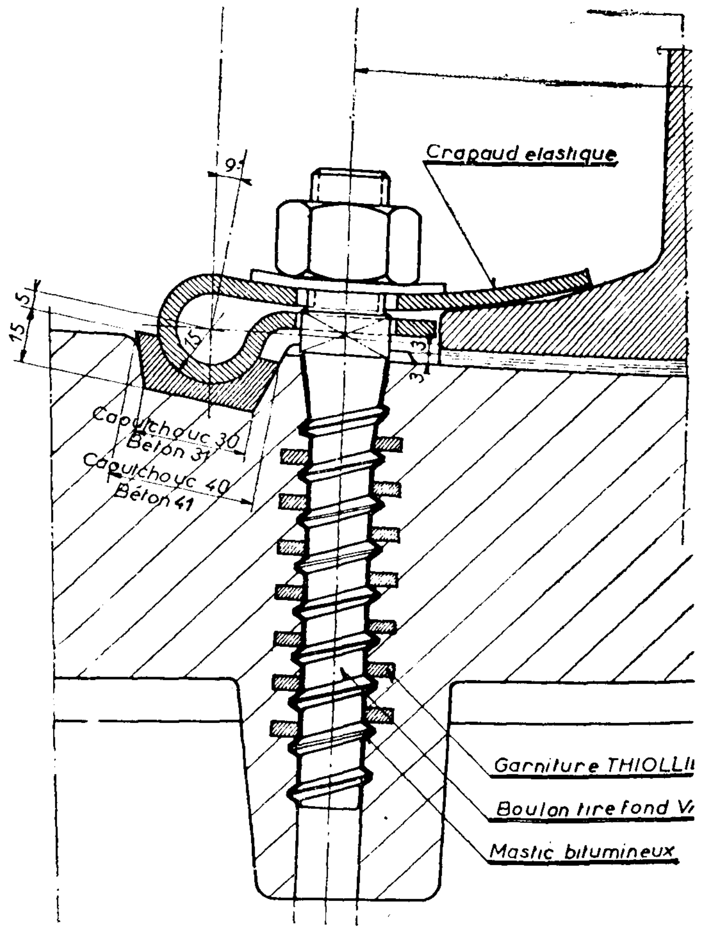


Fig. 4.

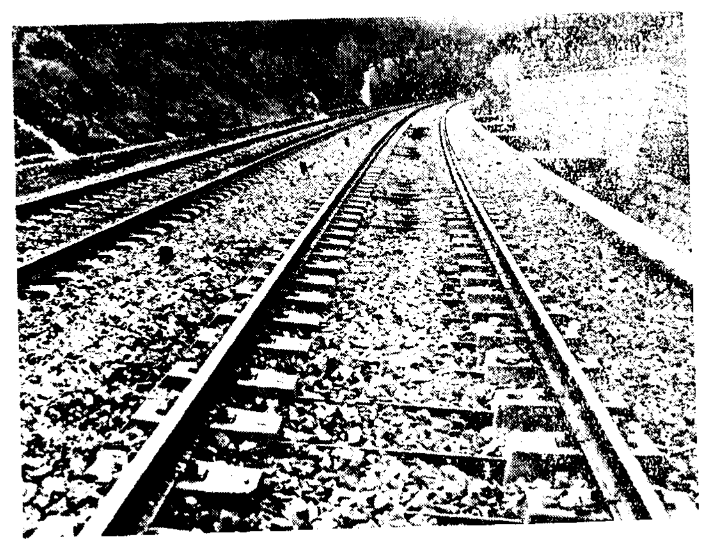
These two types of fastening, (b) and (c), are used on modern tracks with heavy and rapid traffic.

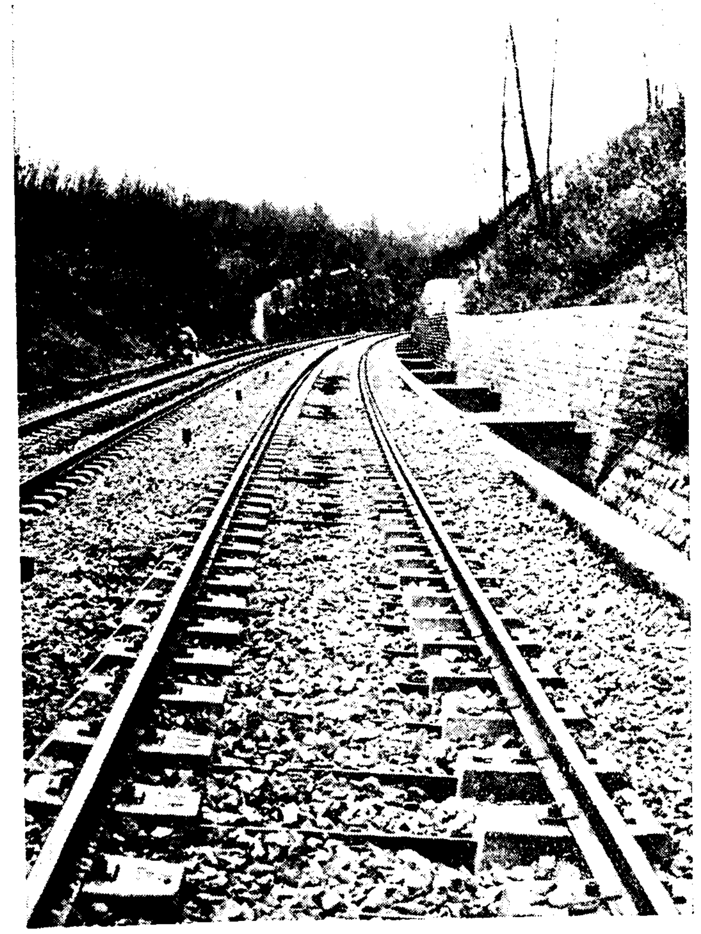
The type (c) is particularly suitable to the realisation of tracks with rails welded together forming lengths of more than 900 meters, which is the latest development in the railway technique.

As have been seen above, thanks to the various combinations which are possible with regard to the fastening of the rail, the VAGNEUX reinforced concrete sleepers can be adapted to the track to which it is destined according to the traffic conditions on the line in question.

Thus the Vagneux sleepers are to be found on lines with heavy and rapid traffic (passengers and goods) as well as on lines with slow traffic, as industrial junctions, or on tracks with very heavy traffic as harbour lines, coal mines, etc.

The two latter types of track supporting a relatively slow traffic can also be equipped with pairs of blocks not united with a metal cross-beam, alternating with ordinary

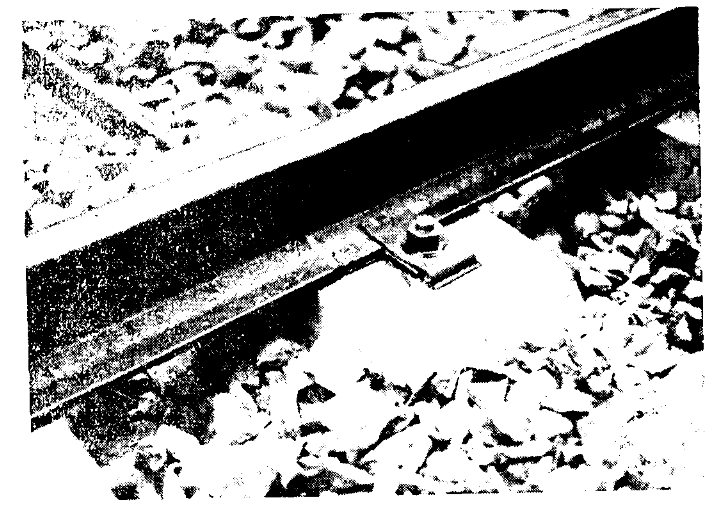




Long rails (900 m) on Vagneux concrete ties type 1954 with

"bolt-tie bolt" Vagneux, spring clip "RN" and grooved rubber-tie pads

(SNCF—DIJON to BESANCON 1955)



Fastening with "bolt-tie" bolt Vagneux spring clip "RN" and grooved rubber tie-pad on Vagneux concrete tie type 1954.

sleepers. This reduces considerably the cost price of the track in question.

The Vagneux sleeper is thus characterized by this suppleness in adapting to the traffic conditions that the track has to ensure.

To sum up, in addition to the qualities of resistance proved by the wide use of the Vagneux reinforced concrete sleeper made by the French National Railway Society (more than 2,500,000 sleepers in service, some of them since 1930 and still satisfactory), the following particularly interesting advantages are to be mentioned:

— Suppleness in adapting to the traffic conditions.

— Possibility of equipping without difference with any one of the three principal types of fastening used at present:

(1) ordinary coach-screw,

(2) Vagneux bolt coach-screw with rigid clip,

(3) Vagneux bolt coach-screw with elastic clip.

— A very reduced maintenance requiring only a minimum of labour.

— Absolute resistance against atmospheric agents, and against parasites, termites, etc.

— Possibility of manufacturing on the spot, either in an important centre or on a movable working place near the place of utilisation. The simple conception of the

Vagneux sleeper permits a fabrication that needs only a small proportion of highly skilled labour thanks to the use of a material containing all the latest improvements, manufactured by the SOCIETE DE TRAVERSES EN BETON ARME SYSTEM VAGNEUX in their own factory at Persan (Seine & Oise), France.

At the present time, when great efforts are made, or are going to be made, in the railway service in all countries either in renovating or in completing the public or private lines it is of importance to lay a great stress upon the advantages offered by the VAGNEUX sleeper, by far the most economical sleeper, because it is the best adaptable to the various subjections of the traffic and because it has the most important references.

These considerations have not escaped the attention of the technicians and railway owners who are studying the development and the modernisation of the substructure of their railway system basing their calculations on the use of reinforced concrete sleepers of the VAGNEUX system.

EDITORIAL NOTICE

Contributions are invited from the Engineering Profession in India and abroad in the form of original articles, research write-up, Summary of papers read before Technical institutions etc. relating to Civil, Electrical, Mechanical, Signal & Interlocking and Telecommunication Engineering sections and of particular interest to the Railway Engineers. Besides, suggestions for the technical improvement of various aspects of Railway Engineering Practice are also invited with suitable write-ups and photographs wherever possible.

Contributions are accepted on the distinct understanding that they are sent solely to the " Indian Railway Engineer ". The Editor accepts no responsibility for the views and statements of the Contributors.

All contributions intended for publication in any particular issue should reach the Editor at least 30 days prior to the scheduled date of publication. The Publishers reserve the copyright of contributions published in the journal and reproduction either in full or in part will be permitted only with the previous permission of the Editor.

Manuscripts should be typewritten, double spaced or legibly written on thick paper on one side only with sufficient margin on either side, with the sheets numbered in order. The name and full address of the author should appear on the first sheet of the contribution. The Editor cannot undertake to return unused Mss. but will make every endeavour to do so. Accepted Mss. are not returned. All photographs accompanying the contribution will be retained by the Editor unless there be special reason or request for their return to the writer.

ALL ACCEPTED CONTRIBUTIONS ARE PAID FOR AT OUR USUAL RATES.

EDITOR

Printed and published by S. Sundaram at S. R. Press, Tanjore, for
"The Indian Railway Engineer," 79, Jayprakashnagar, Goregaon, BOMBAY.
Managing Editor: **T. S. N. Rao.**