The Indian Railways Work Shop Magazine.

Vol-6 NO-4

August-1960.

The Indian Railways Workshop Magazine

Vetted
325

Vol. VI No. 4 ~~International, Steam,~~ Electric and Diesel Railway Traction Number Price 50 nP.

CONTENTS

	Page
Fibreglass on the Railways	1
Nohab-GM 1950 HP. Diesel-Electric Locomotive Streamliner, Two Cabs	3
BICC Group Railway Traction Research Laboratory at Tolworth	6
Diesel Engine Testing and Tuning	8
Soviet Railway Equipment News	10
Screen-Cleaning Equipment for Transport	12
The Application of Surge Injection to the Tungsten Arc process for welding aluminium and its Alloys	18
Automatic Flash Butt Welding Machines for the production of long Rails	24
High Pressures Herald a Revolution in Technology	27
The relative merits of Diesel and Electric Traction and the problems of change over—A phase of the Railway Traction Development	28
Developments with Diesel Railway Traction Engines	37
Contribution of RIV Products to the improvement of Railway Equipment	44
Modern Brake Equipment and Controls for Diesel and Electric Locomotives	52
Concrete Sleepers, Elastic Fastenings and Modern Track-laying in Sweden	60
"Pride of Iran"—General Motors World	65
Self-Contained Air Conditioning Unit for Railway Cars	69
The French Railways Locomotives with Single-motor Bogies and Two-speed Gearing	73
Italian A. B. L. Shunters	79
High Speed Diesel Engines	86
The development of rectifier locomotives with special consideration of the rectifiers	94

★

FIBREGLASS ON THE RAILWAYS

By An Engineering Correspondent

FIBREGLASS finds many applications in the transport industry; as a reinforcement for plastics, as insulation against heat and cold, and for soundproofing.

The unique properties of glass fibre make it possible, in all these uses, to provide high efficiency at minimum weight and cost.

One of the problems faced by body builders about ten years ago was a shortage of skilled sheet metal workers and body builders. Fibreglass Reinforced Polyester Resin moulded panels were the answer to this, at a lower weight, giving in addition freedom from corrosion, increased resistance to impact damage, and a substantial saving in fabrication costs compared to metal.

Fibreglass Reinforced Plastics have, therefore, found ready applications in the transport industry, first for buses and road coaches and then in railway vehicles.

The Diesel Railcars introduced by British Railways for high capacity suburban services have front and rear domes in Fibreglass Reinforced Plastics—over 2,500 domes have been made for the railcars built at Derby.

Fibreglass Reinforced Plastic domes and roof panels are also used in some of the new British Railways Type 2 Bo-Bo diesel electric locomotive units.

These reinforced plastics moulded pieces may be pigmented—white in the case of the diesel railcars to aid quick recognition; or translucent, so that light may be let in to the engine compartment of the locomotives. Hot air ductinig, instrument panels, water tanks, battery boxes, drivers and guards seats—all these items have been made in glass fibre reinforced plastics for use in diesel cars or locomotives.

One of the most interesting of all the applications for reinforced plastics has been in Railway Carriage Doors—in production by two Regions of British Railways, and giving a valuable saving in weight and cost compared with the traditional construction. Particularly important in this application are the excellent fatigue characteristics of Fibreglass Reinforced Plastics.

Derby Diesel Car showing F. R. P. dome moulded by C. & W. Works

Fibreglass insulation is also being used in considerable quantity in the new construction of rolling stock and locomotives in British Railways. Fibreglass CROWN, a new development in glass fibre production, makes it possible to make efficient preformed slabs of insulation at densities down to 1-lb./cu. ft. Applied in the wall cavities and in the roof space Fibreglass Insulation has been shown to be a most effective soundproofing, and will stand up to the most severe conditions of vibration.

In many of the diesel locomotives being built for British Railways, Fibreglass insulation is being used in both the cabs and the engine compartment. Particularly interesting is the use of Fibreglass Navy Board, a glass fibre slab faced with its own glass cloth lining, in an ultra-lightweight, sound absorbing and sound insulating construction.

(Continued on page 7)

NOHAB-GM 1950 HP DIESEL-ELECTRIC LOCOMOTIVE STREAMLINER, TWO CABS

By An Engineering Correspondent

SINCE 1865, when the first steam locomotive left the works of Nydqvist & Holm Aktiebolag, rolling stock for the railways in the form of locomotives, railway coaches and wagons has been one of that firm's foremost lines of manufacture.

During the past years, locomotives have been supplied to a great number ef countries. After the first world war, the largest order in the history of the locomotive industry, was received from Russia, and 500 locomotives were delivered from Trollhattan during the years 1921—1924. Two years later an order was received from Turkey for 100 locomotives and 1500 coaches. Other large orders have been received from the Argentine, Persia and other countries.


Lowering the car body of a NOHAB-GM diesel-electric locomotive in the NOHAB shops.

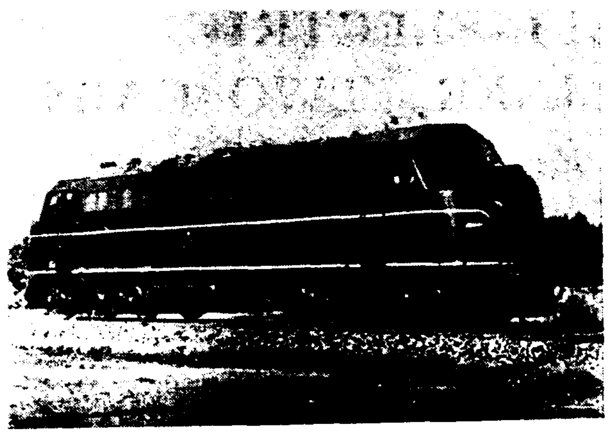
At NOHAB, as the firm is generally called, the locomotive designs have developed in pace with the requirements of the times.


NOHAB-GM diesel-electric locomotives being manufactured in the NOHAB shops.

The first electric locomotive built by NOHAB was supplied as early as 1897.

NOHAB has long been interested in diesel locomotives. An agreement was made in 1950 with Electro-Motive Divion, (EMD), General Motors Corporation, (GM), USA, covering the manufacture of diesel-electric locomotives. Through this agreement NOHAB was offered the delivery of EMD's well-known and well-tried diesel engines and electric equipment. Diesel-electric locomotives using these components were introduced in Europe by the Danish State Railways, DSB, who ordered four locomotives from NOHAB. The first of these locomotives was supplied in February, 1954.

Thanks to the good test results and later based on experience with the first four locomotives, DSB estimated that they saved 678,000 Danish Crowns (£ 35,300:— $ 97,900:—) per locomotive per year as compared with steam locomotives of the same size. On this basis, operation of these locomotives resulted in



One of the NOHAB-GM diesel-electric locomotives, delivered to the Danish State Railways.

savings over a two and a half year period equal to the purchase price of the locomotives.

As per the latest information from the Danish State Railways, the savings which have been attained, only with regard to fuel costs, imply a yearly reduction of about half-a-million Danish Crowns per locomotive.

Due to the operating economy of the locomotives and their reliability in operation, DSB have placed another three orders with NOHAB for a total of 85 diesel locomotives. After one year's test run with a NOHAB-GM locomotive the Norwegian State Railways, NSB, found it so robust and reliable as well as economic that they decided to introduce 22 such locomotives on their most exacting lines.

In Belgium a large number of diesel locomotives of this type have been manufactured to NOHAB's design.

Also the Swedish State Railways have been supplied with diesel-electric locomotives of the NOHAB-GM type. These are of the road switcher hood type rather than the streamliner type supplied to DSB and NSB and, although smaller and lighter, they have proved to be capable of handling all tasks assigned to them. Thanks to the good results, obtained by the first NOHAB-GM locomotives on the Swedish State Railways, NOHAB received a repeat order for 25 locomotives of the same type.

TEN NEW HYDRO-ELECTRIC STATIONS

The USSR will build 10 more big hydro-electric power plants, in addition to those envisaged by the Seven-Year Plan to keep up with the rapid advance of the national economy, and of the heavy industry particularly. The total capacity of the new electric stations will run into 10 million kw.

At the power plant designing administration, it was learned that one big hydro-electric station will be built on the Vakhsh River, near the city of Stalinabad, capital of the Tajik Republic. The station will have the world's tallest dam—300 metres high.

The blueprints have been completed for a hydro-electric station that is to go up near the city of Cheboksary on the Volga. It will be the third largest project on the Volga, after Stalingrad and Kuibyshev. This station's annual output will equal practically the total production of all the electric stations in tsarist Russia in 1913.

⁂ ⁂ ⁂

AUTOMATIC CHECKING MACHINE

The Kalibr plant in Moscow is a major supplier of control and measuring instruments. So far a big army of checkers are working in the national economy. However, in many places this responsible and painstaking job has been taken over by automatic machines bearing the Kalibr plant's trade mark.

Recently a test model of an automatic electronic checking machine which measures and sorts out high-precision bearings was manufactured and delivered to the bearing industry. One such machine replaces ten checkers. Another important work of the factory designers are standard units for automatic checking machines. This will make it possible to design and launch serial production of such machines much faster.

⁂ ⁂ ⁂

MACHINE FOR PATTERN MAKING

Pattern making is one of the most labour-consuming jobs in foundry work. Highly skilled pattern-makers have to perform a great deal of work by hand. The Institute of Woodworking Machinery decided to try and improve on the work of pattern-makers. A group of research workers together with rationalizers and engineers of the Stankolit plant has produced an automatic unit for cross-cutting sawed timber. Recently two such units went into operation at the plant's pattern-making shop.

EDITORIAL NOTICE

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

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

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

All published contributions are paid for at our usual rates.

Editor

BICC Group Railway Traction Research Laboratory at Tolworth

THE BICC Group designs, supplies and installs overhead electrification equipment for British Railways as well as railway modernization schemes in overseas countries and has naturally, in this field of its activities, a special interest in the mechanical problems peculiar to the operation of such equipment. Foremost among these is that of achieving absolutely uniform current collection from a static overhead wire traversed by a pantograph mounted on a moving train.

The problem arises because the contact pressure between the two components is continually changing. This has been recognized for a long time, but it becomes more important as higher supply voltages and, hence, lighter overhead wires are used, and as running speeds increase.

For information on the performance of his equipment, the designer has hitherto had to rely almost entirely on observations made on the actual railway track but such observations are difficult, lengthy and of limited accuracy. The BICC Group has, therefore, augmented its already extensive research facilities by setting up a new laboratory designed specifically for research of this nature by means of a scale model capable of reproducing faithfully all the dynamic mechanical characteristics of the full-scale equipment at simulated speeds up to at least 100 m. p. h. Believed to be the only one of its kind in the World, this model has been operational for some months in the laboratory at Tolworth, which was visited by the overseas delegates to British Railways Electrification Conference.

The laboratory housing the models measures about 200 feet by 20 feet. The track is in the form of a closed loop with two straight sides 144 feet in length and closing curves 14 feet in diameter. The middle parts of the straight sides, the actual test sections 80 feet in length, are enclosed and temperature controlled. A trolley, about 12 inches long, driven by a 50-volt d. c. motor supplied with current from the rails, is used as a vehicle for the pantograph and the necessary instrumentation. The motor is underslung to lower the centre of gravity and avoid the risk of derailment at the curves. The scale of velocity is such that an actual train speed of 100 m. p. h. is represented by a model running speed of nearly 18 m. p. h.

The model pantograph follows closely the articulated design of the prototype. Each member was designed with the correctly scaled bearing length and approximately the correct centre of gravity, but with a lower mass than required. The necessary additional mass was then added by two separate weights which were so positioned that each member possesses the correct centre of gravity and moment of inertia. The two working springs are steel helices and the springing of the pantograph head is achieved with leaf springs.

The three arrangements of overhead equipment—simple catenary, compound and stitched catenary—which have been designed and are being installed by BICC for the British Railways 25 kV a. c. system are being reproduced. The solid contact wire and the stranded catenaries are represented by fine wire on which closely spaced cylindrical beads are fixed to give the correctly scaled mass and elasticity.

In all, more than 300 beads are used in each one-foot length of model contact wire so that there was a considerable manufacturing problem. Similarly, the assembly operation was a tedious one requiring a high degree of precision and patience. Every 6-foot length was tested for extensibility and flexural rigidity, after which the separate lengths were joined, with a bead covering the joint position so that mechanical uniformity was preserved throughout. The droppers were also manufactured from wire carrying beads or fractions of beads.

The first form of support to be studied is the "hinged cantilever", consisting of a diagonal strut tube supported from porcelain insulators by a stranded tie-wire and hinged at the vertical mast. The upper end of the strut tube holds the main catenary, the auxiliary catenary and contact wire being attached to hinged "registration" and "steady" arms. The latter, which can move independently of all other hinged members, are arranged to be always in tension and are reserved at alternate supports to give the necessary stagger of the contact wire. The inertial mass and distribution of mass are scaled in the model.

Position, velocity and acceleration of the pantograph trolley are essential data which must be known at all times. These are gathered from devices which feed back high frequency signals to a receiver from a transmitter carried underneath the trolley. The transmitter aerial consists of two underslung flat plates spanning a receiver aerial wire carried by the supporting structure.

The movements and displacements of the wires in the model are measured in several ways which may be used separately or in combination; they are either optical or electrical. The optical methods are high speed cinematography, and a method which registers the position of a wire by casting a shadow of it on to a photo-sensitive device. The favoured electrical method employs a capacitive coupling to a high frequency signal carried by the model wires. The results of the last two methods, together with signals from the trolley instrumentation, are simultaneously displayed on a multi-trace oscilloscope with recording camera, or on a multi-channel chart recorder.

Practical experiments have been in progress at Tolworth for only a few months but, already, considerable progress has been made. Results so far achieved show that the method of approach to the problem is the correct one and BICC scientists are hoping that their findings will soon be guiding the design of improved overhead equipment for all forms of electric traction.

INDIANS INSPECT BRITISH ELECTRIC LOCOMOTIVES

Two Indian visitors, Mr. P. N. Murti (left) and Mr. P. C. Kapoor, inspecting one of the British electric locomotives on show at the British Railways' Electrification Exhibition in London, England, recently. The exhibition was held in conjunction with British Railways' Electrification Conference, which was attended by delegates from many parts of the world.

The aim of the exhibition and conference was to show overseas railway administrators what is being achieved in the United Kingdom in the electrification of railways by the A.C. system at 25,000 volts 50 cycles (that is by electricity taken from the domestic grid at the standard frequency) and to demonstrate the advanced locomotives and electrical equipment now being produced in Britain.

The exhibition was the most comprehensive assembly of specialised A. C. railway electrification equipment and electric rolling stock ever displayed in the United Kingdom.

(Continued from page 1)

The many properties of Fibreglass products, particularly in reinforced plastics, but also in the less spectacular field of thermal insulation and soundproofing, will find still further applications in all forms of transport.

Possible uses for Fibreglass Reinforced Plastics in the future include carriage seating, one-piece translucent roofs for parcel vans, and prefabricated toilet units. Insulated Containers and fish boxes made entirely of Fibreglass Reinforced Plastics have been found very successful due to their low weight, high impact strength and resistance to corrosion. And ultimately we may see the whole railway carriage, fabricated in two halves, with both inner and outer skins of reinforced plastic in a sandwich construction.

Diesel Engine Testing and Tuning

EFFICIENCY IN COMBUSTION

THE efficiency of the diesel-powered locomotive depends largely on correct fuel combustion. The factors governing this are the correct operation of the fuel injection system and sufficiently high compression in the cylinders. If either of these factors is not correct combustion will be incomplete, with a consequent loss of engine power, wastage of fuel, emission of smoke, uneven running, excessive vibration and engine noise, a tendency to stall when idling, difficult starting and engine wear.

The fuel injection system depends for its proper operation on the pump which accurately meters the exact quantity of fuel required and at the correct moment delivers it to the injectors at the necessary high pressure for correct atomisation. It also depends on the injectors which open at a given pressure and distribute the fuel in the cylinder in the form of a fine spray. The intimate connection between pump and injector means that no engine can be considered correctly adjusted when the injectors have not been balanced to the pump in question under true operating conditions.

Diesel engineers have long recognised that the ideal method would be to set injectors to the fuel pump dynamically—that is to say on a running engine rather than on a neutral hand pump, where many vital factors differ.

IMPORTANCE OF DYNAMIC SETTING

Electronic Testing: the Research Departments of most up-to-date diesel engine manufacturers are now establishing recommended injection pressures on prototype engines by the dynamic method. The Oscilloscope can also carry out tests on the fuel pump under operating conditions. But with the introduction of up-to-date maintenance instruments the testing and resetting of injectors and the testing of pump elements and delivery valves can all be carried out dynamically on the engine in all maintenance workshops. The fact of testing under true running conditions means that faults can be accurately and quickly traced without unnecessary removal of the various components of the fuel injection system, with a consequent saving of man hours, load time, demurrage and specialist charges.

When an engine is set up and corrected dynamically it will be found to show an increase in power and engine life, smoother running, improved fuel consumption and no smoke.

Bench testers have fixed diameter plungers which cannot be altered to suit the various sizes of plunger fitted to different types of engines. But when testing injectors on the engine the correct element or plunger is used. Also different fuels will give slight differences in nozzle setting pressure and therefore by using the normal fuel on which the engine is run this difference is eliminated. Temperature changes are non-existent when injectors are adjusted with the engine running as the injectors are at normal working temperature. Finally, under working conditions the operation of an injector is affected by the following factors which are not present under bench testing: the condition of the delivery valve seat, the cut-off of the delivery valve and the condition of the plunger.

Smoke in a diesel engine is a sign of inefficiency. Only an efficient diesel engine will give the maximum advantages which the more efficient fuel combustion has to offer—greater power, longer engine life and more m. p. g. at less cost. By eliminating the wastage of unburnt fuel indicated by black smoke fuel bills are automatically reduced.

It should be noted that a worn injector needle can produce a solid stream of fuel instead of a good fine spray, resulting in poor or bad atomisation—there then being too much fuel to be dealt with by compression in the cylinder. Excessive noise if often accounted for by injection pressures being too high.

Maintenance equipment offering dynamic tuning and on-site fuel pump fault-location is the modern answer to inefficiency in diesel operation, securing rapid, accurate maintenance and peak performance to every diesel operator in all fields.

Soviet Railway Equipment News

By N. Zakharov

New Gas-Turbine Electric Locomotive

THE gas-turbine electric locomotive is a new development in motive power. It has a number of advantages over the other types of locomotives. For instance, when compared with a diesel electric locomotive of the same rating, it shows the advantage of smaller overall dimensions and weight per one horse-power.

The gas-turbine which is the heart of the new locomotive makes 8,500 r. p. m. and develops 3,500 HP, burning inexpensive types of fuel, including mazut.

The gas-turbine electric locomotive is fitted with remote push-button control installed in the driver's cab.

The rated speed of the new locomotive is 100 km per hour. It can haul trains weighing 2,200 tons.

This gas-turbine electric locomotive has been built at the Kolomna Diesel-Electric Locomotive Plant (RSFSR).

NEW BATCHING HOPPER CAR

Ballast unloading and filling of tracks is one of the most labour-consuming operations carried out by tracklayers and railway construction engineers. To mechanize this job, special rolling stock, the so-called batching hopper cars, has been designed and is now being mass-produced by the Steam-Engine and Car-Repair Works in Velikiye Luki (the Russian Federation). The first two ballasting trains each consisting of 20 allmetal batching hopper cars have left the works' yard.

When being unloaded the ballasting train moves at a speed of up to 5 kilometres per hour. By using special batching devices mounted on each car, the laid ballast bed depth can be varied from 15 to 30 cm.

Mechanization of ballasting yields a large saving. It has been estimated that the use of batching hopper cars cuts the expenditure of labour for overhaul of one kilometre of track by 133 man-days. Besides this, unloading losses of crushed rock, gravel and sand are greatly reduced and conditions are being created for the integrated mechanization of track-laying work.

"GI-OI" gas-turbine locomotive produced by a plant in Kolomna.

This year the works will produce 500 such batching hoppers.

MACHINES FOR ERECTION OF COMMUNICATION POLES

The Alapayevsk Machine-Building Works (RSFSR) has started the production of crane-type boring machines, for installation of communications line poles. The boring machine and crane are mounted on a truck and are actuated by a hydraulic system. Two driving axles allow the truck to move across swampy ground at a speed of 60 km. p. h.

Working by hand, a 14-man crew can erect no more than 5 or 6 poles per shift. The crane-type boring machine raises the productivity to 50 reinforced-concrete poles per shift. Only 3 men are needed to operate the unit.

PAINTING AND DRYING INSTALLATION

The Kharkov Railway Car Repair Works (Ukraine) has developed an experimental painting and drying installation. It comprises two separate production lines on each of which two all-metal railway coaches can simultaneously be painted.

On both sides at the entrance to the drying compartments there are special platforms from which two painters, using airgun paint-sprayers, paint the walls of the coaches which slowly move on a conveyor into the compartment. By pressing a button the painter adjusts the height of the platform. Nearby there is the exhaust ventilator system to draw off the air polluted with the solvent fumes.

The coach is thus moved inside the drying compartment for one hour during which time the entire painting process is completed.

The painting and drying installation is controlled by one operator, who regulates the coach movement, closes and opens the drying compartment gates and controls the ventilators and motors. The control desk is fitted with a "talk-back" facility (a telephone-microphone communication line), enabling the painters to report on the completion of the painting and the full entry of the coach into the drying compartment.

The compartment gates close automatically after which steam is introduced and hot air is forced through heater batteries into the compartment by powerful fans. The temperature in the compartment is raised to 70-80 degrees Centigrade and the car is dried out in two hours.

During this time preparatory work is done on the next coach, and the one that has moved out of the compartment gets numbers, the railway owner code and the decorative strips.

Leclanche Type Dry Batteries

The Indian Standards Institution has recently published IS: 586-1959 Specification for Leclanche Type Dry Batteries for Telecommunication, Signalling and General purposes (Revised). The standard prescribes the dimensions, tests and performance requirements of Leclanche type cylindrical dry batteries of nominal voltage of 1.5 V and intended to be used for telecommunication, signalling and general purposes under the climatic conditions prevailing in India.

This standard is a revision of the same specification published in 1955. The revision has been done in the light of experience gained during the currency of the standard. The following are the main modifications :—

(a) The designations of batteries have been modified to conform to IEC practice.

(b) Tests and requirements have also been aligned with the IEC Recommendations, as far as practicable.

(c) Definitions of terms originally included as part of the standard have now been deleted. These definitions have been covered in a separate standard, namely, IS: 1025—1957 Glossary of Terms for Primary Cells and Batteries.

(d) Reference to internal constructional details of the cells has been deleted.

(e) The rated life and performance requirements under delayed continuous discharge test have been slightly raised in the light of experience and progress in the manufacture.

Screen-Cleaning Equipment for Transport

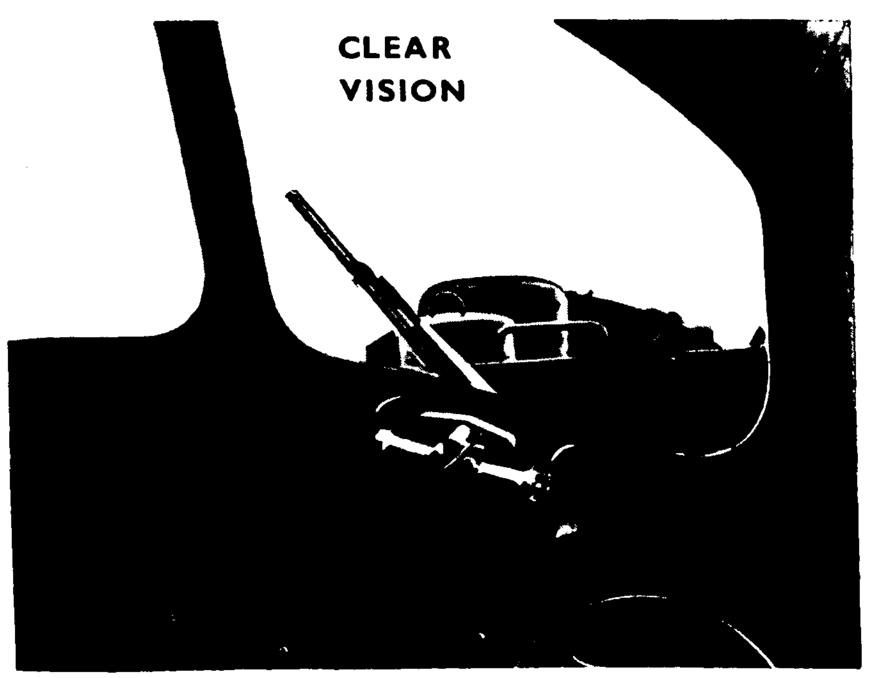
By An Engineering Correspondent

ONE of the essentials of any form of transport is optimum visibility. When the driving compartment was enclosed to improve the comfort of the driver of road vehicles, attention had to be given to keeping the front window free from rain, snow and fog. Thus, the windscreen wiper has become one of the essential components of a road vehicle, and its design and manufacture a complete technology of its own.

One of the foremost companies in this specialized field is Trico-Folberth, Ltd., Great West Road, Brentford, Middlesex. This company manufactures a complete range of parts and accessories for windscreen wiping, including motors—electric, vacuum and air pressure—linkages, arms and blades of all types. Originally, the greatest interest in efficient screenwiping was vested in the passenger car, and here the demands of styling led to the solving of many unusual problems. There has been a tendency in the case of heavier vehicles to regard the screenwiper as an afterthought, brought out and fitted without great consideration. However, the advent of more advanced cab designs has been accompanied by new thoughts on maintaining the improved visibility provided by these designs. The windscreen-wiper manufacturer is now consulted at the design stage so that the best possible cleaning action can be provided.

In this way, Trico engineers have been able to apply their knowledge to heavier and heavier vehicles, acquiring new techniques at the same time. Thus, when modernization of the British railways system commenced, and locomotives with enclosed cabs and railcars were produced, Trico were in a favourable position to supply the very essential equipment necessary to supply the driver with a clear view. From a small start this field of activity has grown until it is a sizeable section of the business. Trico equipment is fitted by most British locomotive and railcar manufacturers, and some continental producers. Many of these locomotives have been made for use in overseas countries.

At first locomotive engineers, used to massive construction, were somewhat sceptical of the light construction of Trico motors and arms, but experience showed that these components more than exceeded their estimated life and performance. Trico engineers are now called in at an early stage in the planning of a new design and are able to suggest the best motor location, the appropriate linkage, length of arms and



View from the cab of a type 4 2,000-H.P. diesel electric locomotive showing Trico FPK compressed air windscreen wiper motor.

blades, and so on. Another fitment necessary for the provision of adequate visibility under all conditions of operation is the screenspray, and Trico have developed an air-pressure operated heavy-duty unit to accompany the compressed-air windscreen wiper motor which is widely used for locomotive work.

The £ 1,500 million modernization scheme of British Railways includes the electrification of many lines as well as the provision of diesel and diesel-electric locomotives to replace steam, and speeds of over 100 m. p. h. (161 km. p. h.) are contemplated on main lines, which have introduced many problems. The experimental and development resources of Trico-Folberth, Ltd., have been used freely to design suitable window-wiping equipment to operate satisfactorily at such high speeds and in addition, to provide a steam of water to remove track dust that is deposited on the glass by the air turbulence created in tunnels by passing trains.

Locomotives Nos. 10201—2—3 were the first diesel-electric type built by British Railways at their Ashford Works in 1950 and the driver's cab had windows which were curved in the horizontal plane. Suitable wiper units had to be found which complied with the following conditions :

(*a*) to give adequate vision to a short driver sitting down.

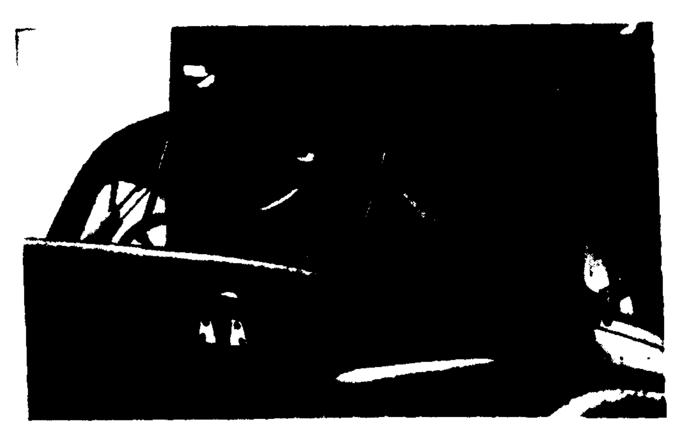
(*b*) to be equally satisfactory for a tall driver standing up.

Nine years ago this was a formidable proposition, and with the co-operation of the Chief Mechanical and Electrical Engineer's Department of the Southern Region of British Railways a complete window was brought back to the Trico works for the development of a suitable wiping movement.

It was evident that with simple arcuate motion a curved blade would be necessary but for traction speeds of 90 m. p. h. mechanical strength of the blade was an essential requirement, such as would be provided by a strong one-piece straight blade. Examination of the glass itself showed a slight curvature in the vertical plane due to the heat treatment of the glass when formed, but this condition could be met by the design of a suitable rubber moulding which would allow the trailing edge of the rubber to follow the slight deviation from a straight line in the vertical plane. The blade was maintained in a vertical position throughout its travel by the adoption of pantograph motion for the wiper arm, and with the introduction of a completely new compressed-air-wiper motor into the Trico range it was found that all conditions of operation had been met subject to high-speed trials proving satisfactory.

When the first locomotive went into service it was found that there was a tendency for the blade to lift from the glass at speeds in excess of 65 m. p. h. (105 kmp. h.) caused by the massive displacement of air created by the comparatively broad front of the locomotive which did not have the aerodynamic styling which has proved so advantageous in the modern car. In addition, the outward thrust of the arm and blade caused by wind pressure at high speeds was unlike anything experienced before with cars or commercial vehicles and, to overcome this effect, pneumatic controls were introduced into the motor

Crossley left-hand drive coach with Trico wipers in an unusual "Diagonal" arrangement.



On a snow-plough supplied by all Wheel Drive, Ltd., compressed air powers the wiper arms on the Quarter-screens.

to restrict the movement at the end of each stroke so that the operating unit was well-behaved even at high traction speeds. Further development was then given to the arm to increase the spring tension sufficient to overcome the lifting effect, but the limit was reached when it was found that the arm-piece itself curved under this heavy tension so that most of the pressure was lost. A completely new arm design was indicated, with the adoption of Tee-section high-grade steel for the arm-piece and a positive attachment of the arm head to the output shaft, and this took the form of an accurately-dimensioned tapered coupling with a fine-pitched knurl. As this could not be sufficiently accurately machined, an iron sintering process was used and subsequently found to be most satisfactory after a few early failures.

By this time it was realized that most of the problems associated with locomotive work had been overcome, but it was evident that very careful planning of each wiper installation would be necessary, with full consideration being given to :

(*a*) maximum operation traction speed.

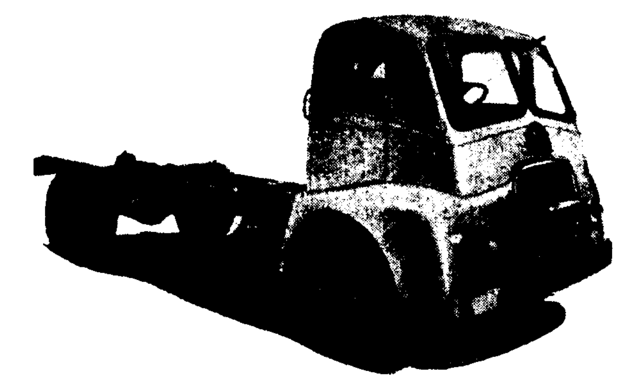
(*b*) aerodynamic features of cab styling.

(*c*) if curved windows were to be used they should only be curved in the horizontal plane.

(*d*) nominal arc of wipe of wiper unit when measured on a stationary test bench was not indicative of the true arc of wipe when affected by wind pressures at high high speed.

Failure to observe these essential requirements of operation, in the opinion of Trico engineers, would cause trouble in service and the necessity of careful design has been confirmed by the large number of locomotives that have been fitted with pantograph arms and suitable blades which operate quite successfully at speeds of over 90 m. p. h. (145 km. p. h.). However, all locomotive windows are not approximately square in shape, which is the ideal proportion for pantograph motion, and bonnet-type locomotives invariably use windows shallows in height and of considerable width. This led to further developments in wiper design for fitting to the prototype 3,300-h. p. diesel-electric locomotives designed and built by the English Electric Co., Ltd., which is now in service on British Railways.

These windows, which had some similarity to those of a car, were provided with two wiper arms and blades operated by a single power unit, but as the shape was not truly rectangular and sloped to a shallower depth at each side, differing lengths of arms and blades were used on each pair of wiper shafts which were coupled to the driving-motor mounted



Guy warrior cab equipped with two TPM compressed air motors and screenspray.

between. A very compact unit was finally produced, operated by compressed air, which proved highly satisfactory at the high speeds which this well-known locomotive achieved. Twenty-two more of these locomotives have now been ordered by the British Transport Commission.

In this application the destructive effect of wind pressure at speed was made evident by the rapid wear on the mechanical parts of the linkage mechanism and, contrary to car practice, which uses resilient bushes at points of movement, metal bearings were found to be essential with limiting controls to counteract the sideways thrust on the arm and blade at high speeds.

A large number of Type 2 A1A-A1A diesel-electric locomotives built by the Brush Electrical Engineering Co., Ltd., are now in service on the British Railways. One corner of the cab window has been reduced by an angle and, as a consequence, a pantograph wiper action would have restricted movement. Maximum window coverage was provided by selecting a corner position for the wiper motor and with single-arcuate motion gave excellent vision to the driver through the required angles of observation. These locomotives are also fitted with compressed-air windscreen washers with the jet position towards the inside lower corner so that the water spray is assisted across the window by the natural air flow of traction movement.

Window wipers for diesel railcars and electric motor coaches do not require the same serious consideration of design, as speeds exceeding 70 m. p. h.

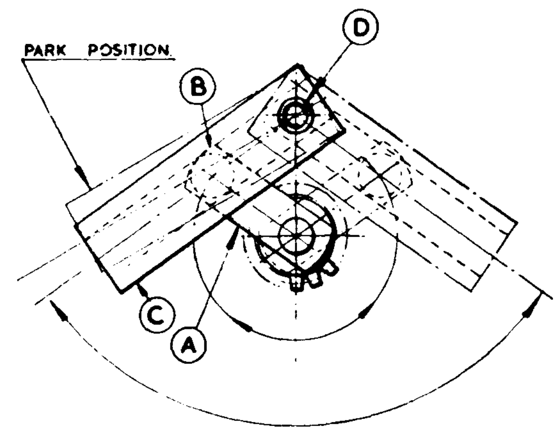


Diagram showing the driving of the FPK motor

a. Driving lever. b. Roller bearing.

c. Driven lever. d. Output shaft.

are seldom achieved. Invariably, pantograph motion for the wiper movement is decided upon, as generally the windows are narrower in width than in height, with vertical sides. A bold radius at each corner is not desirable if maximum width of pantograph motion is required as well as the highest possible wipe of the window. It will be appreciated that if the windows are left perfectly square at the top corners it will be possible for the top of the blade to enter these corners fully so that the maximum travel of the blade would coincide with the maximum width of the window. Allowances would have to be made for manufacturing tolerances and slight discrepancies in fitting, but in theory maximum wiping efficiency would be obtained with such a design of window, especially if height of wipe is considered important.

A most unusual application of window-wiping occurred during the design and construction of the prototype British Railways track-recording coach, built by D. Wickam & Co., Ltd., and equipped by Elliott Brothers (London), Ltd., in conjunction with the British Transport Commission's research and development engineers. In addition to the traditional window-wipers at each end of the coach, one particular side window was required to have similar treatment, necessitating an exceptionally long pantograph arm. The purpose of this window was to observe track conditions in all kinds of weather and, although high speeds were not possible with a 55-m. p. h. (89-km. p. h.) max, limited to 30 mp. h. (48 km p. h.) when operating, the unequal thrust of wind pressure on the side of the coach would have overloaded the whole mechanism unless consideration was given to the wiper design.

In this instance, tests were carried out reproducing operating conditions as far as possible and which confirmed first thoughts that special modifications to the wiper motor would be necessary. These took the form of a spring-loaded air restriction in the exhaust system of the motor so that any acceleration of a rear-ward travelling wiper stroke would cause an increase in back pressure in the exhaust air and so create a braking effect. The spring was included to permit foreign matter obstruction to be expelled when the exhaust pressure was sufficiently high. The whole arrangement proved to be exceptionally smooth-working and self-compensating even for such a severe application of window wiping.

Compressed air for the operation of auxiliary devices on road and rail vehicles has undoubtedly proved its many advantages when an abundant supply is available, as is usually the case on most forms of rail stock, but it is not always realized that the power derived from such a source is a product of volume as well as pressure. Volume, as represented by a closed cylinder, is allowed to expand by a piston which is free to move under the pressure applied to its operating head and, unless this movement can be related to time in linear proportions, violent acceleration of the piston will occur. In a wiper movement, which is an oscillating motion, such acceleration is most undesirable, especially if there is borne in mind the exceptional frictional properties of rubber on glass when dry and conversely its free running qualities when adequately lubricated with water.

Well-designed compressed-air wiper motors should include simple features which will control the comparatively enormous power which can be released when a wiper movement is suddenly freed after a temporary stall, and in such cases a single shock load can destroy the whole wiper mechanism, including the arm and the blade. Some form of self-compensation must be interposed between the wiper motor piston and the output shaft, and the system adopted by Trico-Folberth, Ltd, in its design of FPK wiper motors has proved its ability to deal with shock loadings of this character.

A short lever, A, as shown in the schematic drawing, is geared by rack and pinion to the operating piston and this lever carries a roller bearing at point B, which engages with a slot milled in the long lever C, which in turn operates output shaft D. Subject to the piston speed being constant, as also lever A, lever C would decelerate from mid-point of its travel to each side. At top dead centre it would, in fact, be

stationary. Further movement of lever A would have the same effect on lever C as if it were moving in the opposite direction.

It is known, however, that the piston speed is not constant and acceleration is inevitable, which may be assisted by the inertia of the arm and blade, especially at times of inadequate water lubrication. The deceleration of the wiper-output shaft, which would occur if the piston speed were constant, is therefore in direct opposition to the acceleration with actually occurs and the effect is virtually self-cancelling.

A further feature of this system of levers is the facility with which it provides a mechanical lock to park the arm and blade when not in use. The control valve when turned to "Park," permits the piston to travel slightly further in the cylinder than is normal, which, in turn, moves lever A over centre relative to lever C. This secondary lever cannot then be moved by any outside means, such as an arm and blade, and only movement of the primary lever A will effect an unlocking action. This, of course, can be achieved by operating the control valve or the emergency manual handle, which is always fitted in railway work. There is then no need to maintain air pressure on the wiper motor, so that all the piston seals are preserved in their lubricating grease without the harmful effects of water contamination, which is difficult to eliminate in any compressed-air installation. This is of particular benefit when air wipers suffer long periods of unuse, which can cause piston seals to harden and so immobilize the piston.

A feature of the Trico service to users of their equipment is the provision of complete aids to service during the life-time of a component. Due to the variations which may be necessary to suit a particular application, each such application is covered by a complete installation drawing and a schedule of parts, which are available to any engineers concerned.

The development of the passenger transport and commercial vehicle aspect of Trico-Folberth, Ltd., business is the responsibility of J. A. Clark, sales engineer, to whom we are indebted for the information on which this article is based.

(Courtesy : British Engineering & Transport)

ELECTRIC GAS FILTER

A group of Soviet scientists led by Professor Yuri Baimakov have designed an original electric filter for clearing any gas of harmful admixtures.

The new filter is 8 to 10 times more compact than the filters now in use and can be easily fitted into any, even small premise. It works 10 times faster than the existing installations as the speed of the gas stream in it can reach 10 to 15 metres per second.

The filter consists of a hollow tube with thin germanium wire strung inside. A 50,000 volt current is passed through the wire. The resulting electric field electrifies the particles of foreign matter and throws them to the walls of the tube whence they drop into a special bunker.

The new filter catches 99 per cent of the foreign matter.

The electric filter will find extensive application in the metallurgical and chemical industries where the removal of harmful admixtures from gases is a big problem.

* * *

FERRO ALLOYS

The Indian Standards Institution has recently published the following two specifications covering the general requirements, sizes, chemical compositions, sampling and supply for ferro-vanadium and silico manganese.

IS : 1466—1960 Ferro Vanadium

IS : 1470—1960 Silico Manganese

These standards belong to a series of Indian Standard Specification for Ferro Alloys. Standards covering ferro silicon, spiegeleisen, ferro chromium, ferro manganese, ferro tungsten, ferro titanium, ferro molybdenum and ferro phosphorus have already been published.

The Application of Surge Injection to the Tungsten Arc process for Welding Aluminium and its Alloys

FOREWORD

FOR a long time railway engineers have been aware of the merits of light alloy construction, and particularly of Aluminium cladding for passenger stock but use of these materials has only recently become widespread. This is largely due to the advent of improved welding techniques, amongst the latest of which is the employment of Surge Injection with Argon gas shielded Tungsten arcs.

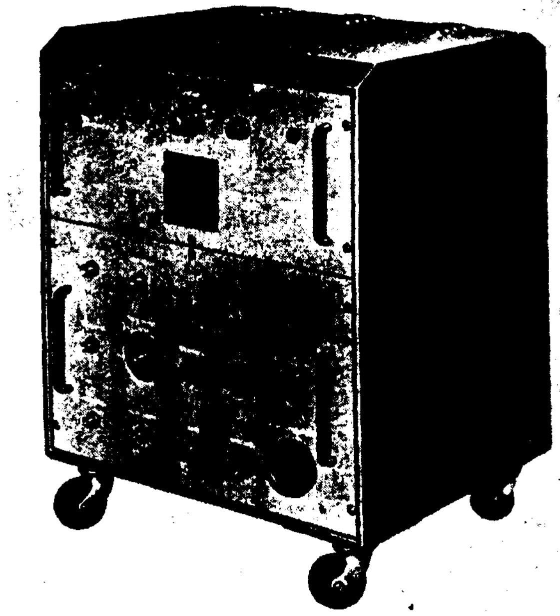
It has been thought that readers of this Journal may care to know more about this important contribution, and the following article describes how welding at below 50 R. M. S. open circuit volts has become practicable by using an electronic device to initiate, maintain and greatly increase the flexibility of the arc.

SURGE INJECTION

Originally conceived by Orton and Needham of the British Electrical Research Association several years ago, the basic principles of Surge Injection have been retained in the latest Saturn welding units, but improvements and additions have been made by Saturn Industrial Gases Ltd. to enhance the performance and provide thorough reliability in service.

THE WORKING PRINCIPLES

1. The arc is initiated by a single timed firing pulse of approximately 5 KV. which ionises the arc-gap at the commencement of each positive half-cycle, during the starting period.
2. The pulse is of the same polarity as the welding current which will follow in that half-cycle.
3. The pulse is derived from a capacitor charged with D/C to about 300/400 volts. The capacitor discharges through a step-up transformer, which transfers a 5 KV. D/C pulse via a spark gap, into the arc.
4. The pulse is timed by connecting the grid of a triode valve across the welding lines, so that this valve will conduct once in every positive half-cycle.
5. When this valve conducts it transfers a signal to a Thyratron or Neostron valve, and triggers this valve so that the capacitor is able to discharge through the step-up transformer.
6. The Negative half-cycle does not require an open circuit voltage higher than 40 volts for self-re-ignition of the arc, hence the firing pulse is only applied to the positive half-cycle.



A Mk IA Surge Injector, suitable for connecting to any existing normal welding transformer having an open circuit welding voltage between 40 and 100 volts, and an output up to 300 amps.

7. Immediately the arc has struck, the voltage across the welding lines will fall to a value below 30 volts lower on the negative half-cycle than on the positive.
8. The arc will ignite, firstly on the positive half-cycle, then when the tungsten has

become sufficiently hot to emit electrons, on the negative half-cycle also.

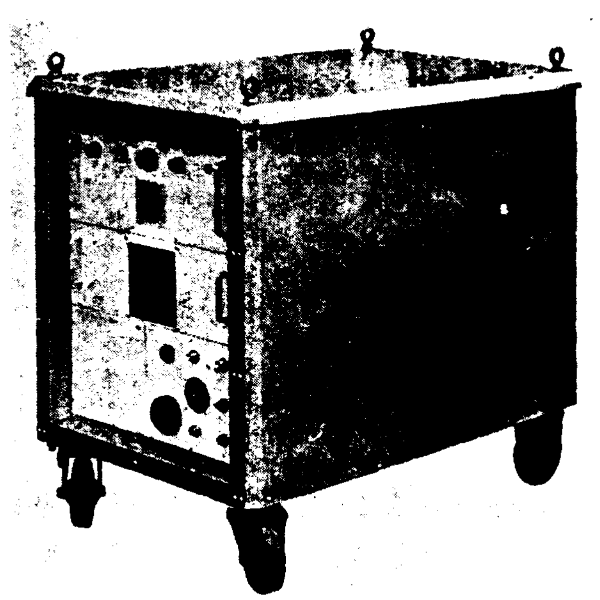
9. With a fully ignited arc it is unnecessary to employ a 5 KV. firing pulse for succeeding re-ignitions. In fact, 300/400 volts surge is ample for the purpose.

10. When the negative half-cycle has ignited, the drop in volts across the welding lines automatically releases a relay, which short circuits the primary of the step-up transformer and allows the 300/400 volts surge to pass directly to the welding lines from the capacitor to maintain the arc on the positive half-cycles during welding.

ADVANTAGES OF THE PROCESS

(a) The single timed pulse affords rapid starting with reduced interference in the commercial radio wave bands, and then only during starting.

(b) The arc is much more stable due to the presence of the surge and welding can be conducted at high speed.

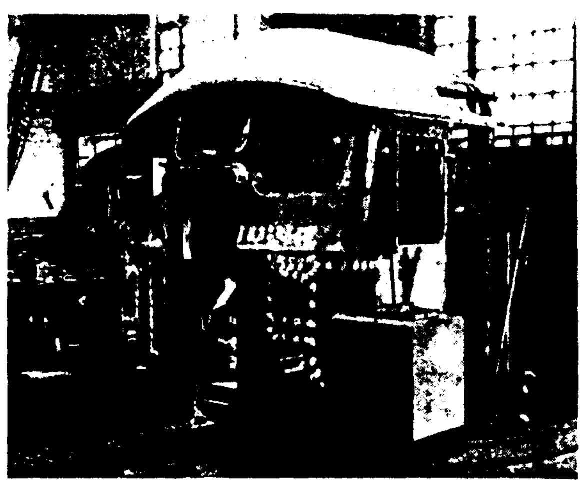


A Mk II or Mk III Surge Injector. Both are similar in appearance, but the Mk II unit is rated up to 300 amps., whilst the Mk III is rated up to 600 amps. These units are self contained, with their own welding transformers, which supply welding power at 42 open circuit volts.

(c) Surge Injection gives satisfactory welding with considerable variation of arc length.

(d) The low open circuit voltage reduces considerably the KVA and size of the welding transformer.

(e) The short duration of the pulses and a power source having a low open circuit voltage remove any risk of serious electric shocks.



A Mk IA Surge Injector in use constructing new stock for British Railways.

THE D/C COMPONENT

The alternating current arc between tungsten and aluminium in an Argon shield produces an inherent rectification of current due to the difference in the average voltages for the positive and negative part cycles. Thus, more current flows when the electrode is negative than when it is positive, and this unbalance in the current wave may be even further accentuated by any appreciable current zero pause, caused by the late ignition of the positive part cycles. The D/C component is undesirable since it increases the heating losses in the transformer and also the saturation of the reactor. Although it is possible to obtain a satisfactory weld, the cleaning effect of the positive part cycle may be much reduced.

In practice the D/C component is generally suppressed by connecting a large capacitance in series with the welding circuit, about 120,000 M. F. being usual for 300 amps. welding current.

In the original Surge Injectors, it was found that arc initiation was not practicable with the D/C suppressor

capacitance permanently connected in series and it was manually linked in only after both negative and positive parts of the cycles of the arc were fully struck. The reason for this may be better understood by a consideration of the starting conditions.

It has already been stated that the arc was initiated and maintained by pulses at the commencement of the positive part cycles only. Thus, when starting, the series capacitance would become rapidly charged by successive positive going part waves of current, eventually to oppose any further flow of positive current, unless in the interim, the tungsten electrode became sufficiently emissive through heating to strike an arc on the negative part cycles also. In practice it was found that the arc was usually self-extinguishing, unless the capacitance was short circuited by a switch, until both part cycles were arcing.

DEVELOPMENT

Investigation by private interests resulted in the introduction of novel features and enabled them to provide the first satisfactory commercial equipment of this kind.

The objection to inserting and removing manually the D. C. suppressor at the correct times has been overcome by employing a relay to perform automatically this function*. This relay is controlled by the negative part cycle voltage across the arc.

The system ensures that the suppressor can be inserted only after full cycle ingnition, and that when welding ceases, the suppressor will be immediately short-circuited through a low resistance path. By such means, very rapid starting has become practicable.

With the object of still further reducing manual operations, an adjustable electronic time control has been added. When the Surge Injector is switched on a solenoid valve opens to allow the flow of argon to purge the air from the hoses to the Torch. After a short time interval, it closes again and the equipment is then ready for use. When welding ceases, the Argon continues to flow for a pre-determined period in order to cool the weld-metal and tungsten in an inert gas shield.

A water pressure operated switch also has been added to switch "off" the Surge Injector in the event of failure of cooling water when a Water Cooled Torch is in use.

FURTHER DEVELOPMENTS

When certain welding conditions obtain, it has been found that the positive part cycle arc may extinguish during welding, to leave the negative part cycle only striking. Rapid restoration of the starting spark is then essential, but with the original circuit this was not possible since control was by the negative cycle mean voltage only. The spark could only be restored when this voltage rose to open circuit value. That is, when the arc was completely extinguished.

A welder using a hand Torch to weld Aluminium flooring in a road vehicle.

A re-arrangement of the control circuits* has now overcome this objection and ensured that optimum striking conditions obtain at all times. This development has led to successful hand welding at currents hitherto considered impracticable.

COMMERCIAL FORMS OF SURGE INJECTORS—SATURN/HIVOLT

In its simplest form, the Mk IA model, the Surge Injector is supplied for connection to any existing standard type of welding transformer to form a complete unit, when it is suitable for welding with currents up to 300 amperes.

Another more comprehensive form, the Mk II model, embodies a transformer together with a magnetic amplifier and stepless control, to deliver currents up to 300 amperes at 42V open circuit.

* Patents pending

A later model, the Mk III, has now been developed to deliver still heavier currents up to 600 amperes at 42V open circuit. Although similar in appearance to the Mk II, this machine operates in a manner different from its predecessors, control circuits being modified to enhance the starting conditions and to afford rapid restoration of the starting pulse should the arc become extinguished unintentionally.

In conjunction with these Surge Injectors, a range of hand welding torches has been developed to cover the currents to be employed. With the exception of a small pencil torch, all are fitted with hand switches to afford the operator complete control over starting and stopping the arc by the 'flick of a switch'.

SOME APPLICATIONS

In Great Britain Surge Injection is now recognised as an ideal means, for obtaining high quality Aluminium welds, by Government Departments, Fighting Services, Atomic Energy Authorities and Industry generally. The illustrations show some of these applications.

INDIAN INVENTION MAKES HISTORY—WORLD EXPLOITATION BY W. GERMAN FIRM

The Government of India have granted a licence to a well-known West German firm of diesel locomotive manufacturers for the world exploitation of a major Indian invention which promises to revolutionise the manufacture of diesel locomotives the world over.

The inventor is 32-year old Shri M. M. Suri, Deputy Director (Diesels) in the Indian Railway Research, Design and Standards Organisation at Simla.

Shri Suri has been responsible for the invention of a new system of diesel locomotive power transmission which has officially been named as "Suri-Transmission". The invention of the Suri-Transmission puts Indian "knowhow" in the field of diesel locomotive design ahead of contemporary knowledge in advanced countries like U.S.A., West Germany, U. K. and Japan.

In locomotives of the future, the introduction of the Suri-Transmission will be a substantial factor in saving manufacturing and recurring operating costs. For instance "Suri-Transmission" if fitted on to locomotives similar to the 2,000 H. P. diesel-electric locomotives recently imported for U. S. A. and now in service in the eastern region of the country, would secure a saving in fuel costs of something like Rs. 16,000 per year per locomotive.

The manufacturing cost of the 'Suri-Transmission' locomotives is also expected to be substantially cheaper than current types because of its lighter and simpler and more compact construction. When fully developed, the 'Suri-Transmission' would pave the way for the construction of very powerful locomotives of 3,000 H. P. to 4,000 H. P. as compared to the 2,000 H. P. locomotives now currently in use in India and other countries of the world.

Shri M. M. Suri joined the Indian railways as a Special Class Apprentice in the Superior Establishment of the Mechanical and Transportation Department of the Indian railways at Jamalpur in 1945. In 1950 he was appointed Production Engineer at Jamalpur. In early 1954 he was sent abroad on deputation with the Director-General, India Store Department, London as a Junior Railway Inspecting Officer. Mr. Suri was abroad from 1954 to 1957 during which time his official duties carried him to Italy, Germany, Switzerland, Australia, France, Belgium, Sweden and U. K. It was in 1956 in London that he filed an application for a patent on his invention, on which he had been privately working approximately for two years. On return from deputation abroad Shri Suri was posted as Deputy Director (Diesels) in the newly-created Diesel Department of the Research, Design and Standards Organisation of the Indian Railways.

* * *

RAILWAY BRONZE INGOTS AND CASTINGS

The Indian Standard Specification for Railway Bronze Ingots and Castings (IS : 1458—1959) prepared recently by ISI covers the requirements of the following five classes of bronze ingots and sand castings :

Phosphor bronze	Class I
Gunmetal	Class II
Leaded Bronze (78-7-15)	Class III
Leaded Bronze (83-7-10)	Class IV
Leaded gunmetal (85-5-5-5)	Class V

The classification is based on the typical purposes for which these bronzes are employed.

In view of some of the special requirements of bronze ingots and castings not being exactly met by IS : 28—1958, IS : 306—1951 and IS : 318—1952, the necessity was felt that there should be a separate standard for covering the requirements of bronze ingots and castings used by the railways.

Automatic Welding is Leaping Ahead

With 12,000 automatic and semi-automatic arc welders and more than 40,000 contact welders in operation the Soviet Union has leaped ahead of any European country and of the United States as well.

Depots and shops are being set up to specialise in centralised manufacture of welded semi-finished units and supply them to machine building works. The Urals heavy machinery building works, for instance, is erecting the biggest block of welding shops in Europe with an annual capacity of 135,000 tons, and an even bigger welding plant will be started in 1962 in the Ukraine. Within the nearest future it would be possible to create a new system of controlling welding processes, using modern means of radio-electronics; and special programme-controlled automatic machine tools are to be created for mass production of welded structural units.

* * *

METRIC COPPER WIRES AND CONDUCTORS

The Indian Standards Institution has recently published IS : 1594—1960 Metric Sizes of Copper Wires and Conductors for Electrical Purposes. Consequent on the decision of the Government of India to introduce metric system of weights and measures in this country, it became imperative for the electric cable industry to evolve rational sizes for wires and conductors in the metric system. This standard gives the diameters of copper wires for electrical purpose in metric system. It also gives the sectional areas with the number and diameter of wires of copper conductors for use in insulated cables and for overhead transmission purposes.

The present cable manufacturing practices in this country follow mostly the British practices and the existing Indian Standards, based on corresponding British Standards, are in the fps system. The conductor sizes specified in this standard are derived from the CEE series as well as the sizes in vogue at present in this country. This step has been taken with a view to bringing about the minimum amount of dislocation in the cable industry in this country in changing over to the metric system, although the advantages of adopting a series which follows a geometric progression are fully realized. It is, however, hoped that with the efflux of time, the need in this country will tend towards an ideal series and that, at a later date, it will be possible to delete many of the sizes representing the present practice.

Automatic Flash Butt Welding Machines for the Production of long Rails

THE use of long welded rails in permanent way construction has been the accepted practice by progressive railways throughout the world due to the tremendous advantages in the use of long welded rail which are :—

(a) Reduced maintenance costs.

(b) Extended life of track materials.

(c) Quieter running and greater passenger comfort.

(d) Less wear and tear of rolling stock.

Whilst (c) and (d) are very important the main inducement to adopt a policy of laying in long welded rails rests on (a) and (b).

This practice of Flash Butt Welding long welded rails has been carried out by Indian Railways for many years now, and has proved to be by far the most efficient method in weld quality, speed of production and overall economics.

The Automatic Flash Butt Welding Equipment for providing extended track lengths is manufactured by A. I. Electric Welding Machines Ltd., who due to close negotiations with railway authorities in various countries for many years have been able to develop the most efficient type of rail welders and consequently their machines are selected by many countries, and are at present operating in India, Great Britain, America, Canada, South Africa, etc.

A. I. Electric Welding Machines Ltd., also manufacture a wide range of automatic welding machines besides Rail Welding Equipment, many being supplied for eliminating complicated forging and reducing costs in Carriage and Wagon Production.

In 1947, Eastern Railways India, installed an A. I. Automatic Rail Welder, whilst in December, 1952 a complete mobile rail welding train, including welder, diesel alternator and ancillary equipment was ordered by Central Railways, India to be initially established at Pachora.

Several years later in February, 1957, a further Rail Welding depot was laid down to serve Calcutta Electrification Project, and this equipment is now operating at Bandel.

The actual rail lengths for welding, vary from country to country, the normal being from 600 ft. to 720 ft. although in certain depots lengths of 1000 ft. and more have been handled.

An important application of Automatic Flash Butt Welding of rails is the reclamation of second-hand rails. With existing track the short rails are distorted at the ends which makes replacement of the rails necessary while a substantial portion of the rail still has

Fig. 1. A. I. Type APHF/30 Automatic Flash Butt Rail Welder.

many years of life before scrapping. The distorted rail ends are, therefore, cut away and the sound pieces are welded into long lengths for relaying.

Mobile Rail Welding Plants have also been supplied by A. I. Electric Welding Machines, Ltd., each consisting of Rail Welder, Diesel Generating Set, Compressor and other ancillary equipment, all of which is mounted on special flat cars to form a complete and independent Rail Welding Train. The advantage of a mobile plant for welding new and used rail is that the welding of rail can be carried out at various locations, thus avoiding the problem of transporting long welded rail for great distances.

The machine illustrated in Fig. 1 namely the A. I. Type APHF/30 Automatic Flash Butt Rail Welder has sufficient capacity for welding rails up to 110 lbs. per yd. and Fig. 2 illustrates the A. I. Type APHF/60 Welder which is capable of welding rails up to 155 lbs. per yd. The clamping units and forging unit of these welders are of course integral parts of the machine and self-contained units which eliminate the necessity of having separate pump units for the clamping and forging operations.

Fig. 2

To weld rail the two lengths of rail to be joined, are fed into the welder and each length is clamped rigidly in the copper alloy jaws of the machine which are connected to the secondary side of the welding transformer, incorporated in the welding machine.

The two rail ends almost touching, the current comes on at the depression of the push button and the welding operation begins. When the rail ends touch, electric current flows through the interfaces which creates heat and raises the temperature of the rail ends. This procedure lasts ouly a few seconds and then the rail ends break contact and meet again quickly.

This process, which is called the pre-heating operation, continues automatically until the rail ends are sufficiently hot for the flashing operation to commence.

When flashing begins the rail no longer breaks contact and flashes freely and continuously until the correct forging temperature is obtained when the current is cut off and simultaneously the two ends are forged together by a high upsetting pressure. This forging action is effected with the highest possible speed so that a sound welded joint is obtained.

This whole welding cycle takes place automatically on depressing a push button and the welding time lasts only from one to two minutes depending on the size of rail section.

After completion of the weld, the clamps are released and the welded rail is moved out of the machines so that further lengths of rail can be added to the complete length.

With regard to the production output this largely depends on the handling facilities available on site, and it is the case that some railway depots with A. I. Equipment are producing an average of 15 to 20 welds per hour.

The point which is of paramount importance to the Railway Engineers throughout the world is of course that consistent and high quality welding results are constantly maintained, as naturally railway track must be of the highest quality for the rolling stock which it carries. The welds which are produced by these machines have to pass stringent tests by permanent way engineers so that the welds are of the optimum quality.

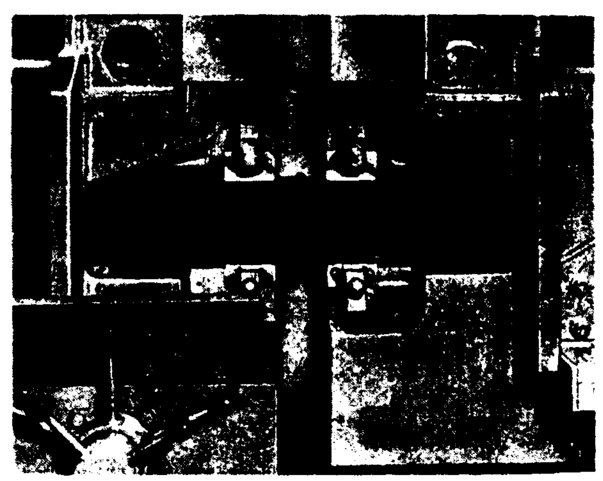


Fig. 3. Close-up of Welding Dies on Automatic Flash Butt Rail Welder

There is no doubt whatsoever that the advantages mentioned at the start of this article to be gained by long welded rail are tremendous and to quote the Chief Civil Engineer of one country where five A. I. Welders are in operation, and Mobile Plants at present being considered will prove this statement. 'I have no longer any concern regarding the use of Long Welding Rail, I merely accept it as a tried and proved process'.

Further details of Automatic Flash Butt Rail Welding Equipment can be obtained from the nearest office of Messrs. James Finlay & Co., Ltd., of Calcutta, Bombay and New Delhi who are the representatives of A. I. Electric Welding Machines Ltd., in India and Pakistan.

High Pressures Herald A Revolution in Technology

By V. Pospelov

THE physics of super-pressures is a comparatively young science but it is already receiving a good deal of attention from specialists employed in many branches of engineering.

The term super-pressure refers to pressures above 1,000 atmospheres. In nature pressures of this kind exist only in the ocean depths and deep inside the bowels of the earth.

Only a comparatively short time ago did specialists begin to produce pressures equivalent to thousands of atmospheres. Notwithstanding this, more and more use is being made of super-pressures in the world of science and engineering.

MAN-MADE DIAMONDS

It is known that all substances consist of atoms which are constituted of nuclei with electrons revolving around them. Under the action of super-pressures the atoms of gaseous and liquid substances are compressed in consequence of which these substances are converted into solids. Super-pressures change the crystal pattern in solids. Further increases in pressure, after the atoms have been "solidified" to the highest point, produce a compression within the atoms, and the electrons are brought closer to the nucleus.

It has been found that all solid substances placed in a liquid under a pressure of about 20,000-40,000 atmospheres acquire entirely new properties.

Graphite and diamonds are varieties of the same chemical element, carbon, but they differ sharply even in appearance. How unlike the gray unsightly graphite is the sparkling diamond! Using super-pressures specialists have in fact started producing diamonds. True, the man made diamonds are so far small in size, but they may well be used for technical purposes.

Graphite passes into diamond in consequence of the changes in its internal crystallic pattern. Diamonds are produced under pressures ranging up to 100,000 atmospheres and a temperature of about 2,000-2,500 degrees. Special equipment has been designed for this purpose.

Studying the action of super-pressures upon solids, specialists have produced substances which are even stronger than the strongest natural material—diamond. One of the new substances is called borazon. It is produced, under a pressure of 100,000 atmospheres and a temperature of 2,000 degrees, from a chemical compound of boron and nitrogen, boron nitrate. The new mineral is extremely valuable since it can be used under a temperature of 2,500 degrees, which even diamonds cannot endure. Borazon is so tough that it leaves deep scratches even on natural diamonds. Borazon is apparently the first ultra-hard material to be obtained by means of high pressures and temperatures.

SUPER-STRONG METALS

Soviet scientists are conducting important investigations into the action of super-pressures upon other tough substances. A special laboratory has been equipped in the Soviet Union for studying the action of super-pressures upon metals, for designing powerful compressors and other special equipment. Pressures of thirty thousand atmospheres have already been produced in big reservoirs. It was discovered that under such pressures metals acquire entirely different properties; they become more plastic and enduring. That holds out a very great promise before engineering.

The most fragile pig iron is converted under great pressures into a very enduring material, while steel becomes several times stronger after compression in special reservoirs. A brittle material like marble becomes plastic to a considerable extent when subjected to all-round compression.

Special rolling mills where metal will be subjected to the pressure of 25,000-30,000 atmospheres are going to be built in the USSR. These rolling mills will have to be built in huge reservoirs where the liquid will be compressed by means of very powerful compressors.

There will also be units for drawing super-strong wire. Under a pressure of several thousand atmospheres it will be possible to produce a very plastic

(Continued on page 85)

THE RELATIVE MERITS OF DIESEL AND ELECTRIC TRACTION AND THE PROBLEMS OF CHANGE OVER — A PHASE OF THE RAILWAY TRACTION DEVELOPMENT

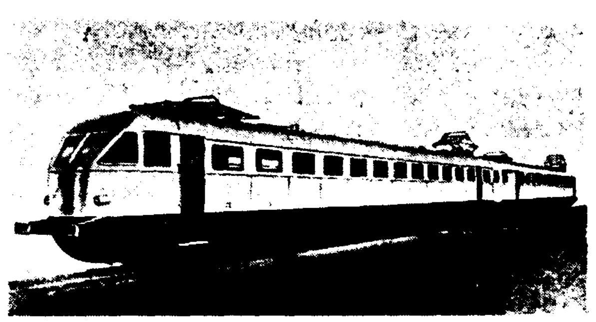
By Dott. Ing. Leone Ravenna
of Ercole Marelli & C. S.p.A Milan - Italy

DIESEL Traction was born in Europe—the first Diesel Engine application on rail-vehicles appeared in France in the first years of the 20th century—but developed in America, United States.

During the last years, however, a remarkable impulse in this branch arose also in Europe : something did move, and new solutions were offered by new manufacturers to new buyers.

Birth and affirmation of Diesel locomotive were due to a definite exigence, when it was remarked the determining influence the kind of the employed motive power has on the railway operating total expense.

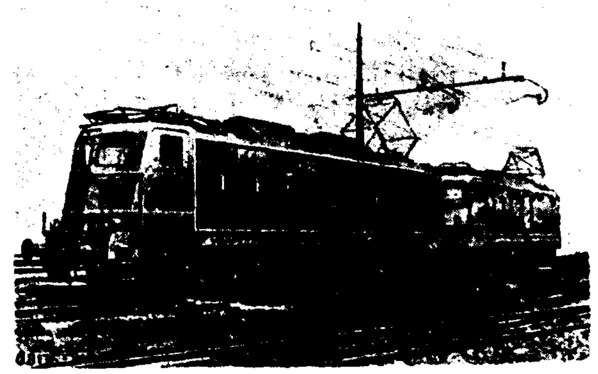
The most proper choice of the locomotive type was taken then in the greatest consideration : a locomotive is to be regarded as an instrument, but, more-



Motor coach for Italian State Railways
- 1 hour rating 368 kW
- maximum speed 80 mph
Electric parts by Marelli - Milan
Mechanical parts by Fiat - Turin

over, is to be valued on economical terms, from the standpoints of the purchase expenses and of the yearly operating cost.

Stating beforehand that the comparison is specially done between dieselisation and electrification, since steam traction is not suited to the 20th century, the factors affecting the change of motive power are various, but, above all, the initial cost of plans as transmission and distribution lines, substations and overhead system, has always been the main obstacle for new electrifications. Therefore, speaking of new electrifications, the decisive factor has always been the traffic records.



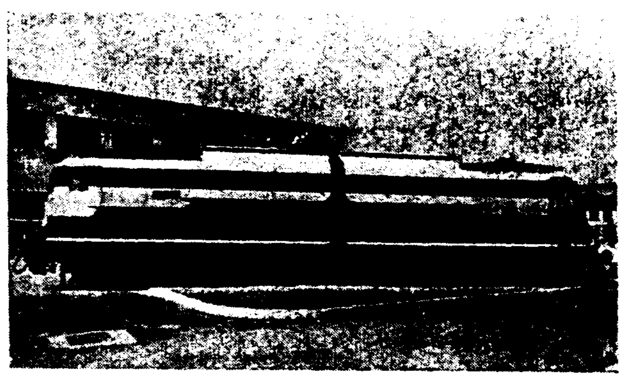
Electric locomotives for Italian State Railways
- wheel arrangement Bo-Bo
- weight in working order 72 metric tons
- 1 hour rating 1560 kW
- maximum speed 70 mph
Electric parts by Marelli - Milan
Mechanical parts by Reggiane - Reggio Emilia

Except special cases, as profils of line on which the tonnage has to be handled (mountains), and conditions of power supply (large water resources and fault of coal for steam locomotives or of fuel for Diesel engines)—i. e. Switzerland—electrification is not a good business when ton-miles to be handled are under a definite limit.

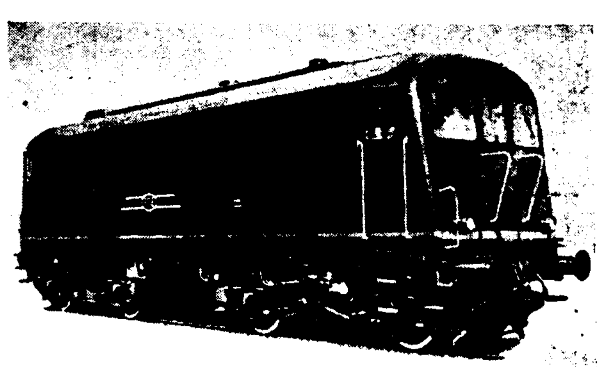
Really electrification means a new expense for plants to save an operating expense, and other items are to be considered besides the handled traffic and the line potentiality : the cost of transformation (locomotives, substations including switching, trolley catenary system and bonding, transmission signal and communications circuit changes, and so on) and the operating cost with steam, diesel and electric locomotives (locomotive maintenance, locomotive depreciation, crew expense, engine house expense, cost of electrical energy, distribution system and substations maintenance, distribution system and substations depreciation, and so on).

The difference between operating cost with new and old system, should, at least, equal the yearly charges.

Practically all the most important railways that are electrified at present, began with steam operation.



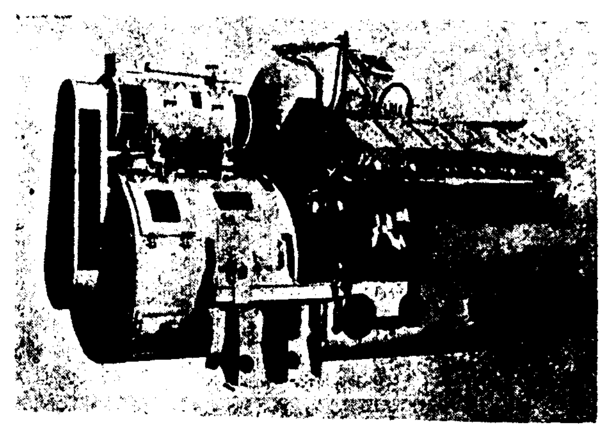
Electric locomotives for Italian State Railways
- wheel arrangement Bo + Bo + Bo
- weight in working order 108 metric tons
- 1 hour rating 4000 kW
- maximum speed 90 mph
Electric parts by Marelli - Milan
Mechanical parts by OM - Milan



Diesel Electric locomotives for Italian South East Railways
- wheel arrangement Bo-Bo
- weight in working order 52 metric tons
- continuous rating 825 HP
- maximum speed 50 mph
Electric parts by Marelli - Milan
Thermal parts by Reggiane - Reggio Emilia
Mechanical parts by Reggiane - Reggio Emilia

Then, at a given moment, substitution of steam traction by an other system thrust itself upon, to face new or simply increased exploitation exigences and they passed to the Diesel or even to the electric traction, but always on the basis of the so-called "convenience limit": a limit that is reached as faster as lower is the expense for new plants, as higher are the traffic records and, obviously, as remarkable is the difference between new and old operating cost.

Of course, such "convenience limit" cannot be established as absolute and general value, but it depends from number of elements that are characteristic of different countries and that can influence choice between dieselisation and electrification, when steam traction will obsolete. Then, normally, the specific solution of the one region's problems is not necessary applicable in another place.



Diesel-generator set for Diesel electric locomotive
- continuous rating 825 HP at 1300 rpm
- total weight with auxiliary set 6900 Kg
Engine built by Reggiane - License Man
Electric generators built by Marelli - Milan

As always, the reasons of such differences are partly technical and partly economical : take, i. e., USA and Europe's situations.

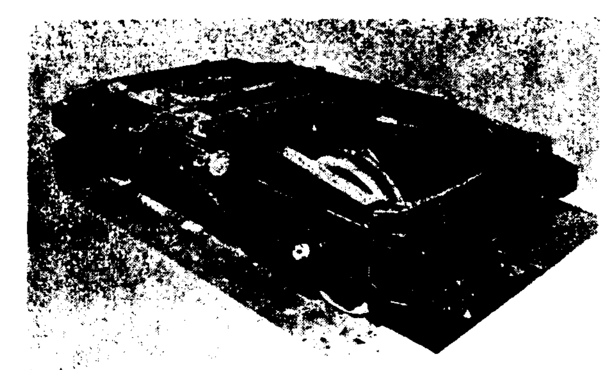
A first problem's side concerns motive agents : electrification allows to employ a large range of fuel qualities: firstly, hydraulic energy, then, more or less select masut methane, coal; on the contrary, Diesel locomotive operation is joined to the use of select fuel.

Electrification is really a sort of insurance, when available sources of such fuel are limited in quantity or in time.

In Europe we found lacking masut, coal only in few regions, large hydraulic resources, and there electrification appeared as surety against every supply's uncertainty with railways motive agent and against its high prices. On the contrary, in USA they have plentiful and cheap masut, with assured production in every world politics emergency, and Diesel traction has practically stopped for several years whatever development of a real electrification.

A second problem's side is concerning the different traffic exigences, versus the ambient : crowded populated countries, with high records of traffic on short distances, lines run by frequent and relatively light trains, with high ton-miles standards and consequently somewhat limited incidence of the fixed plants investments, as in Europe, push forward electrification.

Long lines through poor unhabited territories with relatively few heavy trains made till now in USA the balance slope in favour of Diesel traction : in fact, the Diesel locomotive cost, both as initial expense and



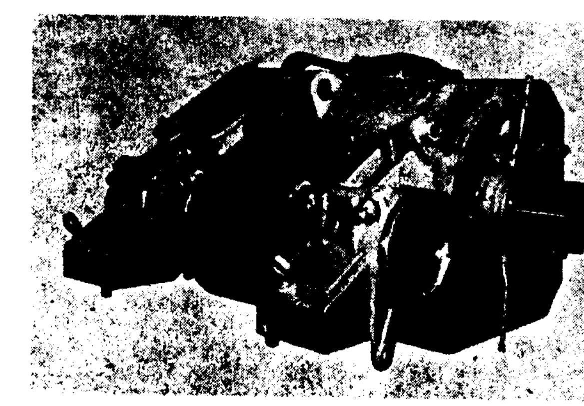
Bogie with traction motors and reduction gear for Diesel Electric locomotive
-- total weight 10300 Kg
- continuous rating for motor 160 HP at 508 rpm
Electric parts by Marelli - Milan
Mechanical parts by Reggiane - Reggio Emilia

as maintenance, becomes of less importance when the locomotives per line-mile are relatively few, while the incidence of electric energy production, transmission, transformation and eventual conversion is high.

The third problem's side is given by the difference between financial structures of European and North-American railways: the main European railways are State Railways, the American are private Companies : now, European railways are in a better position for new electrifications, because of the more important investments they require in comparison with dieselisation : capital outlays, with consequent passive charges, taxes, debt redemption shares and so on, are easier to be supported by European than by North American railways Companies.

The establishment of the Diesel locomotive in North America is closely related to the rise in the cost of coal due to prolonged pressure from the Unions in the mines.

The difficulty of running railways equipped for the most part with steam locomotives, gave an incentive to the rapid development of the diesel traction engine as a practical system with distinct immediate advantages.

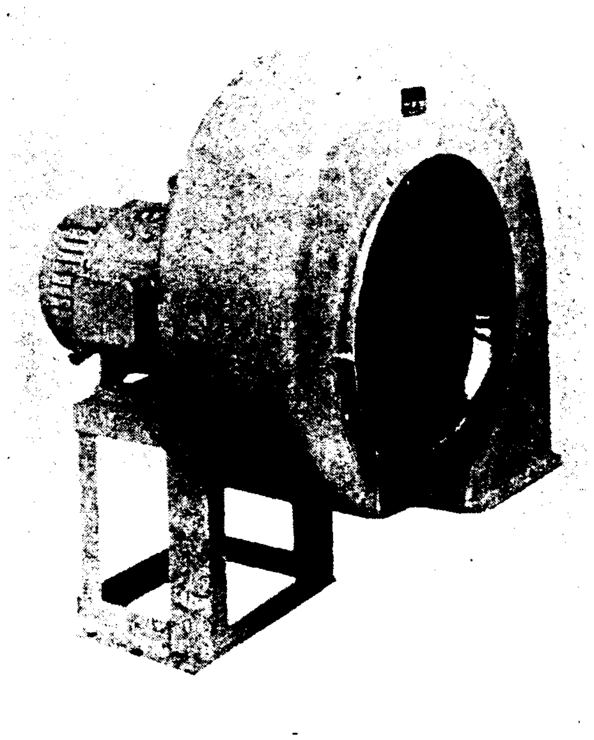


Traction motor for Diesel Electric locomotive
- continuous rating 160 HP at 508 rpm
- total weight, gear box and pinion included: 1660 Kg
Builder : Marelli - Milan

The Diesel engine, with electric transmission, reached the realisation of a locomotive capable of developing constant power at wheels between minimum and maximum running speed, with a smooth running of all characteristic tractive effort/speed allowing for longer trains, and the stricter keeping of time-tables with consequent economy of operating costs. In general these are the precise qualities of the electric locomotives, but electrification would have involved permanent installations of great extent, whereas the Diesel locomotive could be constructed in a relatively short time and be put into service without any extensive modification of existing plants.

Thus it was that, until some years ago, in North America some 2000 electric Diesel locomotives were produced annually and at the beginning of 1954, in the United States and Canada alone, more than 24,000 locomotives of this type were on the rails, whilst in the whole of Europe. Gt. Britain—Ireland included, in a total of 74,000 locomotives, there were no more than 900 Diesel, inclusive of the small switchers.

Also in Europe, however, within the last few years this problem of the Diesel locomotives has been looked at from a broader point of view, and European industry has embarked upon an extensive study



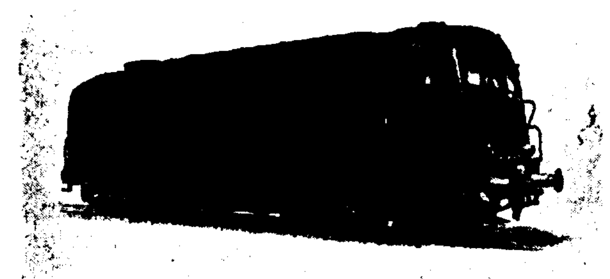
Electric fan for Diesel Electric locomotive traction motors
- 3180 cu / ft per minute - 5"
- DC motor at 2300 rpm
Builder : Marelli - Milan

programme of research into the determination and classification of fundamental Diesel and Diesel electric locomotives, to clarify the needs and projects of constructors, and the demands of the different European Railways.

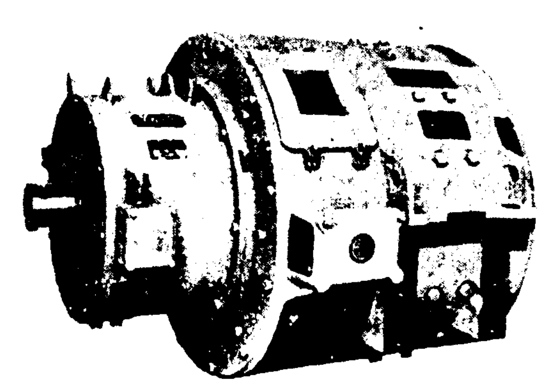
In recent years, moreover, the problems of the railways are not a subject of lively interest only in North America and Europe, but in the whole world; a great number of other countries are undergoing the same phases of development which has taken place in Europe and the United States of America: from North to South Africa, from the Middle East to Indonesia and from South America to Australia (not to mention Russia, where at the beginning of 1960 the length of lines served by Diesel locomotives had risen by 150% in comparison with that of 1955 and it is expected that this will be five times surpassed by 1965), they are turning over from steam traction (or passing over this completely) to diesel traction, and, when reached the mentioned "limit of convenience", over to electrification.

Immense countries, and continents rich in natural resources and with a continually rising technical potential, are destined to make their needs felt.

In fact, these needs, in the field of plants, appear, for the moment at least, to resemble those of Europe

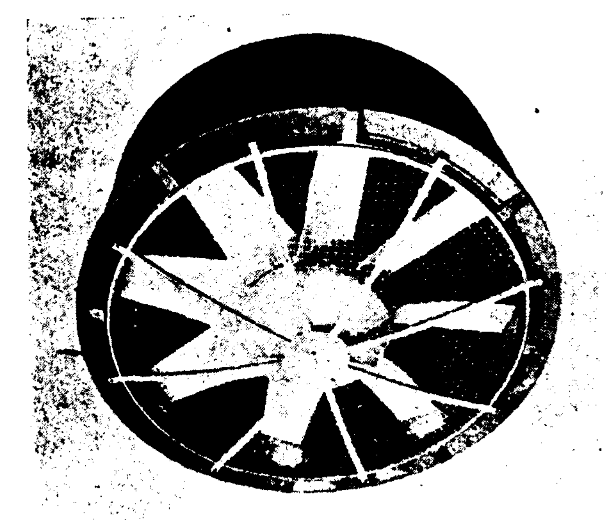


Diesel Electric locomotive for Italian State Railways
- wheel arrangement Bo-Bo
weight in working order 64 metric tons
- continuous rating 1120 HP
- maximum speed 63 mph

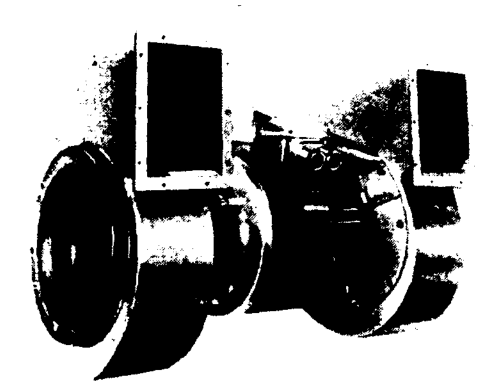


Main generator for Diesel Electric locomotive
- continuous rating 770 kW at 960 rpm
- weight with auxiliary services alternator 6600 Kg
Builder : Marelli - Milan

more than North America. The North American railways have at their disposal an armament suitable for a load of 30 tons per axle; this is too much if one wishes to use the Diesel on existing lines without wasting time on re-inforcing the tracks :— progress has not to wait! Herein has the similarity just mentioned, i.e. the need for lightness : light locomotives for the new Dieselisation.



Electric fan for Diesel Electric locomotive engine
- 48000 cu/ft - 2" with AC induction motor at 1390 rpm
Builder : Marelli - Milan

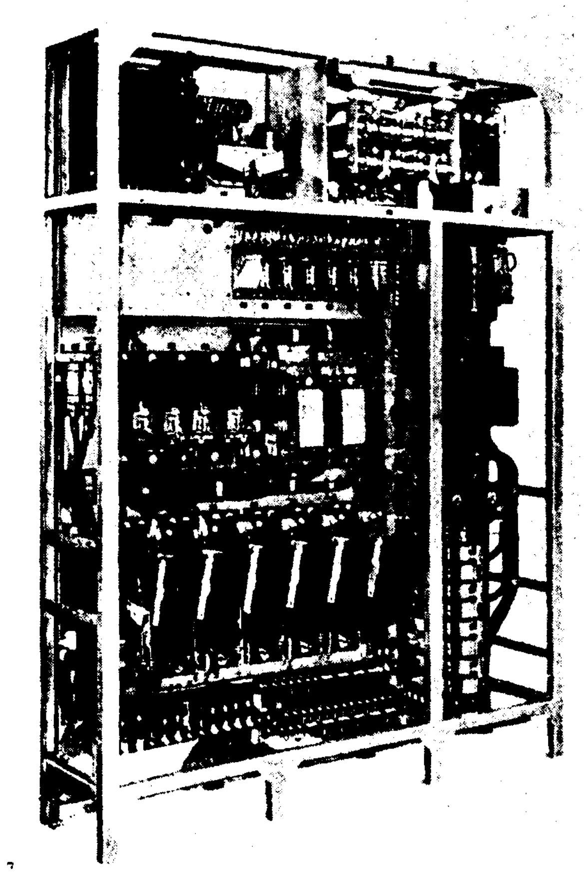


Electric fan for Diesel Electric locomotive traction motors
- 2700 cu/ft - 7" with AC induction motor at 2820 rpm
Builder : Marelli - Milan

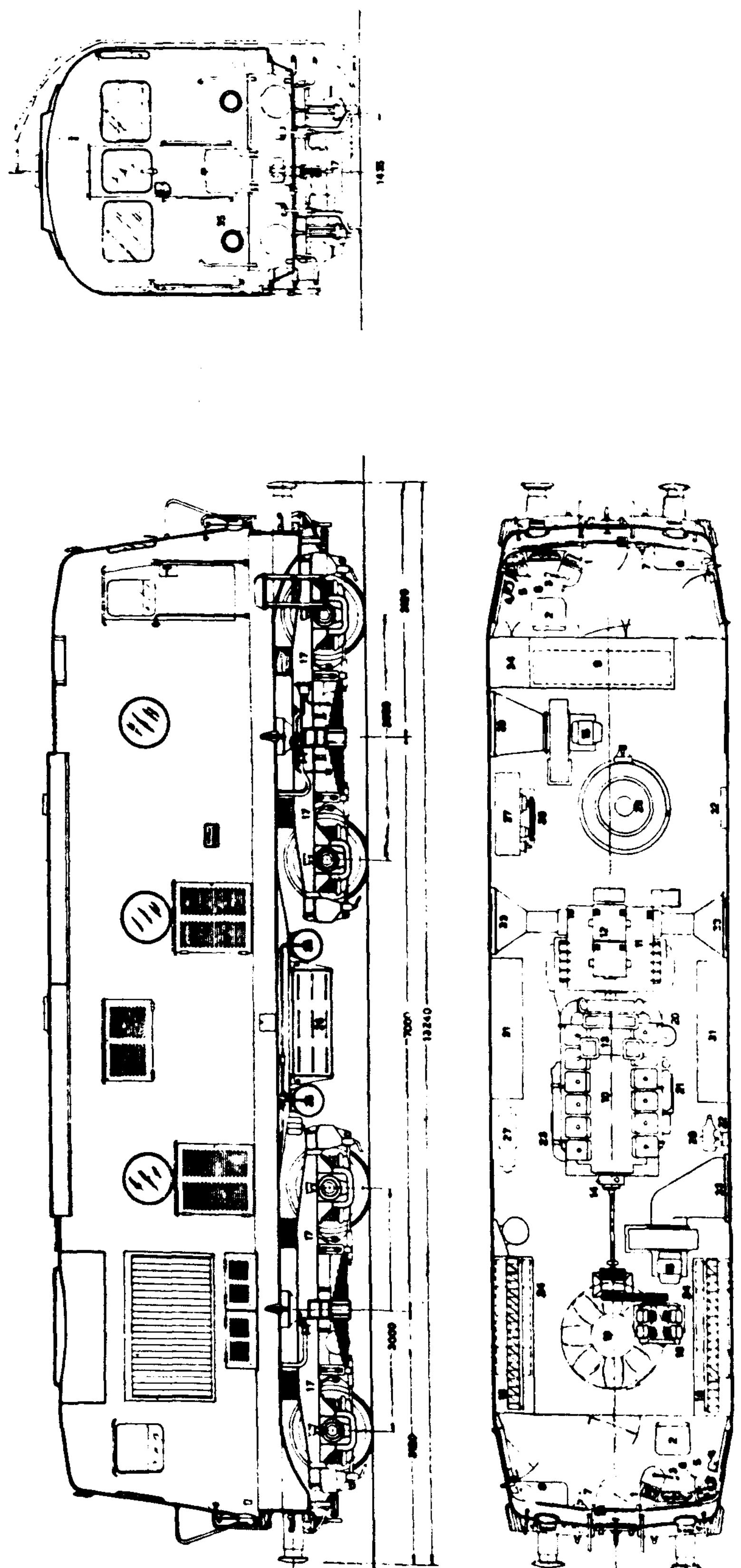
The technical progress in the industry of the high speed Diesel engine, the development in constructing welded steel bogies, and frames of the locomotive, the use of light alloy metals of high specific resistance, which have been highly developed in European industries to answer the needs of each one of their countries, correspond perfectly to the needs of many parts of Asia, Africa and South America where new techniques can be rapidly assimilated and new constructions normes realised.

The Diesel has become of prime importance throughout the whole world, and the exigences which become each day more pressing (reduction in weight and sizes, increase in power) involve higher revolution speed, supercharging, internal cooling of the pistons.

The technique of various systems of transmission: hydraulic and electric, and the various types of mechanical transmission, is in constant evolution and making rapid progress in a way which renders it impossible to foresee which system will eventually predominate. One cannot expect the same progress and numerous innovations, however, in the field of electrical transmission, as in that of mechanical and hydraulic.



Cubicle for Electric Control Apparatus of 825 HP Diesel Electric locomotive
Builder : Marelli - Milan



LOCATION OF PRINCIPAL PARTS

1. Operator's controls
2. Seats
3. Master controller
4. Independent brake valve
5. Automatic brake valve
6. Sander foot push button
7. Handbrake
8. Fire extinguishers
9. Equipment cabinet
10. Diesel engine
11. Main generator
12. Auxiliary generator and exciter
13. Turbocharger
14. Woodward governor
15. Traction motor electric blowers
16. Air compressor
17. Traction motors
18. Water radiators
19. Radiator fan
20. Prelube oil pump
21. Lube oil filters
22. Fuel oil filters
23. Heat exchanger
24. Batteries
25. Air reservoirs
26. Fuel oil tank
27. Diesel engine pre-heating boiler
28. Fuel oil pump
29. Train-heating boiler
30. Train-heating boiler pump
31. Train-heating water tank
32. Train-heating control panel
33. Traction motor and main generator air filters
34. Service cupboard
35. Headlight

Electrical transmission was already in a highly satisfactory state when the first hydraulic system was patented and it has never ceased to improve, while hydraulic systems have often proved laboursome in the perfecting of them.

The constant tendency to lightness is evident even in the transmission as in the Diesel engine—between two locomotives, one of 600 hp. produced in 1945, and the other of 800 hp. produced 10 years later, the gain in weight reached 35% in favour of the second.

Points to notice in the field of electrical transmission: the auxiliary generator, traditionally fitted on the main set shaft, is belt driven in order to use a higher speed machine; the mechanical connection between engine and auxiliary services is more and more employed and the auxiliary generator is subsequently reduced in importance, no longer feeding the separate fans of the traction motors, the compressors, etc., whilst the radiator fans are driven by hydraulic or electric couplings from the end of the Diesel shaft.

Same tendency to electric traction motors at higher speeds, connected to the axles by way of cardanic rods, with a view to reducing considerably the weight of the locomotives, has had little result, because the system becomes thereby more complicated.

With regard to the systems of regulation, these all tend to permit a more efficient utilisation of the whole power of the Diesel without ever overloading.

The control device, therefore, must regulate, at a constant rate, the power which the Diesel develops for each of its running speeds, by means of the electric parameters of the main generator (voltage and current) acting through the excitation of the generator itself, in order to vary the mechanical parameters of the locomotive (tractive effort and speed) continuously and accordingly to the conditions of load, or to gradient.

These modern Diesel electric locomotives: reduced weight per axle (thanks to the constructive characteristics of the mechanical parts and to high speed and supercharged engines); electric transmission studied in its entirety (whether as traction generator and motors or auxiliary services); perfected control systems; minimum maintenance demands; adaptation to every service requirement, whether on main lines services or as goods trains, or (for small powered or medium powered types) as switching service—have been produced and run regularly. Moreover they have been submitted to tests of comparison with similar locomotives, (similar except in transmission which is hydraulic) and have proved a saving and, with equal performances at wheels, less consumption of fuel.

In most parts of the world, today is the day of the Diesel; almost every day a steam locomotive gives way to a Diesel, or, more precisely, a Diesel takes the place of two or three steam locomotives (according to its use). However, ultimately, this is but a phase in the development of the Railway, which must constanly search for more simple and more economic means, if it is not to be submerged by the competition of the other means of transport.

With which, one returns to the question of electrification: as already mentioned, the cost of equipping for Diesel rises sharply in relation to power, owing the impositions given by gauge and clearance limits, and by admissible axle load, and when heavy trains are to be pulled, the cost of change over to Diesel traction approaches that for electrification, without taking into consideration the fact that, as regards electrification in comparison with the Diesel, in such case the saving on maintenance and energy is considerable, and can completely out-balance the other advantages.

Under these circumstances, electrification becomes more practical than the Diesel: the questions of density of traffic and tonnage become determining factors between the two systems.

On the ever increasing distribution of electricity throughout the whole world and the extension of great interwoven networks, we cannot ignore the fact that, owing to many more powers stations of all types, even atomic, put into use, the cost of electricity will constantly be reduced, and this renders electrification easier.

Each electrified kilometer consequently decreases in cost and also the above-mentioned "limit of convenience" steps down—the Railway can therefore face the constant competition of other means of transport.

Which will eventually be the prevailing system of electrification cannot be said for certain: direct or alternate current?

One hears much of the latter and of the highly attractive possibilities of single phase industrial frequency traction, which gives added incentive to the idea of electrifying railways the world over. Certainly, the progress already attained is considerable but not all the difficulties have yet been overcome : rather, they have been overcome thanks to the aid of direct current, with rectifying on vehicles. But are these vehicles D. C. or A. C. locomotives ? And how many are the savings with one substation per vehicle?

Thus the question here lies not so much in the technical field, as in terms of actual cost. An exact assessment of the situation, moreover, is difficult to come by, for all reports come from different parts of the world with greatly differing economic conditions.

In effect, the railways have at their disposition two methods of traction—electric and diesel—both international and both integrating each other. It is impossible, today, to say where the boundary between them will lie, the day in which the last furnace dies in a steam locomotive. The technicians never rest in their constant search : the two camps, mechanical and electrical (and thermal when required), no longer stay far from one another, but come together and realise their importance one to the other, and the necessity to work together, in order to obtain, in the future, a more perfect and more economic locomotive.

Developments with Diesel Railway Traction Engines

By An Engineering Correspondent

ALMOST every major railway in the world is engaged in modernising its motive power, replacing steam haulage by either, or both, electrification or diesel power.

Typical of recent European developments is British Railways which by its impressive 1955 Modernisation Plan, makes provision for the eventual introduction of some 2,300 main-line diesel locomotives (besides diesel shunters and railcars). These locomotives will play an important part in replacing the steam locomotive wh'ch has been the backbone of motive power in Great Britain for over a century and a quarter.

In this changeover of motive power, the Sulzer design of rail traction engine will be well represented for of the 1,653 diesel locomotives so far ordered by British Railways, 603—more than one third—will have Sulzer engines. Three engine types, all of the LDA28 range have been ordered.

Other notable European railway orders for Sulzer engines have included 70 for Red National de los Ferrocarriles Espanoles (RENFE) shunting locomotives, and over 230 for French National Railways (SNCF) for shunters and powerful freight locomotives (Fig. 1).

In all, Sulzer-engined locomotives have been supplied to railways in over 100 countries. Sulzer

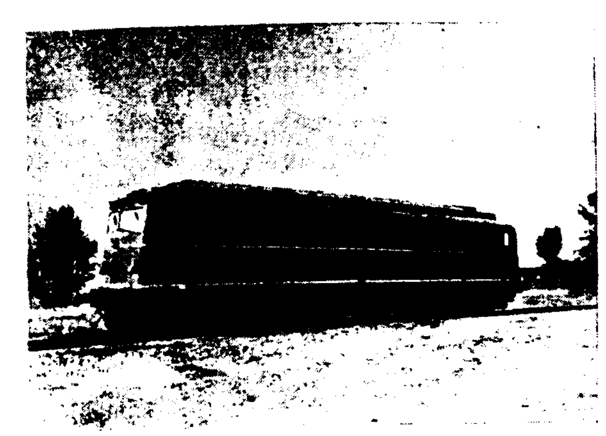


Fig. 1. Diesel-electric locomotive rated at 2,000 h. p. built in 1954–55 for the French National Railways for duties on the Grande Ceinture line (Paris).

Brothers have had a hand in the earliest developments of oil-engined traction on many railways, and it is a tribute to the workmanship and design of the engine that a number of early locomotives and railcars still continue to give good service.

The oldest Sulzer engine still in operation was one fitted to one of five Sulzer railcars which were put into service in 1914 by German railway companies, among the first diesel-electric vehicles to be constructed. Each of them was fitted with a six-cylinder four-stroke V-engine developing 200 h. p. at 440 r. p. m. One of these railcars is still in service to-day on the lines of the Val-de-Travers Railway in Switzerland as a stand-by unit (Fig. 2). Another example of long-life is that

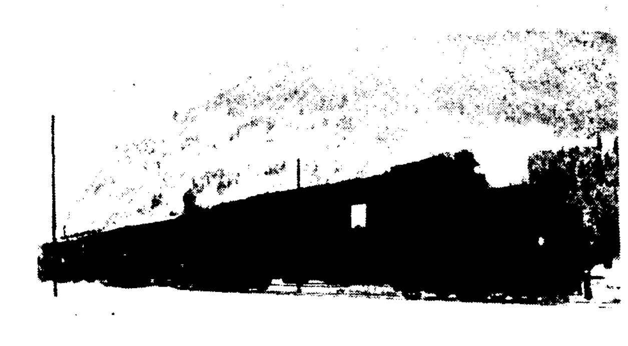


Fig. 2. One of the world's first diesel-electric Railcars, built in 1914.

of the four 270 h. p. railcars put into service in 1935 by the Ferrocarril Provincial de Buenos Aires. Each railcar has now covered about 1,250,000 miles (2,000,000 km.); and all are still in service.

An outstanding locomotive design is the diesel-electric double locomotive of 4,400 h. p. built for the Rumanian State Railways in 1938 and intended for handling express trains on main lines (Fig. 3a). This unit is capable of hauling 600-ton trains at 100 km. per hour on the level or at 35 km. per hour on the steepest gradients (1 in 40) of the Ploesti-Brasov line in the Carpathians. It consists of two articulated sections, each equipped with a diesel-generator group (Fig. 3b). The power units feed the four traction motors in each half of the locomotive. The Sulzer pressure-charged double-bank 12-cylinder engines develop 2,200 h.p. each at 700 r. p. m.

The behaviour of these double-bank engines in this twin-unit (still in regular service, 21 years later) has resulted in Rumanian State Railways obtaining further locomotives embodying the latest development of this engine design ; the first of 16 units set to 2,100 h. p. to suit local requirements, with 114 tons all-up service weight carried on a Co-Co wheel arrangement, was delivered in August, 1959 (Fig. 4a and b).

In 1938, a large diesel-electric double locomotive was put into service by the French National Railways (S. N. C. F.), intended for hauling heavy expresses

Fig. 3a. Diesel-electric locomotive of 4,400 h.p. for the Rumanian State Railways, built in 1938 and still in regular service.

Fig. 4a. Sixteen 2,100 h.p. Co-Co locomotives of this type are being delivered to Rumania.

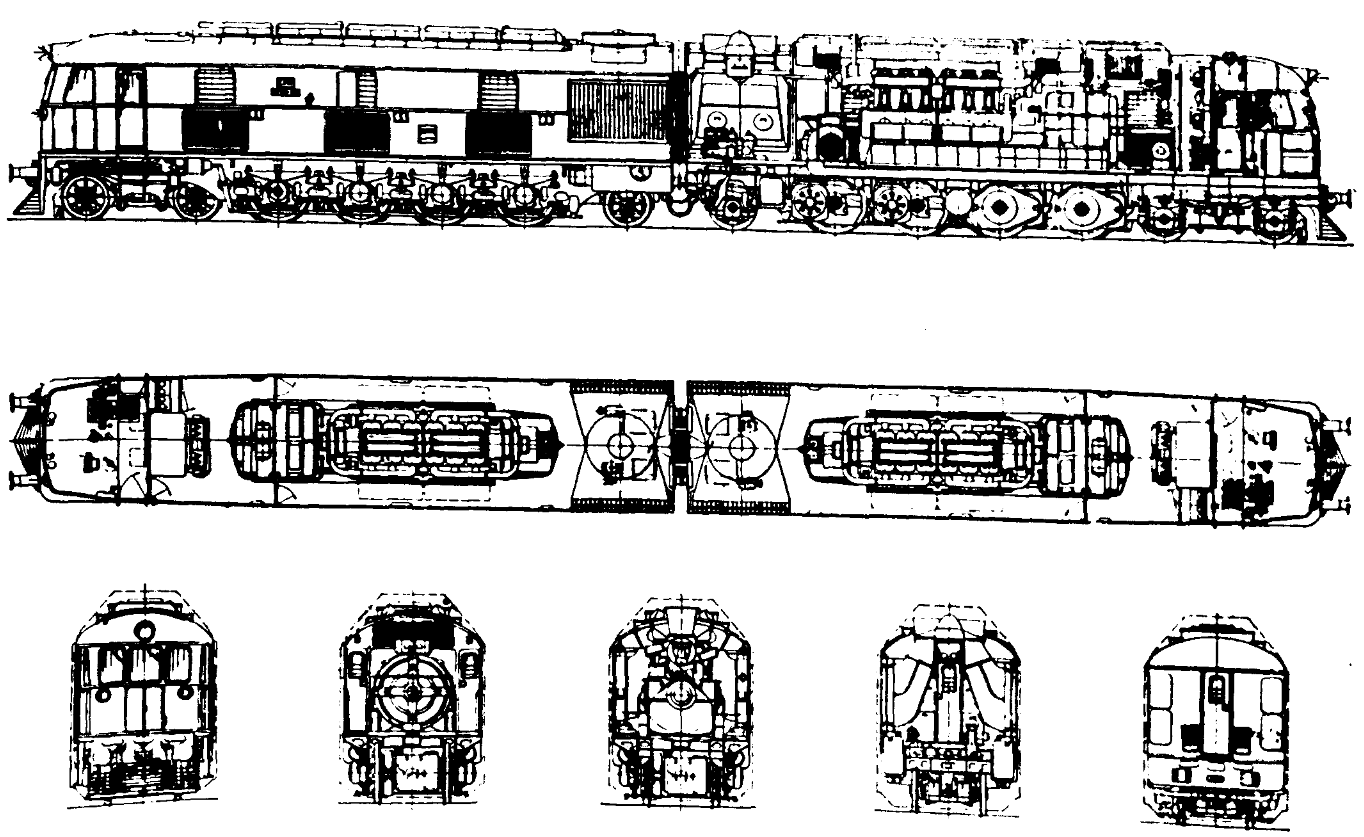


Fig. 3b. Drawings of the 4,400 h p. twin-unit for Rumanian State Railways, built in 1938 and still in service.

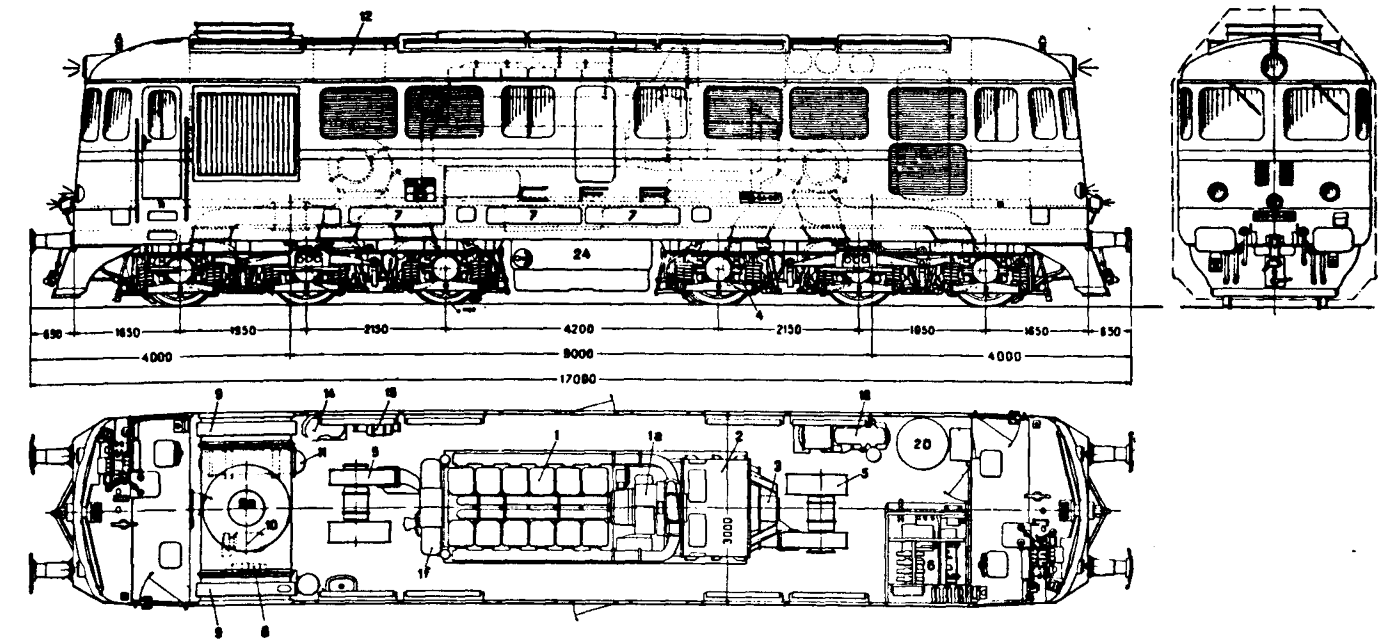


Fig. 4b. Drawings of 2,100 h.p. diesel-electric locomotives for Rumania showing the good layout arrangement of the equipment.

LEGEND : 1. Diesel engine; 1a. Pressure-charger; 1b. Lubricating oil filter; 2. Main generator; 3. Auxiliary generator; 4. Traction motor; 5. Traction motor blowers; 6. Air brake compressor; 7. Electrical control box; 8. Battery; 9. Radiators; 10. Radiator fan; 11. Lubricating oil heat exchanger; 12. Main fuel tank; 13. Water tank; 14. Cooling water pump; 15. Transformer unit; 16. Auxiliary lubricating oil pump and fuel transfer pump; 17. Cooling water and lubricating water heater; 18. Main air reservoir.

over long distances at a maximum speed of 80 m. p. h. (130 km. p. h.) (Fig. 5). This was fitted with two Sulzer twelve-cylinder double-bank engines each supplying 2,200 h. p. at 700 r. p. m. A modern version of this engine is used in 35 S. N. C. F. freight locomotives of the type shown in Fig. 1. The double locomotive was withdrawn from service only a few years ago, after covering 1 million miles, for experimental purposes to enable a thorough investigation of the wear pattern of the engines to be carried out. The data obtained has proved invaluable and has been incorporated in succeeding engine designs and in determining the limits of wear recommendations.

Sulzer experience goes back to the very beginning of diesel traction, for the first main-line diesel locomotive in the world was powered by a Sulzer engine. The Sulzer company has the distinction of affording Dr. Rudolf Diesel effective support in the development of his new engine from as early as 1893, onwards by signing several agreements with him and by building an experimental engine.

The locomotive was built in 1912 and represented the first practical attempt to use the diesel engine for

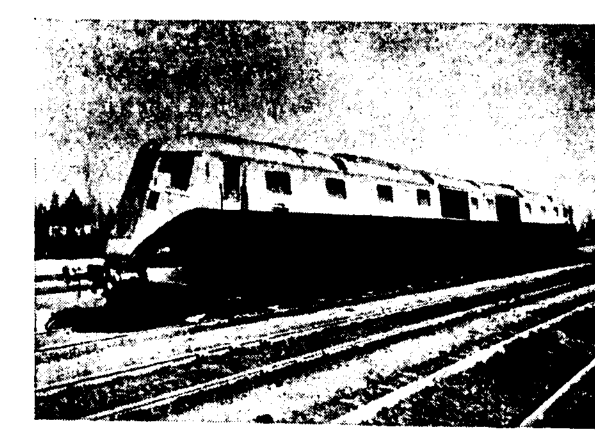


Fig. 5. Diesel-electric locomotive of 4,400 h.p. built in 1938 for the French National Railways for heavy express haulage.

line-service rail traction. The engine was a two-stroke V-type with four cylinders developing 1,000 h. p. The locomotive was put into trial service by the Prussian State Railways and attained speeds of 60 m. p. h. (100 km. p. h.) (Fig. 6). As the diesel engine cannot start unassisted, compressed air was supplied for this purpose by an auxiliary diesel-compressor set. This

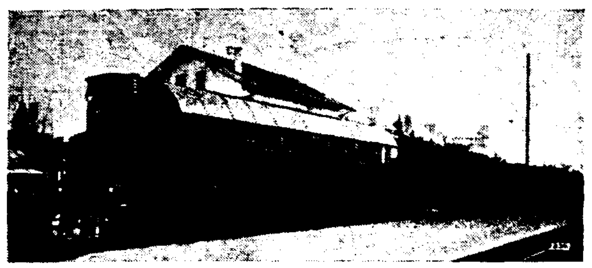


Fig. 6. The world's first main-line diesel locomotive built in 1912 for the Prussian State Railways and equipped with a Sulzer engine.

compressed air cooled the engine so much that ignition became difficult. Although this vehicle, with its direct power transmission to the driving wheels (Fig. 7), did not give satisfaction, as an operating unit, it provided valuable experience for the later development of the diesel traction engine.

Due to failure of the transmission, progress of diesel traction was at first slow, but some years after the end of the First World War diesel engines were already being widely tried in shunting Locomotives ; a great step forward was the application of pressure-charging to a four-stroke engine which enabled the specific output to be increased, and by 1939 main-line diesel locomotives and railcars were already a practicable proposition and many examples with Sulzer engines were in regular service.

Pressure-charging now permits the diesel engine to operate without any serious loss of power even at altitudes over 13,000 ft., and it is now widely applied to all types of traction duty, except shunting for which it is barely of advantage.

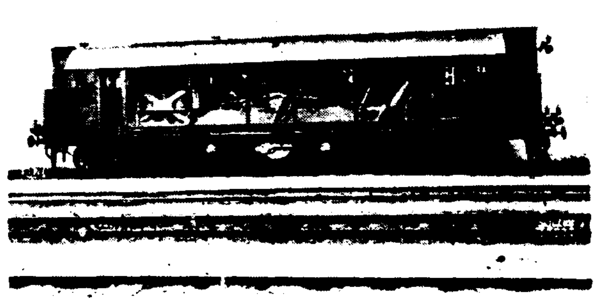


Fig. 7. The first diesel locomotive with side panels removed to show the layout and drive of the V-type engine.

As a diesel engine cannot start up unassisted and will not take very much torque over-load, the direct coupling of the engine to the driving axles presents insurmountable technical difficulties, as the very first diesel locomotive proved. Some form of indirect power transmission is therefore necessary to enable the tractive effort at the driving-wheel rim to be adapted to the widely varying requirements (starting, running on the level, climbing gradients) while the load on the engine is kept constant.

Electric transmission was introduced in conjunction with a Sulzer-engined vehicle as early as 1914—one of the earliest applications of this transmission type. With this form of transmission the control is such that the engine always gives the optimum power to the particular prevailing conditions so that fuel and lubricant consumption and wear on engine components are minimised over the whole working range. Fig. 8 shows the basic working diagram of an electric transmission system for a Sulzer-engined locomotive.

For hydraulic transmission with which Sulzer engines are also used, both in main-line and shunting locomotives, the main controlling force derives from the torque converter which causes the engine to run a predetermined speed for each output ; and consequently

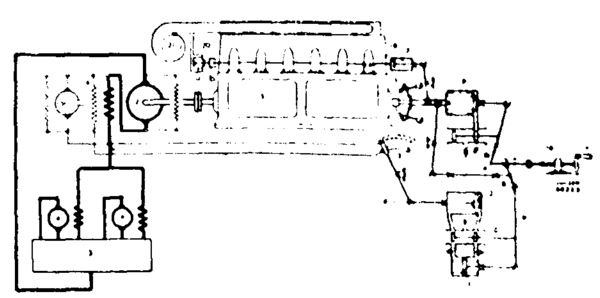


Fig. 8. Basic control diagram of a diesel-electric Vehicle.

1. Diesel engine
2. Main generator
3. Main-circuit control gear
4. Traction motors
5. Governor
6. Speed adjuster for 5
7. Control valve for 6
8, 9. Levers connecting speed adjuster and field regulator
10. Control valve of field regulator
11. Hydraulic reset for 10
12. Servomotor piston of field regulator 13
13. Field regulator with regulating resistance
14. Separate excitation of main generator
15. Auxiliary generator
16. Controller
17. Elastic link between governor and fuel pump regulating rod 18
18. Fuel pump regulating rod
19. Fuel pumps
20. Pressure-charging safety device
21. Pressure-charging group

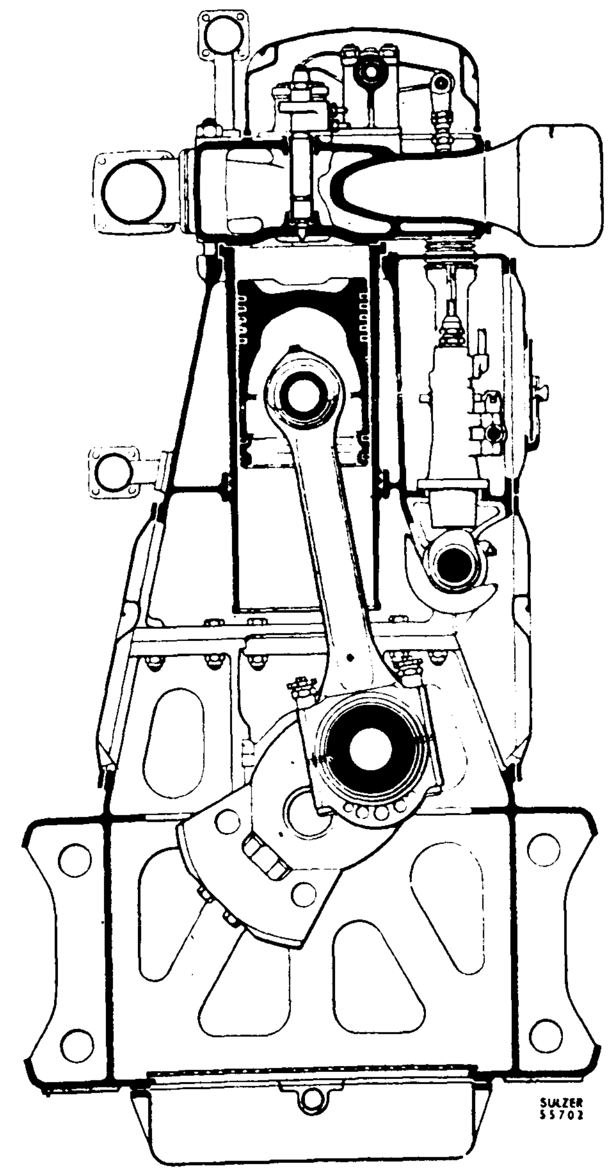


Fig. 9a. Cross-section through a modern Sulzer four-stroke diesel engine for rail traction.

the engine is not as ideally loaded with hydraulic as with electric transmission particularly at part loads.

One of the most arduous forms of service for a diesel engine is main-line railway traction ; and the most successful engine is one having a long history of traction service which has permitted full development of every component to ensure reliability.

The engine designer's aim is always for overhaul periods to be as widely spaced as possible, with trouble-free running between overhauls. Modern traction oil engines vary considerably in both running speeds, and number and size of cylinders ; with the high-speed

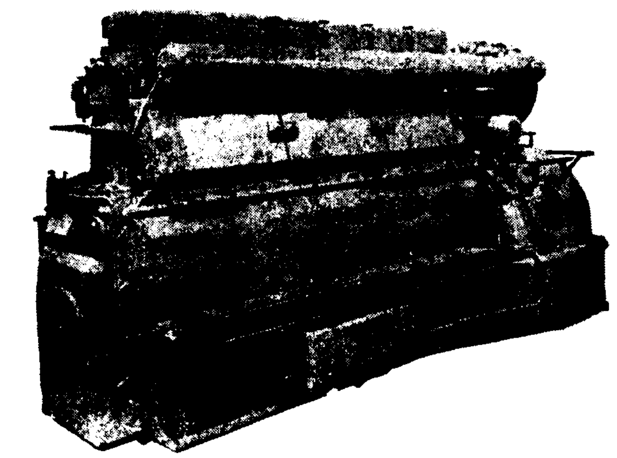


Fig. 9b. Six-cylinder 6LDA28 engine rated at 1,160 h.p. (continuous) at 750 r.p m. (non-intercooled).

engine there is a multiplicity of pistons and cylinders which add to complication, not only tending to an increase of incidents but also increased maintenance costs.

It is the conviction—that service reliability and economy in a traction diesel engine are enhanced by a straight-forward design with a few large and robust parts in preference to a multiplicity of smaller ones, together with a moderate speed of rotation—that has been the hall-mark of the Sulzer design of engine since the very first essay into railway traction. This principle is clearly seen in the present LDA28 range, which embraces three designs of six, eight and twelve-cylinders covering power outputs of 1,160—2,500 b. h. p. The engine speed is 750 r. p. m. The basic design of all three was laid down in the early 1930's since when it has remained unchanged (although not without attention to detail to achieve ever-increasing specific powers). The six and eight-cylinder versions are both in-line designs, the twelve-cylinder having two vertical bank of six in-line each. Details of output, weights and so on are given in Table A.

Throughout their development, Sulzer engines show the application of the idea of reliability from simplicity. Thus with engines having a b. m. e. p. rating of upto 170 lbs./sq. in. two-valve cylinder heads have been used, and during the long period when engine bearings set a definite limit to specific engine outputs, the in-line engine arrangement for lower outputs and the double-bank for higher outputs were preferred to the V-type with its limitation on big-end bearing design. Hence, these cylinder arrangements have been used in the LDA28 range

A cross-section of an in-line LDA28 engine is shown in Fig. 9a which, again, indicates the robust proportions of the engine components. Fig. 9b shows the in-line six-cylinder version.

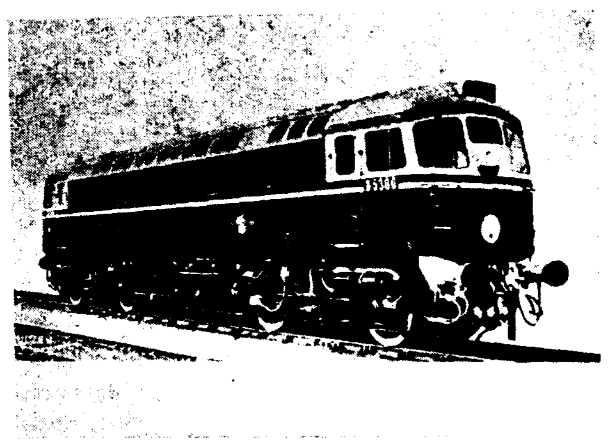


Fig. 10a. British Railways "Type 2" diesel-electric locomotive equipped with Sulzer 6LDA28 engine, and built by the Birmingham Railway Carriage & Wagon Co. Ltd.

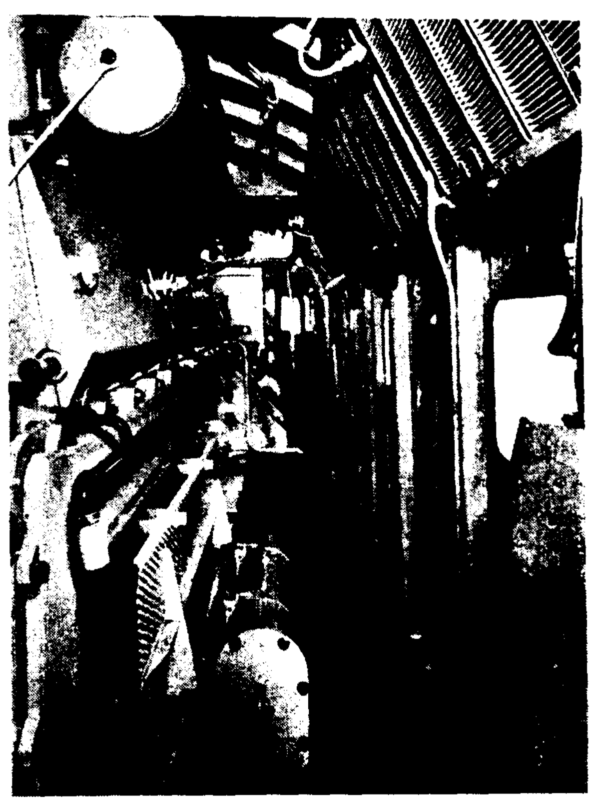


Fig. 10b. Engine room of Birmingham-built "Type 2" 1,160 h p. diesel-electric locomotive for British Railways showing ease of access down the side of the 6LDA28 engine.

Many of the components are interchangeable in the three engines; the pistons, piston rings, gudgeon pins, small-end bearings, valves, valve gearing, cylinder liners, connecting rods, main and big-end bearings, injectors, fuel pumps and so on are identical.

These engines have been built solely for railway work and in consequence they have numerous "railway" features. One of the most important of these is the way they fit within restricted loading gauges and yet give extremely good locomotive layout with ample space for maintenance. By way of example, the Birmingham-built 1,160 b. h. p. diesel-electric locomotives for British Railways (Fig. 10a) have a clear walkway right round the power group, despite an external body width of only 8 ft. 10 in, as the illustration shows clearly (Fig. 10b). Again the twin-bank engine ordered for more than 200 British Railways main-line locomotives of 2,300/2,500 b. h. p. (Fig. 11) affords 1 ft. 3½ in. along each side, being only 5 ft. 9½ in. wide, with a locomotive body width (external) of 8 ft. 10⅜ in.

Main constructional features of the LDA28 Sulzer traction oil engine, include welded steel integral crankcase/generator structure; welded cylinder block, bolted to the crankcase, and designed so that all the combustion forces are transmitted in straight lines

Fig. 11. The first of 217 main-line British Railways locomotives of 2,300 and 2,500 h.p. incorporating the Sulzer double-bank engine.

through the whole framing to avoid long through bolts; the use of rigid steel castings for the transversals of both crankcase and cylinder block which are welded to the side plates and top bearings caps locked into the main framing to act as strong transverse bridges above the U-shape in the framing for the bearing housing. A small, but significant, features which exemplifies the Sulzer attention to detail is the patent toothed locking device for the big-end bolt nuts, providing a definite lock without the use of split pins.

During the most recent years the vast Sulzer development and research organisations have been used to develop yet another range of traction engines which whilst preserving the classical features of moderate speed and simplicity embodies much higher specific outputs. The first step in this direction was in the labourious research of bearing design which included long-term, full-scale testing of these components. Through this work, bearings accepting much higher specific loads than hitherto have been developed so that now a V-engine with the straight-forward, side-by-side connecting rod arrangement could be created. Consequently, V-engines allowing high pressure-charging up to 210 b. m. e. p. were built and tested. The fulfillment of these years of effort is the construction of the new LVA24 range of engines with the characteristics and weights given in Table 'B'.

The eight-cylinder 8LVA24 engines of this range have now completed their test trials and are commencing service trials whilst the first batch of twelve-cylinder 12LVA24 units is now under construction.

TABLE 'A'

LDA28 Engines Bore, 280 m. m. Stroke 310 m. m.

Engine Type	6LDA28-B	8LDA28-B	12LDA28-B
No. of Cylinders	6	8	12
Output (continuous) h. p.	1250	1700	2500
R. p. m.	750	750	750
Weight (dry) tons	9.5	12.4	19.9

TABLE 'B'

LVA24 Engines Bore, 240 m. m. Stroke, 280 m. m.

Engine Type	8LVA24	12LVA24	16LVA24
No. of Cylinders	8	12	16
Output (continuous) h. p.	1750	2650	3500
R. p. m.	1050	1050	1050
Weight (dry) tons	10.3	14.2	18.2

STANVAC WANTS TO EXPLORE FOR OIL IN RAJASTHAN

It is now revealed that Standard-Vacuum Oil Company has submitted proposals to the Government of India for exploration of oil in the Jaisalmer area of Rajasthan. This follows the official statement in the Lok Sabha recently that the Government of India was at present studying the proposals submitted by a foreign oil company for exploration in the Rajasthan area. Asked to comment on this statement, the Standard-Vacuum spokesman pointed out that the new proposals had been submitted before the formalities were completed for the termination of the search for oil in West Bengal under the Indo-Stanvac Project.

The proposals were submitted in response to the Government of India's appeal to foreign oil concerns to engage in the search for oil in India.

Recalling that the abandonment of the search for oil in West Bengal had meant the loss to the Company of crores of rupees, the spokesman went on to say that it in no way lessened Stanvac's intention to look for oil elsewhere in India.

In the best of circumstances, the search for oil was a big gamble and all private companies looking for oil had to reckon with such huge losses.

* * *

VICKERS HARDNESS TEST FOR STEEL

The Indian Standards Institution has recently published IS: 1501—1959 Method for Vickers Hardness Test for Steel. This standard belongs to a series of Indian Standards for mechanical testing of metals. For all practical purposes, this standard is a reproduction of Draft ISO Recommendation No. 120 Vickers Hardness Test for Steel which represents the consensus of international opinion on the subject.

Contribution of RIV Products to the improvement of Railway equipment

By Giovanni Conti

— Higher speeds and quicker accelerations.

— Higher payloads.

— Improvement of conditions making for passenger comfort.

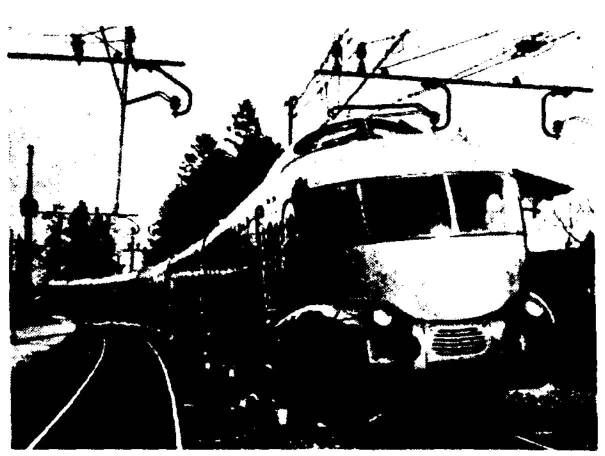
— Safer operation.

— Higher equipment turnover.

— Less maintenance.

These are, briefly, the main considerations governing the design approach for all new equipment. Both operators and builders have been aiming at these desirable features, and, indeed, there is an amazing record of progress in all of the above directions.

The 202-km-per-hour mark reached by the State Railway–Breda three-unit articulated electric train on a straight stretch of the Rome-Formia run some twenty-five years ago—this still being something of a record for determined working conditions—is certainly eloquent evidence of the progress made in the speed field.



Seven-unit articulated electric train ETR 300 " Settebello " manufactured by BREDA for the Italian State Railways, with axle-boxes, traction motors and auxiliary gear equipped with RIV antifriction bearings.

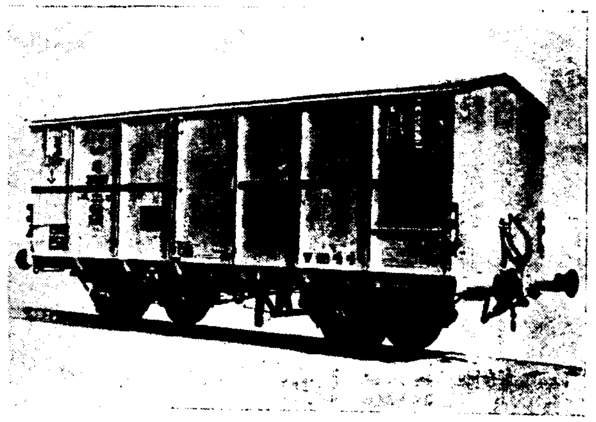
And the payloads to which, under particular emergency conditions, we have seen many cars subjected, point up the fact that the second problem, too, has been successfully solved.

An answer to the third problem is provided by the comfort standard which can now be enjoyed by riders on certain carriages, especially those in crack trains, by reason of the excellent suspensions, freedom from objectionable noise, air-conditioning amenities.

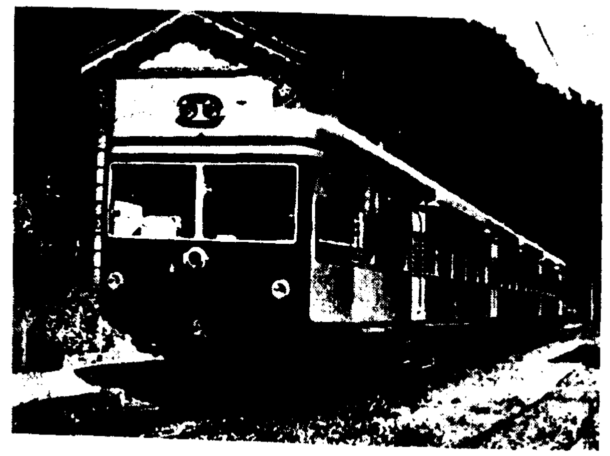
Type " P " stainless steel sleeping car manufactured by ANSALDO for Compagnie Internationale des Wagons-Lits equipped with RIV Tr 233 spherical roller bearing axle-boxes.

As to the remaining counts, railway statistics speak for themselves, particularly so on the score of maintenance, because with modern equipment overhauls have been spaced very much apart, without any maintenance operation, even of a checking nature, being required over the long intervening period.

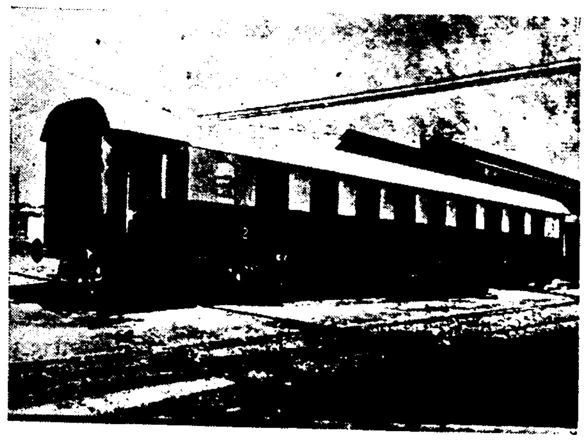
This summary information will serve as an introduction to the development of our thesis about the magnitude of RIV's contribution to the solution of the problem. A brief description of the range of products brought out by RIV for railway applications will serve the purpose of underlining that contribution and promoting their use.



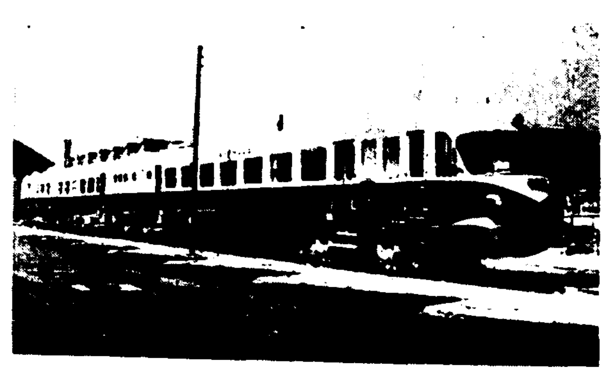
British-form refrigerator car type "Hgb" series 390,000 of the Italian State Railways, with RIV Tr 191 taper roller bearing axle-boxes.



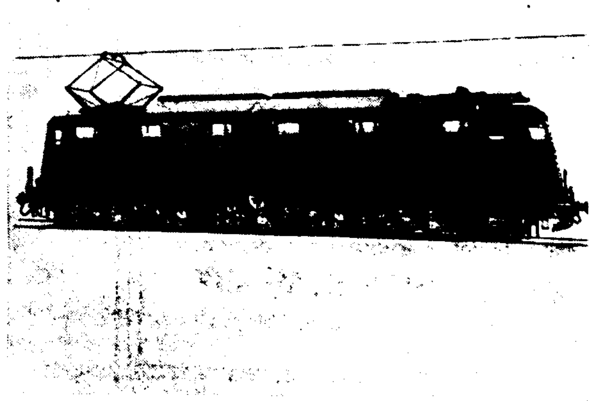
FIAT railcar set for the Indian Railways with axle-boxes, traction motors and transmission gear equipped with RIV antifriction bearings.



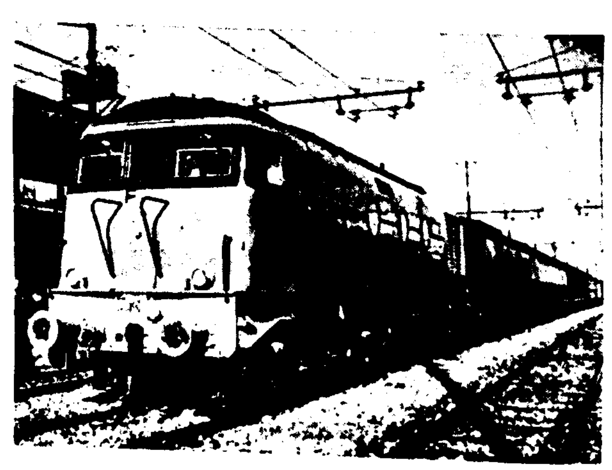
Italian State Railways 2nd class passenger coach, manufactured by BREDA, equipped with RIV Tr 196 cylindrical roller bearing axle-boxes (journal dia. 130 mm).



TEE (Trans. Europ. Express) train manufactured by BREDA fitted with RIV Tr 244 cylindrical roller bearing axle-boxes.



E 636 electric locomotive of the Italian State Railways equipped with RIV Tr 263 cylindrical roller bearing axle-boxes.



FIAT Diesel-electric locomotive for the Italian State Railways with axle-boxes, motors and transmission gear equipped with RIV antifriction bearings.

ROLLER BEARING AXLE-BOXES

Everybody is familiar with roller bearing axle-boxes, in their rough outline, and the advantages they hold over the older plain white-metal axle-boxes. It can, indeed, be said that at present the only consideration which still causes some designers to hesitate in choosing between the two types of axle-box, is the higher initial expenditure involved.

It should, however, be clearly established that this consideration is far from tipping the scales, being much outweighed by other favourable factors, such as maintenance economies, power savings, lubricant savings, which in a short while will pay for the higher initial capital outlay.

Whereas the first roller bearing boxes were rather complicated affairs both as to bearing form and arrangement, the latest designs have emerged in a cleaned-up, simple construction which goes hand in hand with a higher safety of all component parts.

The conventional roller bearing box layout universally accepted as being simple, safe and easy to service, is that shown in *Fig. 1* : it comprises two cylindrical roller bearings, one of which carries on its inner race

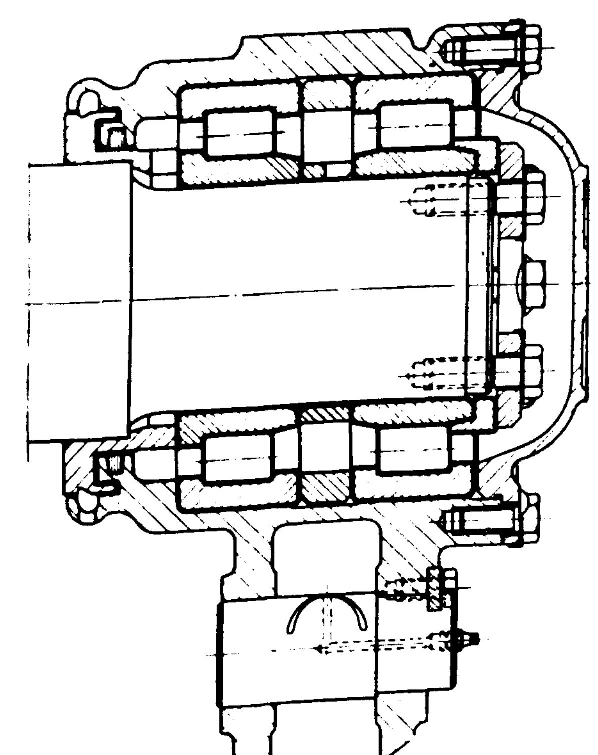


Fig. 1. Axle-box with two cylindrical roller bearings.

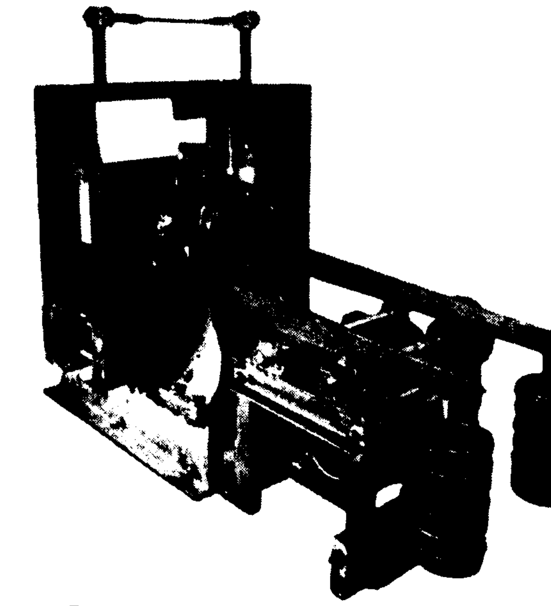


Fig. 2. Machine for testing railway axle-boxes under load.

an applied shoulder ring that makes for extremely easy assembly and disassembly operations.

For inspection, the applied shoulder ring is removed and the main axle-box sub-assembly comprising outer races and roller rows is taken off, thereby uncovering the most critical portion of the roller tracks and permitting an inspection of all component parts.

This design of roller bearing box is suitable for use on tramcars, railway carriages, railcars, electric trains, and also locomotives, namely all rolling stock.

Bearing calculation—which is, of course, always predicated on service conditions—is an easy matter, because the total radial load is equally shared by the two bearings, whilst the thrust ismore than safely dealt with by the roller end faces and race lips with a resultant low sliding friction, thanks to the very good lubrication conditions.

It is generally possible to design axle-boxes with moderate overall dimensions, even where the loads are heavy and the speeds very high.

Extended tests carried out by RIV on the testing machine shown in *Fig. 2*, have borne out the fact that —even where a very high thrust is involved relative to the radial load, as is the case for instance when trains are brought round a narrow curve at high speed or when passing a facing point switch—the bearing shoulder rings are quite up to the job, so that the general arrangement, backed by a background of satisfactory use in tens of thousands of axle-boxes over several years, can be safely relied upon.

The axle-journal packings or seals, simple and efficient, ensure lubricant retention and exclusion of foreign matter : about 1 kg. of consistent grease, suitable for antifriction bearings, is enough for proper axle-box lubrication through at least 500,000—600,000 km, or 4—6 years of operation.

Another design of antifriction bearing axle-box is the taper roller bearing type shown in *Fig. 3*, which has been used extensively by the Italian State Railways on freight cars, including a large number of refrigerator cars for quick transportation of perishable food.

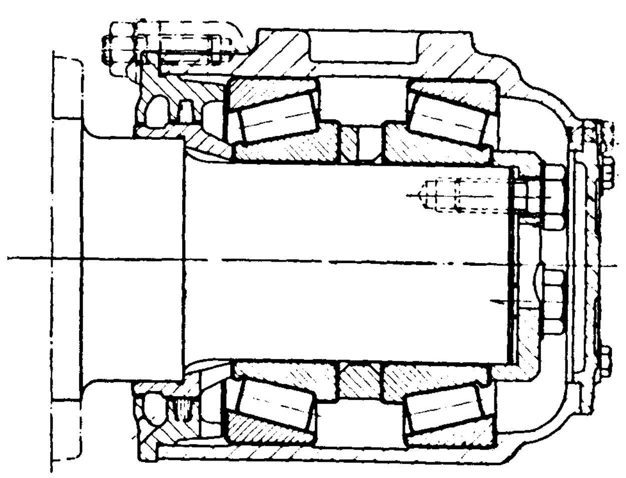


Fig. 3. Axle-box with two taper roller bearings.

The two bearings are arranged in opposed pairs ıamely with the large ends of the rollers facing each ›ther so that all possible combinations of radial and ıxial loads can be easily dealt with.

The boundary dimensions being equal in either case, :hese taper roller bearing boxes have a slightly higher oad capacity than the cylindrical roller type ; on the ›ther hand, they call for somewhat more frequent nspections because taper roller bearings develop a ·lightly higher friction. This is the reason why taper 'oller bearing axle-boxes have much to recommend hem for freight car applications where the yearly mele-ıges are as a rule substantially lower than is the case with passenger cars and locomotives. In these boxes, oo, about 1 kg. of grease will do for 200,000—300,000 km.

Still another design of antifriction bearing axle-box ı the one embodying a single, self-aligning roller bearing, as shown in *Fig. 4*, which is particularly suitable for those bogies where cross motion of the assembly is taken care of partly by the bolster and partly by the connecting member between axle-box and bogie, which is therefore so designed as to be capable of about one degree oscillation either way.

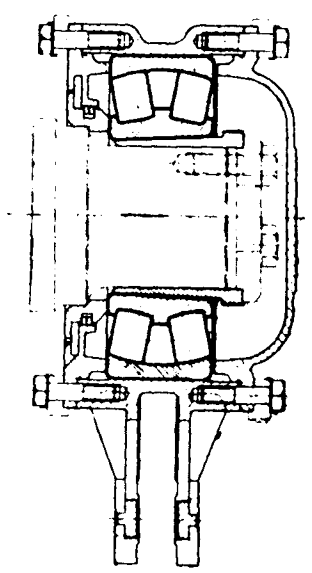


Fig. 4. Axle-box with one self-aligning bearing.

This design of axle-box has been used on many railcars of the Italian State Railways, whereas in foreign countries, such as Switzerland, it is fitted also to passenger cars and even electric locomotives.

The self-aligning bearing unit with its two rows of barrel-shaped rollers permits of keeping overall dimensions within bounds harmonizing with the other bogie components although it generally requires—relatives to taper roller and cylindrical roller boxes—somewhat more radial space, which to some extent is, however, compensated for by lesser endwise space requirements.

Mounting and inspection operations—although still capable of being currently carried out without undue difficulties—are not nearly so easy as with the other designs, because self-aligning bearings are not of the separable construction where the various components can be easily taken apart : mounting is accomplished by arranging the complete bearing assembly (by a force fit on a cylindrical seat or by interposition of a taper adapter sleeve) on the journal, and by subsequent addition of the axle-box body, which can easily be put in place thanks to the clearance fit provided for the bearing outer ring.

Whereas in cylindrical roller and taper roller bearing boxes it is possible to bring into full view for inspection the roller surfaces and the track of one ring, in barrel-shaped roller bearing boxes, the visual inspection is not nearly so complete, because, short of an entire disassembly, it is limited to those parts which can be uncovered by cocking the outer ring as much as possible, namely until it comes up against the edges of the covers.

This construction of antifriction bearing axle-box will get along through 200,000—300,000 km. on about 800 grams of grease.

VARIOUS ANTIFRICTION BEARING APPLICATIONS

Worthy of particular mention—besides all applications which have by now become standard practice on auxiliary equipment in general—are those on traction motors, reduction gears, hollow axles, which involve heavily loaded large-size bearings.

Apart from the usual advantages flowing from a low friction co-efficient, ability to stand up safely to thousands of hours of operation at a stretch, freedom from any appreciable departure from the initial clearances, antifriction bearings in these applications have made a substantial contribution toward the solution of one of the major traction problems, because they have made it possible to increase twice and even thrice the time between inspections, in addition to making for much quicker inspection operations in the interest of a better car turnover.

In traction motors antifriction bearings have become standard fitments throughout the world : the typical arrangement is that which in the D. C. locomotives of the Italian State Railways was experimentally introduced shortly after 1930 on a few units of the E 636 Group, and then, on a large scale, in E 424 Group locomotives (see *Fig. 5*).

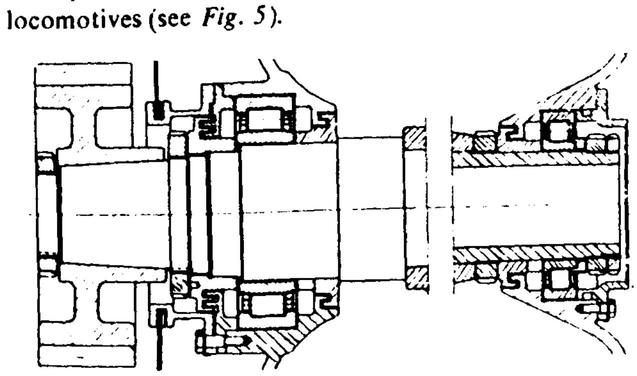


Fig. 5. Traction motor equipped with cylindrical roller bearings.

This scheme comprises two cylindrical roller bearings, one of which is of closed construction with four lips and locates the assembly end wise, whereas the other is of open construction to provide freedom and compensate for any faulty parts or mountings, or dimensional variations due either to thermal expansion effects or elastic distortions.

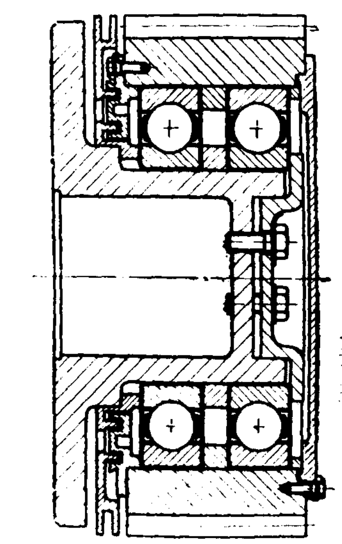


Fig. 6. Reduction gear for locomotive.

The motor designer, by adopting antifriction bearings, can easily scheme out matters in such a manner as to ensure :

- A very easy end-shield mounting, because inner and outer rings are mounted separately in their respective seats and are only brought together when the various motor components are assembled ;
- A simple disassembly operation for inspection or replacement purposes ;
- The possibility of matching rotors and frames of the same type without the need for any selective assembly of the bearings ;
- Sufficient lubricant retention, it being possible to devise very good protection schemes and adequate grease chambers without taking up too much axial space.

In reduction gears—which have now gained favour with most designers because they permit of locating the motor axes far away from the drive axles as desired and of obtaining certain rather high transmission ratios in a simpler way—the high speeds and stresses involved have always led to some trouble with plain bearings.

Application of two paired ball bearings as shown in *Fig. 6*, although it involved some initial research and development work in order to overcome certain defects produced by electric currents, as these gears generally operate in stray currents from exciting coils, has now solved the problem in all respects: ball bearing equipped reduction gears require no maintenance between overhauls.

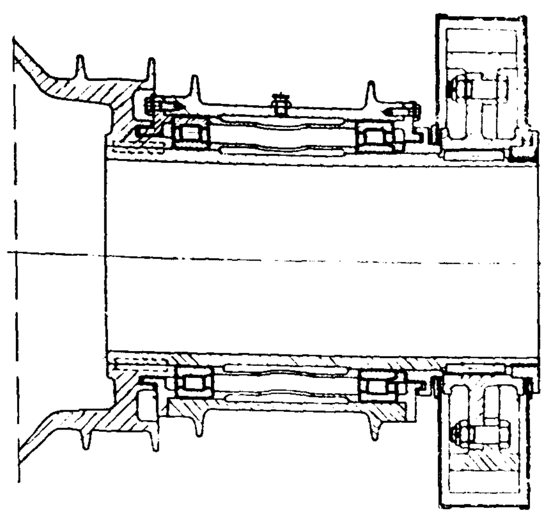


Fig. 7. Roller Bearings fitted on hollow axle of electric rail car.

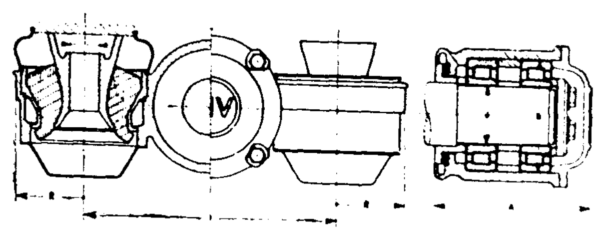


Fig. 8. Rubber springs fitted to a railway axle-box.

In hollow axles, use of antifriction bearings presents some design difficulties due to the need for special sizes of bearings having a large I. D. and taking up a limited radial space. For all these difficulties, this application has been satisfactorily developed and is currently used on many vehicles according to arrangements similar to that shown in *Fig. 7*, which has reference to the hollow axle of electric rail cars operating on the Italian State Railway System.

Those rail cars for which roller bearing applications have been adopted, appear to be running free from those troubles which are associated with wear and seizures of plain bearings, while the substantial maintenance and lubrication expenses required with white-metal bearings have also been overcome.

RUBBER SPRINGS, SILENTBLOCS AND ANTIVIBRATION MOUNTINGS

The battle against wear of sliding surfaces and objectionable vibration and noise has been faring better, with the contribution from RIV-made devices, to the benefit of passenger comfort and the life of certain parts previously subject to premature fatigue failure from vibration.

RIV rubber springs arranged as in *Fig. 8* have already seen considerable service on many cars and it has been established that they ensure sufficient rigidity of the axle sets relative to the bogies, although the arrangement no longer comprises, for connecting the two components, the conventional sliding members that posed so serious wear problems for railway engineers to tackle.

Added advantages are that rubber interposition contributed toward noise abatement, keeps electric currents away from the axle-boxes and cuts the expenses connected with replacement of worn parts.

Silentblocs and antivibration mountings fitted to elastic transmissions or motor suspensions, as in *Figs. 9 and 10*, have also contributed to the solution of major

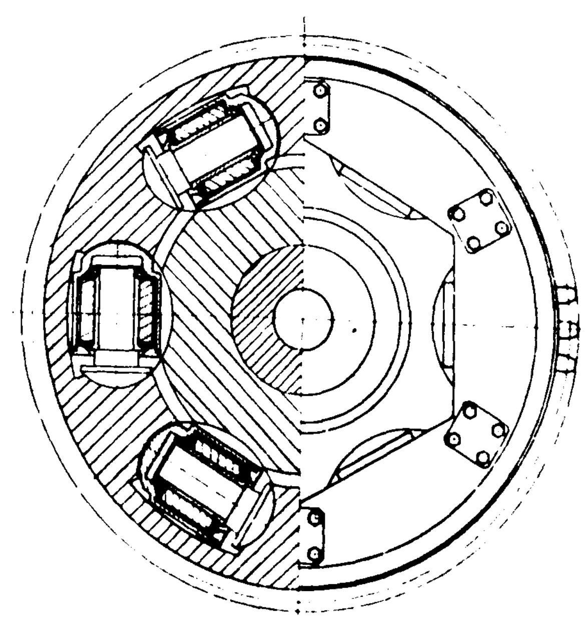


Fig. 9. Silentbloc flexible transmission.

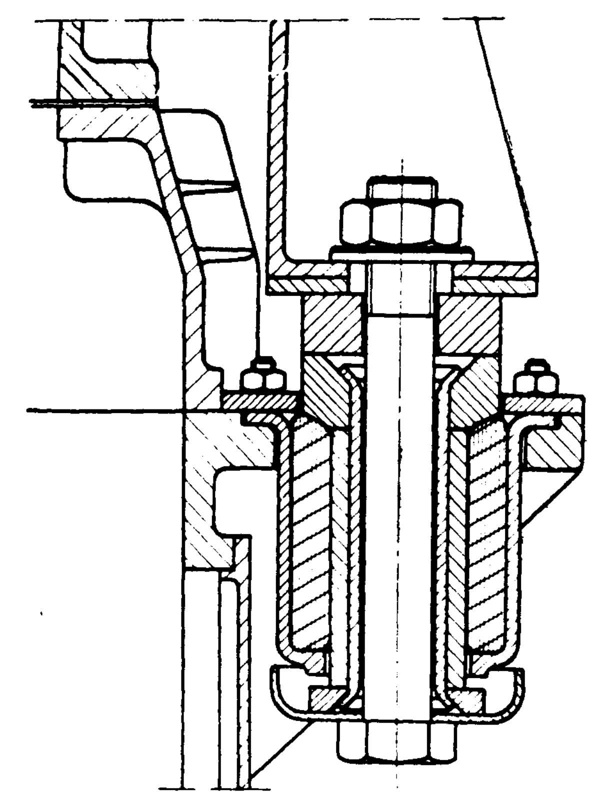


Fig. 10. Motor suspension equipped with antivibration mountings.

traction problems by affording the required degree of flexibility to the assembly, deadening noise, reducing vibration effects, and lengthening the life of certain components subjected to heavy stresses and which, in the older arrangements, suffered badly from alternating stress effects arising from railway joints and other periodic track irregularities.

HYDRAULIC SHOCK ABSORBERS

As in the automotive field so also in railway equipment, shock dampening devices are coming into general use to reduce residual oscillations from any disturbances, and make for a much smoother running, especially at high speeds and over irregular tracks, namely at crossings, curves, switches, etc.

In the latest bogie designs, shock absorbers are now used to dampen both vertical and horizontal motions: of course specially designed, heavy-duty suspension control units are used, so as to obviate the need for any unkeep between inspections.

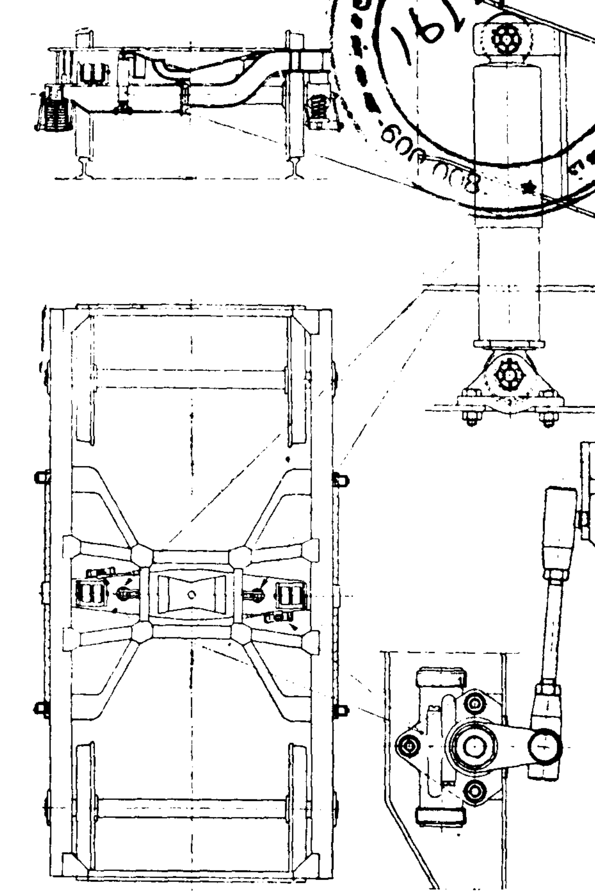


Fig. 11. Shock absorber arrangement on rail car bogie.

A typical application is that in *Fig. 11*, which refers to a railcar bogie suspension.

Generally speaking, where shock dampening devices are to be fitted, the suspension arrangement should be rather flexible so as to permit of better absorbing the irregularity, seeing that with shock absorbers there is no longer any cause for concern over residual motions.

A number of other items are currently manufactured by RIV for rail and tramway applications, such as piston rings and valve tappets for i. c. engines, as well as a wide range of synthetic resin plastic products, of both laminated and powder-moulded type which have properties eminently well-suited for these applications, such as the plasti RIV-Z-3 railway joints, which thanks to their mechanical properties have a by far longer life than any of the other types, including fibre joints; the plasti RIV-mel panels for car internal linings; many technical plastics for electrical applications; porcelanite plastic table-ware for dining cars.

Modern Brake Equipment and controls for Diesel and Electric Locomotives

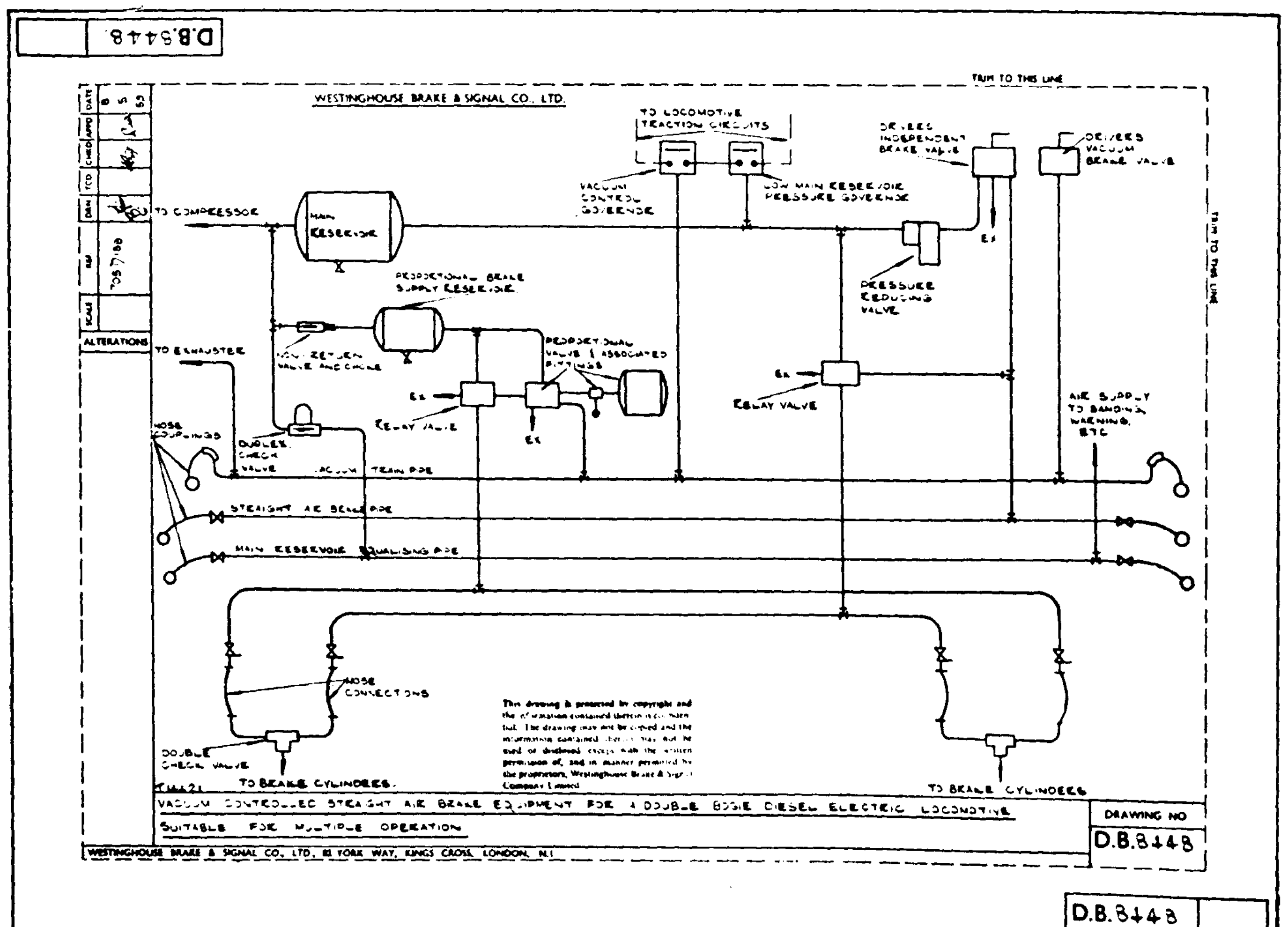
FUNDAMENTAL TYPES OF BRAKE EQUIPMENT

THE requirements of a braking system for a modern diesel or electric locomotive are dictated primarily by the particular class of traffic the locomotive is designed to handle and the type of brake fitted on the rolling stock.

In general, locomotive brakes are operated by air as the working fluid, either as compressed air or as air at atmospheric pressure acting against vacuum; the former arrangement is used on locomotives which are to haul compressed air braked stock, but when the stock is vacuum braked, either of these two systems may be used to provide the locomotive brake force.

The main advantage of using compressed air brakes on locomotives designed to haul vacuum braked trains is that the greater pressures available permit the use of smaller brake cylinders which are more easily accommodated on the bogie frames, particularly on railways where the loading gauge is restricted.

The main disadvantage on the other hand is the necessity for a dual system of control—compressed air for the locomotive and vacuum for the train. This involves the provision of suitable synchronizing devices



Westinghouse Vacuum Controlled Straight Air Brake Equipment for a double bogie diesel electric locomotive suitable for multiple operation.

to ensure that operation of the vacuum brake also automatically controls the air brake and keeps the two brake systems operating in the correct proportion to each other.

Whilst a vacuum system for both locomotive and train is simpler and avoids synchronization problems, much larger brake cylinders are required as the pressure available for operation is limited by the atmosphere.

Until recently, vacuum systems in use for locomotive braking only allowed a maximum pressure of 9 or 10 lb./sq. in. but improved arrangements now available give 12 to 13 lb./sq. in. In the case of the compressed air brake there is no natural pressure limit but 50/55 lb./sq. in. is normally adopted as a standard for maximum brake cylinder pressure with a main reservoir pressure of 85/100 lb./sq. in.

The Westinghouse equipment comprising a compressed air brake for the locomotive with controls for the operation of the vacuum brake on a train is known as a Vacuum Controlled Straight Air Brake.

WESTINGHOUSE VACUUM CONTROLLED STRAIGHT AIR BRAKE

The basic features of the layout of a typical brake of this type suitable for a double bogie locomotive, which has to be able to operate in multiple, are shown in the diagram.

In this arrangement the locomotive compressed air brake is divided into two separate systems, one controlled indirectly by the driver's vacuum brake valve and providing an air brake application on the locomotive in proportion to the vacuum brake application on the train, the other under the direct control of the driver's independent brake valve and providing a straight air brake for the locomotive completely independent of the train brake.

When the train vacuum brake is in use, the synchronous operation of the locomotive air brake is achieved by the action of a proportional valve which admits air to, or releases air from the locomotive brake cylinder in proportion to changes in the train pipe vacuum. The connections to the proportional valve are shown in the diagram which also includes the refinements necessary to cope with the supply of air to the brake cylinders on the bogies and the couplings required for multiple unit working.

Governors included in the two systems, and connected into the traction circuits, ensure that the locomotive cannot be moved under power unless both brake systems are operative, and the equipment is arranged so that if a flexible hose between the main frame and a bogie in one system fails, the alternative system is not impaired. To achieve this safeguard, the air supply for the locomotive independent brake is taken from the main reservoir whilst the air for the proportional brake is stored in a separate supply reservoir fed from the main reservoir through a non-return valve and a restriction or " choke ". In this way one brake system always remains available in the unlikely event of a bogie hose failure in the other. When necessary, greater protection can be provided by use of additional supply reservoirs and associated fittings.

In order to obtain rapid application and release of the brakes and to keep the proportional valve and independent brake valve down to reasonably small size, relay valves of large capacity are fitted between these controlling valves and the brake cylinders, as shown in the diagram. It is then necessary for the controlling valve to pass only sufficient air to apply a pressure to the relay valve which handles the bulk of the air flow and reproduces a similar pressure in the brake cylinders.

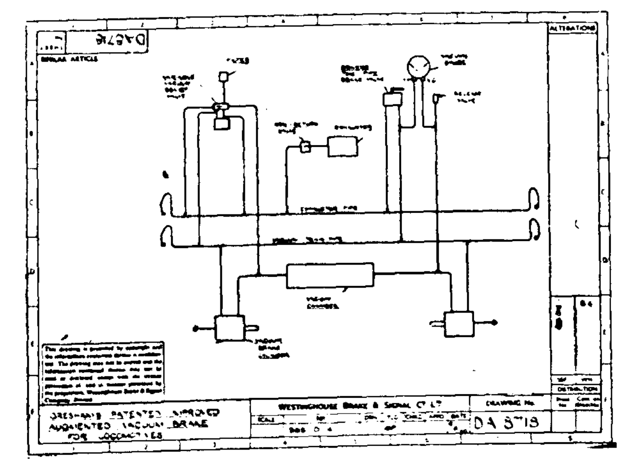
The through pipe to equalise the main reservoir pressures on locomotives working in multiple is connected to the main reservoir by way of a duplex check valve. This valve cuts off the flow of air to the equalising pipe when the main reservoir pressure falls to a fixed level and thereby prevents excessive loss of air if a hose coupling in the equalising pipe fails. The air supplies for auxiliary purposes such as sanding and warning are taken from the equalising pipe in order to avoid the main reservoir pressure being depleted by prolonged use of these devices.

Additional features such as " Deadman's " or a Vigilance control device may be added as required but are not included in this diagram.

GRESHAM'S PATENTED IMPROVED AUGMENTED VACUUM BRAKE

The difficulty in accommodating vacuum brake equipment on modern locomotives is overcome by the Gresham's Patented Improved Augmented Vacuum Brake system which permits the use of brake cylinders smaller than those previously required. This is achieved by allowing the exhauster to evacuate the vacuum chamber side of the brake cylinder, under

braking conditions, to up to 25" Hg., thereby raising the effective brake cylinder pressure. An arrangement of this brake system, suitable for a locomotive designed for multiple unit operation, is shown in its simplest form in the diagram.



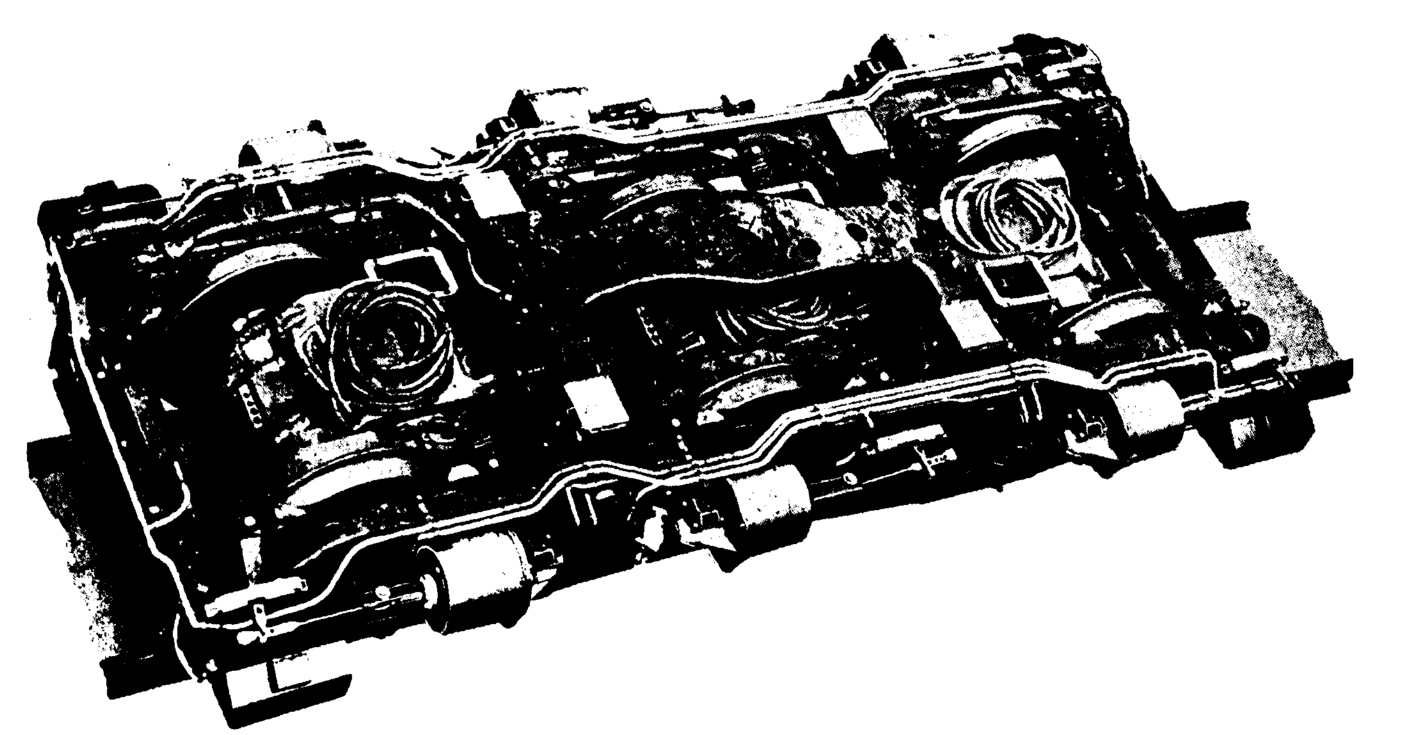
Gresham's Patented Improved Augmented Vacuum Brake for Locomotives.

In this layout the exhauster is connected to an exhauster pipe and connection is made from this pipe to the vacuum train pipe via a two-pipe driver's brake valve. The exhauster pipe is also connected to the vacuum chamber side of the brake cylinders via a non-return valve incorporated in a variable vacuum relief valve.

Two other connections are made to the variable relief valve from the exhauster pipe and the vacuum train pipe for control purposes.

When the brake is released, the exhauster pipe is connected to the vacuum train pipe through the brake valve, and the vacuum in the two pipes is therefore the same. Under these conditions the variable relief valve is adjusted to limit this vacuum to the nominal figure, usually 21" Hg., with a resulting vacuum of 20" Hg. in the chamber connected to the brake cylinders.

When the brake valve is operated to apply the brake, the exhauster pipe is isolated from the train pipe, and air is admitted to the train pipe. The resulting reduction in train pipe vacuum reacts on the variable relief valve and increases its setting, with the result that the vacuum maintained by the exhauster in the exhauster pipe, and in the vacuum chamber, is increased. This increase is proportional to reduction in train pipe vacuum, up to a maximum of 25" Hg. in the brake cylinder vacuum chamber.



View of a bogie for a diesel electric locomotive showing the installation of individual vacuum brake cylinders used with the Gresham's Augmented Vacuum Brake.

By this means effective brake cylinder pressures up to more than 12 lb./sq. in. are obtained, which represent a very considerable improvement on the figure of about 9 lb./sq. in. encountered in conventional vacuum systems. This improvement, together with the development of individual single or double ended vacuum cylinders has eased the space problem and, where the loading gauge permits, vacuum brakes have been successfully applied to many new locomotives. The illustration shows the installation of some of these cylinders, one per wheel, on the bogie for diesel electric locomotives recently constructed in the United Kingdom.

By fitting an additional brake pipe on the locomotive, together with suitable control valves, independent braking of train and locomotive can be provided.

All the usual safety features such as " Deadman's " or Vigilance control may also be added to this equipment.

Another interesting example of the principle of making use of a vacuum higher than the nominal train pipe vacuum is the Gresham's Type AIV quick release vacuum brake for railcars.

Westinghouse Driver's Vacuum Brake Valve.

This system has been developed specially for use on diesel railcars on which the vacuum exhauster is mechanically driven from the main diesel engine. Under these conditions the engine and therefore the exhauster, operates at its minimum speed and capacity when the cars is standing in a station, and the requisite extractive capacity is not available for the rapid release of the brakes.

In the AIV quick release system, a separate release chamber is charged to a high degree of vacuum whilst the car is running and this is utilised to obtain rapid release of the brakes independent of the exhauster speed. Over 4000 sets of this equipment have been fitted to diesel railcars in the past five years.

THE GENERATION AND APPLICATION OF BRAKING POWER

To provide the compressed air and vacuum necessary for the operation of the brake, compressors and exhausters are fitted, which, depending upon the type of the prime mover employed, may be driven either mechanically from a diesel engine or by their own electric motors powered by auxiliary generators or a low tension auxiliary current supply.

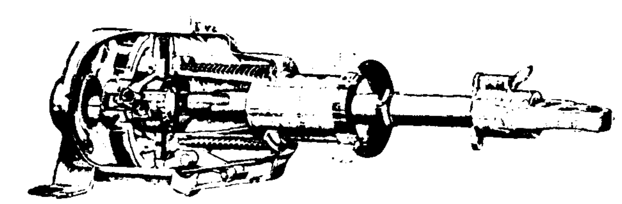
Motor drive allows the running speed of these machines to be maintained independently of the main engine speed, a feature which is most important when the action of a compressor or exhauster is required whilst a locomotive is running down a long gradient or standing with the diesel engine idling. When a mechanical drive is used, the machines must be larger to provide greater capacity to compensate for this and correspondingly consume more power. On the other hand, mechanical drive allows the elimination of driving motors and reduction in the size of auxiliary generators where these are used.

Compressor capacities employed on locomotives fitted with vacuum controlled straight air brake may be up to about 40 c. f. m. displacement for motor driven machines or up to about 75 c. f. m. when mechanically driven.

Exhauster capacities range up to about 130 c. f. m. displacement for maintaining train pipe vacuum whilst running with the brake off, and up to 250 c. f. m. when releasing the vacuum brake, where locomotives are used to haul trains fitted with the conventional 2" train pipe. Where this size pipe is used, no benefit whatever is gained by going above the capacity quoted. Where, however, a 3" train pipe is used,

exhausters with a capacity of 500 c. f. m. in release may profitably be used to get the full advantage of the larger diameter pipe.

The maximum nominal brake forces employed range from 60% to 90% of the locomotive weight, depending on the type of locomotive, in order to provide satisfactory retardation without the risk of wheel slide. The increase in the friction co-efficient experienced as speed decreases when cast iron blocks are used with steel tyres, calls for the lower brake percentages to be applied to low speed vehicles.



Cutaway view of Westinghouse Type JSL Combined Brake Cylinder and Slack Adjuster.

Leverages of the brake rigging between the brake cylinders and the blocks are usually between 4 : 1 and 8 : 1. The use of a moderate leverage ratio even at the expense of brake cylinder size is of considerable advantage to the operator as it reduces the adjustment necessary to allow for brake block wear. This costly procedure may be further reduced by the use of slack adjusters, either in the form of tension members in the rigging or combined in a single unit with a brake cylinder.

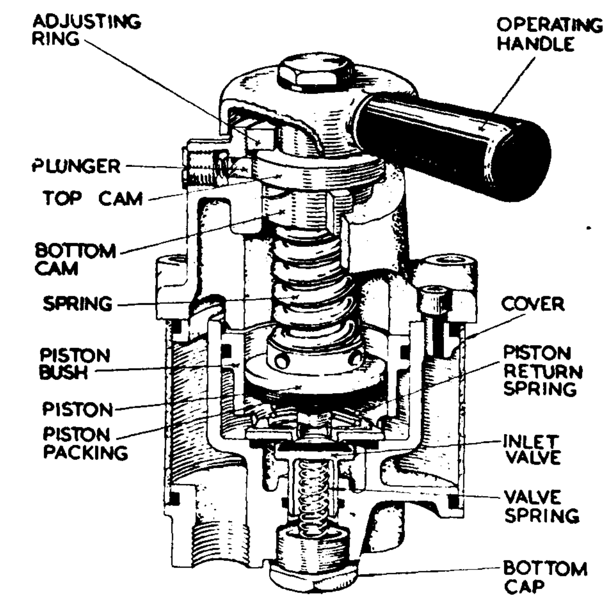
One particularly popular arrangement of this kind is the totally enclosed type JSL unit illustrated, which is of compact light-weight design and is eminently suitable for use with compressed air brakes for the operation of clasp type brake rigging on bogies. Alternatively, conventional brake rigging may be eliminated completely by use of small combined units, each designed to operate one brake block through a totally enclosed lever. Such units are available with fixed or adjustable leverage.

A further alternative slack adjuster arrangement is suitable for fitting at the extremity of a brake rigging remote from the brake cylinder and operated by compressed air from the cylinder.

BRAKE SYSTEM COMPONENTS

Traditional metallic valve seats and sliding pistons are replaced in modern brake components by synthetic rubber seats and rubber diaphragms and rings. These require little lubrication and can be replaced without skilled fitting and so result in reduced maintenance and servicing costs ; at the same time new techniques result in substantial reductions in weight coupled with improved appearance. Typical of such components are the Westinghouse driver's control valves shown in the illustrations.

The vacuum brake valve is suitable for the control of the conventional vacuum brake pipe by simply



Sectional view of Westinghouse Type SA.1. Driver's Straight Air Brake Valve.

admitting air to the vacuum train pipe when a brake application is required. The application is maintained at the desired degree by striking a balance between the air admitted through the brake valve and air withdrawn from the train pipe by exhauster action, normally via a restriction introduced by an exhauster cutout magnet valve.

In the design shown, metallic rotary valves have been eliminated and air is admitted through a spherical valve which slides over an annular synthetic rubber seat which is treated with graphite to provide a nonstick surface and, consequently, a light action.

Electrical switches necessary for the control of exhausters or magnet valves are built-in and are controlled by movement of the single brake valve handle, no additional operating triggers or levers being required.

The valve is of light-weight construction and has a clean cylindrical appearance.

The straight air brake valve illustrated is the type SA1, which is self-lapping and provides an output pressure proportional to the handle setting between " Release " and " Application " positions. The

A diesel hydraulic shunting locomotive built by the Yorkshire Engine Co., with full pneumatic controls and brakes by Westinghouse.

opening of the inlet valve against supply pressure to apply the brake, or the exhaust of air for brake release, is achieved by varying the spring load on a piston according to the operating handle position through the medium of face cams. A soft seated inlet valve is used and synthetic rubber sealing rings are fitted throughout the assembly.

WESTINGHOUSE CONTROLS

There is an increasing trend in modern locomotive design to reduce as much as possible the more onerous mechanics of driving, such as operation of the transmission or the engine throttle, and so relieve the driver of physical strain and leave him more free to concentrate on the track. To achieve this, systems are required which must be capable of precise and finely graduated control, and which embody safeguards and suitable interlocks with other equipment on the locomotive, such as the brakes, to ensure that mal-operation or a fault condition cannot cause any damage to machinery.

The flexibility of compressed air makes it eminently suitable as a working medium for this purpose and by use of relatively simple air valves and fittings, suitable systems, which might be cumbersome and more costly to arrange by other methods, are easily constructed. The pneumatic and electro-pneumatic devices which are used in this way for the control of any apparatus not directly concerned with braking are termed controls.

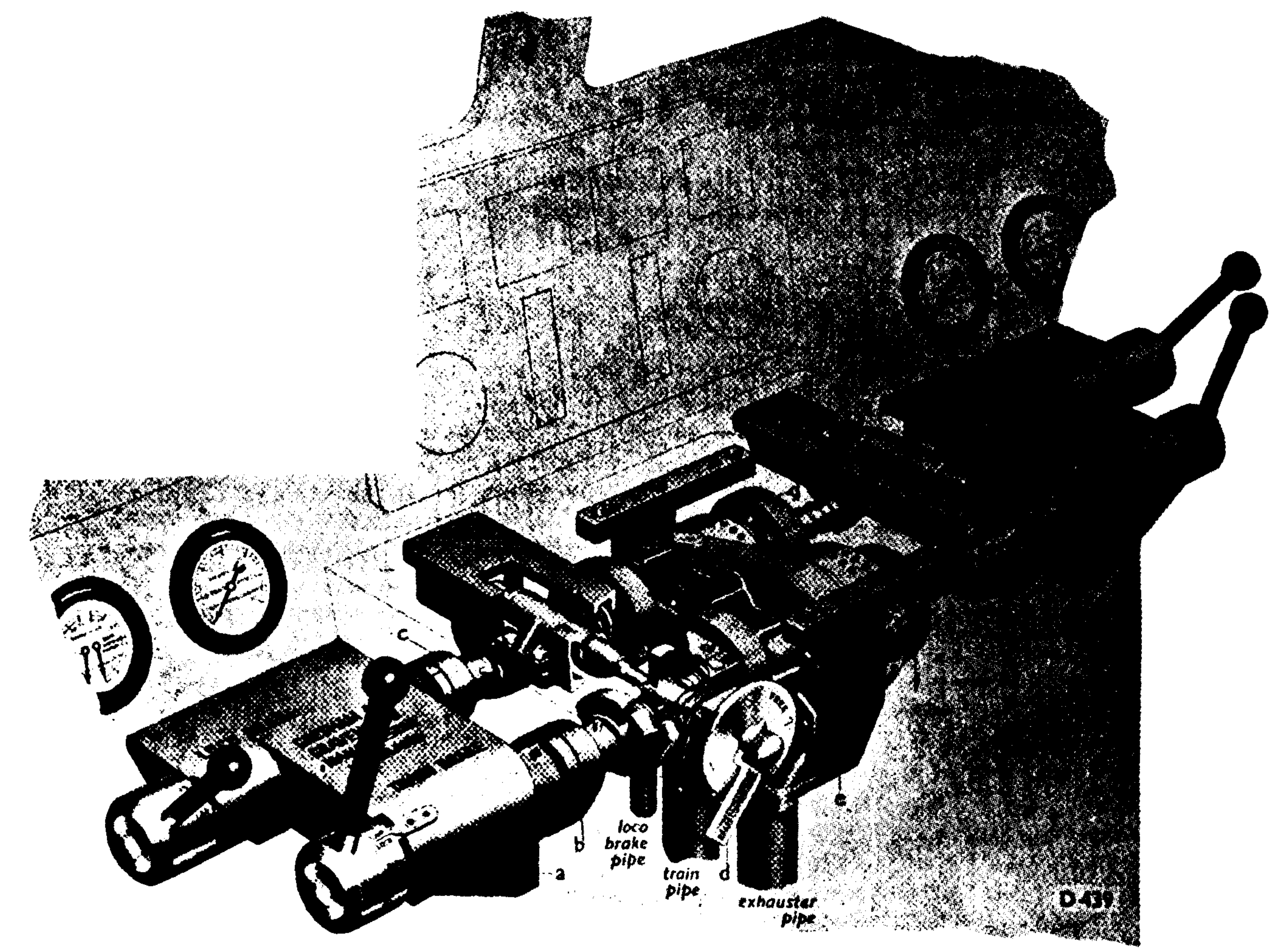
Engine speed control on a locomotive is normally provided by means of two valves. One is the transmitter located in the cab control desk and controlled by the driver and this delivers air at a pressure dependent on the position of the driver's controlled handle. The second valve or receiver is a positioning device mounted on the engine governor and connected by a small bore pipe to the transmitter. According to the air pressure received the positioner will precisely position the engine governor. Thus the engine speed is varied directly in proportion to the handle movement under the driver's control. The advantage of this arrangement with its complete absence of linkage

A diesel hydraulic railcar train consisting of 9 cars built by British Railways for their Eastern Region, with controls by Westinghouse and with Gresham's Type A.I.V. quick release vacuum brake.

between the cab and the engine is even more marked when two or more locomotives may be required to work together in multiple. In this case only a single pipe connection between locomotives is necessary to enable all engines to be controlled simultaneously from the one cab.

This engine speed control is fully graduable and where a notched (or stepped) control is required as on certain diesel electric locomotives the low hysteresis characteristics of the Westinghouse Control air valve, which is the usual transmitter, eminently suit it for this application.

Transmission control consists of the provision of appropriate air signals to the main transmission, which may be a gear box or torque converter, and to the



Perspective view of driver's controls, by Gresham & Craven, Ltd., for 60 Metropolitan-Vickers diesel electric locomotives for the C I.E.

reversing gear box and sometimes a clutch. On-off selector valves in the cab provide the signals and where necessary air cylinders provide the actuation on the transmission. The reversing gear box is protected from damage by a standstill detector which inhibits a directional change unless the vehicle is proved stationary. The pressure sensitive Westinghouse Relay air valve is used to prevent a directional change unless the engine is not above idling speed. It is normally straightforward to incorporate fully or semi-automatic engagement and change of the transmission so that during normal operating the driver uses only his speed control and brakes.

As well as being fitted on all types of locomotives, whether diesel mechanical, diesel hydraulic or diesel electric, pneumatic controls are also supplied for railcars, railbuses, dump wagons and special-purpose vehicles. In addition, in the case of railcars when engines may be widely spaced along a train, localised electro-pneumatic assistance is introduced to minimise any time lag which might result from the charging and exhausting of a long length of pipe from one point. This assistance is automatic and all engines respond simultaneously and equally to the movement of the driver's speed control handle, irrespective of the length of the train.

REPRESENTATION IN INDIA

The manufacturers of this equipment, the Westinghouse Brake & Signal Co. Ltd., and Gresham & Craven, Ltd. are represented in India by Saxby & Farmer (India) Private Ltd., Entally, Calcutta, and Gresham & Craven of India (Private) Ltd., Gobra Road, Calcutta, respectively. As well as handling equipment manufactured in the United Kingdom these latter companies are producing locally an increasing diversity of items of pneumatic equipment, many of which have been referred to in this article.

Concrete Sleepers, Elastic Fastenings and Modern Track-Laying in Sweden

By Gunnar Ruding
Managing Director, Swedish Rail System

DUE to shortage or to the diminishing of the wood resources in various countries, concrete sleepers are being used more and more all over the world.

They have great advantages in comparison with wooden sleepers for their longer duration and easy maintenance. They can also be manufactured within most countries using domestic material.

In Sweden the concrete sleeper, type 101, has been designed and developed, based on international experience and has had great success owing to its superior technical qualities.

The Swedish State Railways have tried various other concrete sleepers of the types that are used on the European Continent, and have now decided to use exclusively type 101. These sleepers have been laid on the most important lines since 1952, and the State Railways have now bought more than half a million of these sleepers type 101 for replacing wooden sleepers—and that in spite of the fact that Sweden is a country, which has an abundance of forestrial resources.

The demands made on the strength and functioning of concrete sleepers are very severe in Sweden, with its hard climate conditions which give rise to continuous settlements and displacements in the track support due to frost. The employment of the sleeper construction has shown that the 101 is competitive and entirely satisfactory from a technical point of view.

The panels are lifted up and lowered on the track by means of mechanical jacks.

The situation is similar in character as regards newly constructed roadbeds in which settlements may be anticipated during the period of consolidation.

The State Railways of the Union of South Africa, S. A. R., who also have used various types, bought in 1958 30.000 units for trial, with the result that they made a contract for 445.000 sleepers 101 in the end of 1959.

For this reason, there has been erected a factory for the production in South Africa. Test tracks are laid also in other countries in Africa, in South America, in Asia, in Europe, and in Australia.

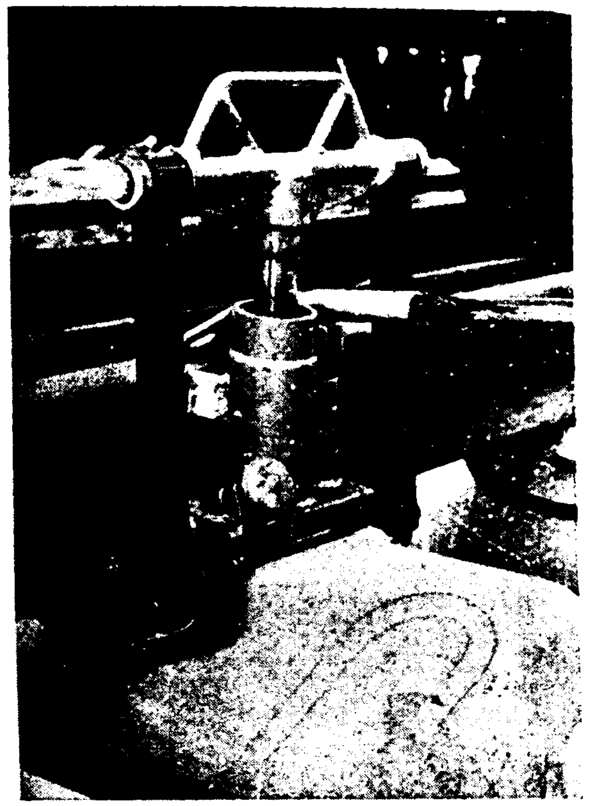
In Sweden, the concrete sleepers cost at present 50% more than wooden sleepers, but it is still considered advantageous to use concrete sleepers. In other countries the difference in price is in general much less.

The Swedish State Railways, in keeping with many other railways, have realised the great advantages of long welded rails and, for some years now, have made increased use of this construction on main line tracks.

However, in order to withstand the great stresses resulting from temperature variations the track components for long welded rails must be entirely different in design to those used on a conventional track with joints. In Sweden, the annual temperature variations may be as high as 90 deg. C. and the daily variation up to 25 deg. C.

In order to prevent the rails from moving and to avoid the need of inserting a large number of rail anchors, it is first of all essential to pay great attention to the rail fastenings. Secondly, to prevent warping, it is important that the track be heavy.

To weld a joint in Sweden costs £ S. 2.10.0. i. e. the same as a conventional joint with steel plates and



Hydraulic jack for mounting one FIST clip at a time.

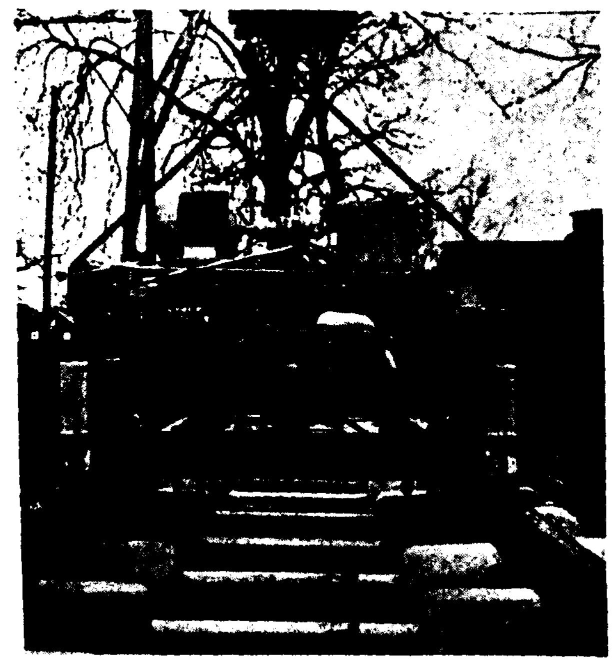
bolts. According to the officials of the Swedish Railways, the maintenance cost for each conventional joint is 4 Crowns (Swedish Crowns) (7/6) a year, which they now can save when they have welded joints. To weld a joint takes 7 minutes.

On the line Stockholm-Malmö, which is the principal line of Sweden, rails have been welded up to 11 km. long sections between the stations. This line has a very strong traffic with trains at a speed of 80 m. p. h.

TESTING

The tube sleeper has been tested in accordance with the German, Belgian, British and French standards and has satisfied all tests. In Holland the 101 sleeper and FIST-fastening are laid down in a track, where O.R.E. (Office des Recherches et d'Essais) of the Union International des Chemins de Fer at present compares the properties of different designs of concrete sleepers from different countries.

In the Union of South Africa, The State Railways have made extensive tests in Vibromachine, and it is



With this electro-hydraulic apparatus the stirrup is pressed forwards, upwards and inwards under and over the rail foot.

known that the sleeper 101 made in the Union with its also domestic-made FIST come out with top-reward.

TRACK-LAYING

About 600 sleepers are laid daily with 16 men and one foreman using equipment which costs £ S. 10.000 This also includes the welding of the joints.

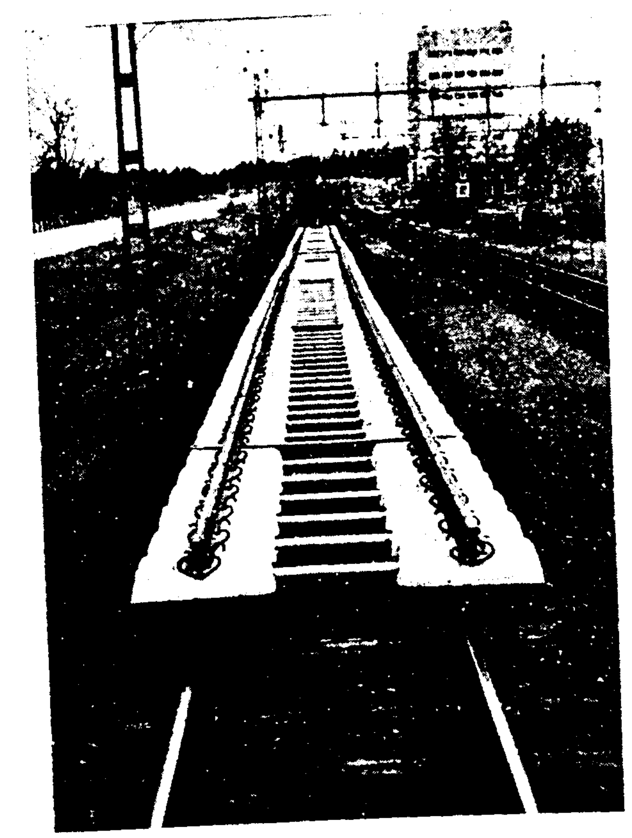
The rails, sleepers and fastenings are assembled at a mobile pre-assembling station.

For applying the fastenings FIST, an electro-hydraulic jack is used for laying larger lengths. This works very fast and puts on two FIST at a time, ten fastenings a minute. For shorter lengths and for replacing sleepers one by one, a hydraulic jack is used which only costs about £ S. 32. In case of emergency, one can also use a special type of lever.

CONSTRUCTION OF CONCRETE SLEEPERS–BASIC REQUIREMENTS

The construction of the sleepers 101 is based on an analysis of international experience. This analysis discloses four major requirements, the fulfilment of which is indispensable. The four main requirements are as follows :

1. The intermediate part of the sleeper must combine resilience with great strength and must therefore be constructed of steel. The steel component must be so designed that great torsional strength is obtained together with a maximum resistance to bending or buckling due to blows from the rolling wheels in the event of derailment.



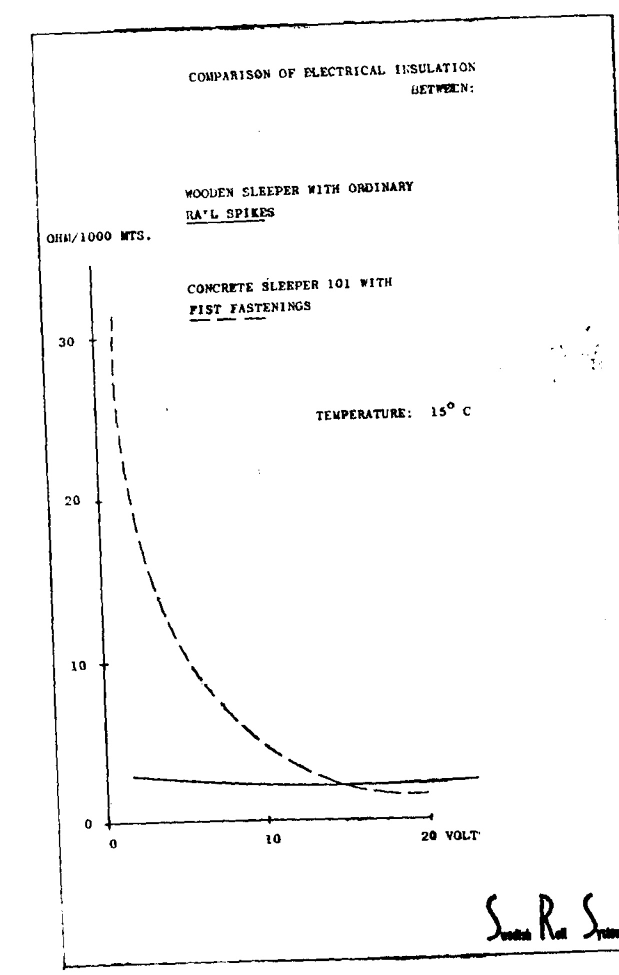
Transport of the panels from the pre-assembling station to the actual place for track-laying.

2. The reinforcement of the concrete must be pre-stressed to prevent the formation of cracks in the concrete, thus ensuring a maximum length of life.

3. The rail fastening device must be resilient in a vertical and transverse direction, but it must entirely prevent displacement of the rails in a traverse and longitudinal direction. It must press the rail against the sleeper with a considerable force, the permanence of which is ensured in such a way that supervision and maintenance are rendered unnecessary.

4. The electrical insulation between the rails must be as high as possible and it must be obtained by means of which exclude all possibility of breaks in the insulation due to faulty mounting or movements of the components in the rail fastening device, for example.

All of these requirements are fulfilled by the tube sleeper 101 and the resilient fastening FIST without bolts, and the result is achieved by the use of a minimum amount of material for production and little demand for skilled labour or supervision and a minimum installation work.



THE ELECTRICAL INSULATION

In a modern track it is necessary with a good electrical insulation, in order to get safe signalling and also to safely use the CTC-system in the line. For concrete sleepers this has been a difficulty, but with the 101-sleeper and FIST-fastening the insulation is even better than for wooden sleepers. The results from long time tests are given in two diagrams.

THE SCHEDULE OF THE DAILY ROUTINE CONTROL FOR THE MANUFACTURE OF CONCRETE SLEEPERS

As a base for the controllers work there is a working schedule, the daily scheme, where it is detailed for every day what is supposed to be checked and what tests to be made. This schedule shall correspond to the specifications approved by the Railway Authorities.

Once every week the controller shows the results of the controls for the past week to the manager who is then to check and approve the different reports.

As a result of the above-mentioned control, nothing is left to chance, nothing is forgotten and every mistake can be traced back to the sleeper in question by the reports. The management has always a firm grip on the quality and the Inspector a mean to check whenever he wishes.

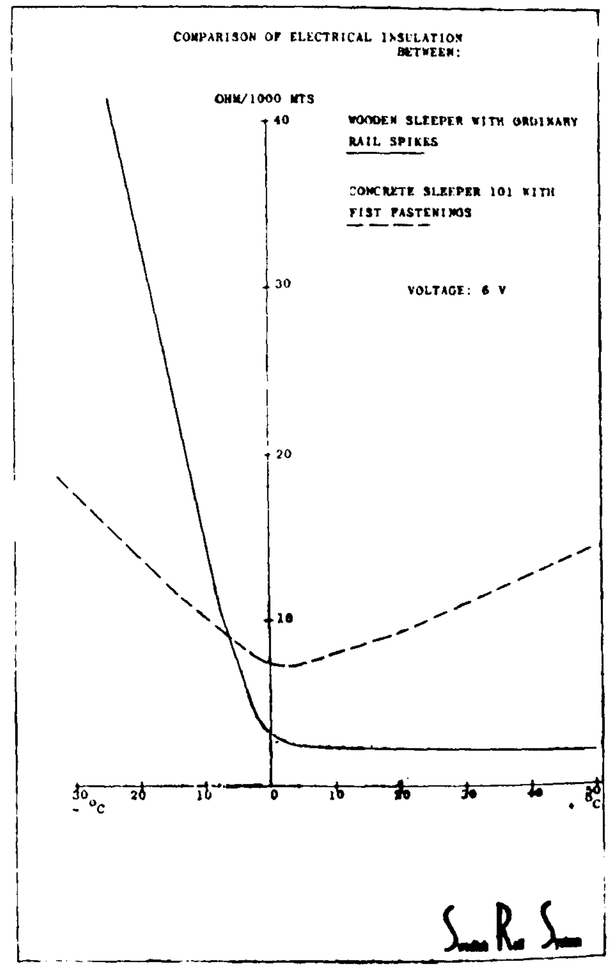
In the following a short description is given to show, how the system works.

1. *A "Diary"* is written every day, and the routine control of cement, aggregates, reinforcing steel, concrete, temperature, humidity and machinery are commented upon. Screening tests are carried out at least once a week. That this has been done is noted in the diary under the heading " Proportioning " where the number and the date are the same.

2. " *Specification of the Aggregates* "

If it is desired to find out how this screening test came out compared to earlier ones, look under the heading " Ballast Specification ". By comparing the numbers in this form with the basic numbers by which the previous proportioning was made, you can judge if a new proportioning is necessary.

3. "*The Diary of Tests*"—Looking into this journal, it is easy to find the results of the tests to be considered. It is also easy to work back from the " Diary of Tests" in order to find out, how the actual mix was made.



4. As a further control there is a statistic control of quality for the mean strength of the test cubes and the co-efficient of variation.

Inspectors from the Railway Authorities or from an official testing Institute have every possibility to check into the factory's own control and can thus also get results by tests of their own, which they can compare.

The Railway Authorities will in this way have a very efficient control of the quality of the Concrete Sleeper 101.

RICH DEPOSITS OF SYLVINITE DISCOVERED IN BYELORUSSIA

Rich deposits of sylvinite, an important chemical raw material, have been discovered in Byelorussia. The sylvinite is not inferior to the many deposits commercially worked in Germany, France and Britain. Preparations for the mining of sylvinite have started at the Starobinsk deposit where a potassium fertilizer plant is under construction. It will not only fully meet Byelorussia's own demand for these fertilizers but also the demand of the Soviet Baltic Republics and adjacent regions of the Russian Federation.

"Pride of Iran"—General Motors World

By An Engineering Correspondent

THREE times a week Armenian tribesmen pop like mushrooms out of the arid hills of Southern Russia. They congregate along the banks of the Aras River that marks the Iranian border. There they gape in disbelief as a square, powerful General Motors diesel-electric locomotive rolls to the end of the line at Jolfa.

The sight is one to make more people than the Russians stare. Thirty years ago Iran had no railway system; five years ago the one they had built in the meantime was on a point of strangling on its own traffic. Today the Iranian State Railway is in the midst of a revival that has earned it a major role in the political and economic development of a nation. And it may be destined for an equally important role in the development of Asia.

Outsiders have attributed this success to two things: the change from steam to diesel power, and foreign technical assistance in operating the lines. But an equally important ingredient has been the work and determination of the Iranians themselves.

How Legends Begin

Railroads in Iran were sure of a place in the folklore of modern transportation well before the first roadbed was laid. The country is a desert with mountains two miles high. Building a line across this wasteland still ranks as one of the world's major engineering feats; operating that line is scarcely less a test of human ability.

The main line runs north from the Persian Gulf through Teheran to the Caspian Sea. It covers 865 miles over a route that would shame a roller coaster at the Tivoli. At one point it climbs from sea level to nearly 7300 feet in 150 miles. Several times floods in the coastal plains have washed out track and interrupted service for weeks at a time. One steel bridge is 3500 feet long. Miles of massive retaining walls and galleried sheds protect the track from landslides and snow. North of Teheran winds blow desert sand across the tracks, impeding traffic and sometimes stalling trains. As the line descends to the Caspian it winds through one stretch of thirty five miles yet covers only eighteen miles as the crow flies. It makes three complete loops to maintain a maximum grade of 2.8 percent; one loop has tunnels stacked up the mountainside one above the other.

Fine for Cupid, but....

Tunnels are a special problem. No one seems to know exactly how many there are, but the count approaches 300 on the main line alone. Many are over half a mile long, and one exceeds two miles. One thirty five mile section has 112 tunnels; another six mile stretch amounts to over five miles of tunnels. None of the tunnels is ventilated. Temperature extremes cause moisture condensation which fights the traction of the locomotive wheels against the rails. In the days of steam power passengers were nearly suffocated in clouds of hot mist trailing back from the engine.

Under these conditions it is not surprising that Iran had no railway system for nearly a century, but it was not for lack of plans. Britain and Russia were old rivals for this key stepping stone in the land bridge to Europe, Asia and Africa. Each was more than willing to build railroads for Iran—but on his own terms.

Britain dreamed of connecting Europe with the Far East via India and enhancing its colonial power on the way. Russia wanted to connect its provinces straddling the Caspian—and incidentally draw Iran into its trading orbit. In the meantime other nations, including the Germans and Americans, offered their own plans.

The Shah Had His Own Idea

But after all the jockeying, it was the Reza Shah, father of the present monarch, who broke the stalemate. When he assumed power in 1925, he had a single-minded desire to forge a group of isolated tribes into a nation. Once he had broken the power of the tribal heads, he started building a system of transportation and communications to make unity last. His ambition was to connect Teheran, the capital, with all of the nation's major cities. The route he chose for the first leg was the most practical.

It connected the capital with the Persian Gulf and the Caspian Sea. Kampsax, a Danish-Swedish consortium, started building the line in 1933, and finished it in 1939, just in time for World War II.

When Reza Shah was forced into exile for being pro-German, the railroad he left the Allies was a mixed blessing. The road-bed was as well engineered as the terrain would allow, but its single track had only passing sidings at key points. The rails were light in anticipation of small Iranian volume; rolling stock was the small capacity European kind; and the locomotives were an assortment of underpowered oil-fired steam variety of American, British, German, Rumanian and Russian origin. The first American troops had to get out and push a train up the more difficult grades over the Zagros mountains. The lines were hauling a mere 200 tons of freight a day.

Early in the war the British officially despaired of getting as much as 5200 tons of freight a day over that line. In the last year of the war the railroad hauled regularly 6500 tons a day. When the Americans left in 1945 the railroad's capacity was 5200 tons. The wartime accomplishment demonstrated clearly to Iran and the world the railroad's potential.

End of the Gravy Train

Peace hit the railroad with a thud. The American Army left a fine legacy of steam locomotives and rolling stock, but took away the skill and ingenuity for maintaining them. The steady flow of replacement parts stopped. It wasn't long until half of Iran's 254 locomotives were out of service for want of parts. The remaining ones were aging and getting too weary to make the steep climbs across the mountains. The rails on curves were worn from heavy war traffic and out of alignment.

The railroad also suffered an embarrassment of riches in freight, passengers and employes. Oil, the country's economic blood, used seven of every ten cars on loaded trains. Food and other goods had to move by truck, and the truck drivers' custom of double loading soon ground the few highways back into the desert. People used trains to make pilgrimages to religious shrines. Traffic rose and so did the number of people on railroad payrolls. Operating efficiency plummeted; costs exceeded revenues.

Circumstance piled on bewildering circumstance. A shortage of water for the steam boilers forced locomotives to be changed five times on a run between the Persian Gulf and Teheran and three more times to the Caspian area. Turn around time for tank cars averaged fourteen days, as opposed to eight days when the U. S. Army ran the line. The steep grades and European standard couplings limited the load a locomotive could pull. As if this weren't enough, Iran's interlude with nationalism and Dr. Mossadegh stopped the country's sale of oil for export. With little money coming into the treasury, cures for transportation ills had to be put off.

Clear Track Ahead

A way out of the dilemma came when the present shah returned to power and the government dusted off a seven-year plan of economic development that had been on the shelf. The United States put up a fifty three million dollar development loan until Iran could get back on its financial feet.

A quarter of the loan went to the Iranian State Railway to begin buying diesel locomotives and spare parts and to outfit a maintenance shop at Teheran. General Motors, one of three American bidders, was chosen to supply seventy locomotives after the proposals were evaluated by a consulting firm. Six Iranian railroad men were trained in diesel electric locomotive operation and maintenance at the Electro-Motive Division at LaGrange, Illinois, then received additional shop experience on American railroads.

Iran's railroad system was in the middle of a transformation by the time the seventieth locomotive was delivered early in 1957. The diesels had replaced twice their number of steam locomotives, and were doing three times as much work. By that time freight traffic increased twenty percent, and passenger traffic jumped ninety percent over the last full year of steam operation in 1955. Both are still rising rapidly.

From Days to Hours

Fuel and lubrication costs for diesel locomotives dropped to one quarter of the equivalent service for steam. The railroad cut its engine crews in half. Passenger trains increased their speeds and cut seven hours from the running time from the Persian Gulf to Teheran; loaded freights cut their time through the mountains from five days to thirty three hours. Maximum freight loads rose twenty eight percent for each train; passenger loads went up forty percent. Freight volume, which had reached 7000 tons a day under steam power, doubled.

Dieselization brought many indirect economies, too. Faster turn around let trains make more trips. Many of the old water stations were closed and the equipment removed.

Braking is another example. Air brakes on steam locomotives require friction braking. On Iran's railroads only one freight car in four had air brakes so the locomotive's braking load was much greater than on better equipped lines. When one of these trains pulled into a station after a downgrade, it had to wait until the brakes cooled before starting again. G. M. diesels use a system of electrical braking similar to shifting a car into a lower gear on a downgrade. The air brakes are needed only when the locomotive speed exceeds engine speed. These electrical brakes reduced replacement of brake shoes on cars by eighty seven percent while eliminating the need for brake cooling at station stops.

Tracks in All Directions

At the same time the American government sent experienced railroad men to advise the ISR on operating efficiencies. They showed the Iranians how to rehabilitate rolling stock from existing parts and how to stagger rail joints to preserve alignment. These specialists also devised a system of scheduling so that loaded trains from the ports travelled the mountains during the day, and empty trains from the interior travelled them at night.

The effect has been a burst of growth on the Iranian State Railway. On the mountains heavier rails have replaced the light ones, and the light rails are being used to extend lines to other cities. Lines have pushed east and west from Teheran until they form a continuous track from Russia nearly to landlocked Afghanistan; and another is abuilding southeast to Pakistan. An extension is planned to join the railways of Turkey. To keep up with this, 103 more G. M. diesel locomotives have gone into service, and fifty steam locomotives have been reclaimed from the scrap heap for short hauls on the coastal plains. New rolling stock is being added. All of this is being done well within the railroad's resources.

The growth of the railway coincides with growth in Iran's economy. In the short time since diesel power arrived, oil production has risen thirty percent, and cement, a burgeoning industry, has trebled. In the same period farm production has risen twenty eight percent, with some of the principal crops climbing sixty to a hundred percent.

There are problems ahead. With a growing traffic volume and increasing industrialization, Iran may shortly have to face the staggering expense of laying new rail lines besides the existing one. Cars will have to be larger and couplings stronger so that each train can haul more freight. The signalling system, now semi-automatic, will have to be made completely automatic to speed the traffic. But until then the railway for the first time has given the country a system with which to feed and supply itself during rapid growth.

New Design Third Class Sleeper Coaches to be introduced on six long distance trains

New design third class sleeper coaches, in which passengers travelling over 500 miles are allowed to travel without the payment of any surcharge, have been introduced on six long distance trains, replacing the old type three tier sleepers for which a surcharge of Rs. 3 per night per passenger is payable.

The trains are Delhi-Howrah Janata Express, Bombay-Dehra Dun Express, Madras-Delhi Janata Express, New Delhi-Howrah Air-conditioned Express, New Delhi-Bombay Central Air-conditioned Express, and New Delhi-Madras Central Air-conditioned Express. As additional new design third class sleepers become available during the next four months or so, they will also be introduced on the following trains in order of priority. G.T. Express, Punjab Mail, Howrah-Kalka Mail, Sealdah-Patankot Express, Frontier Mail, Toofan Express, Howrah-Amristar Mail, Howrah-Bombay Mail, Howrah-Hyderabad Express. Madras-Bombay Express Upper India Express, Pathankot Express, Howrah-Dehra Dun Express, Madras-Mangalore Mail, Howrah-Bombay Express, and Bombay-Varanasi Express.

The Railway Minister recently announced that by the middle of next year all trains in the country covering more than 500 miles will be provided with at least one new design third class sleeper coach. The Indian Railways have no intention to enhance passenger fares to meet increased expenditure as a result of accepting the recommendations of the Pay Commission, it is learnt.

Self-Contained Air Conditioning Unit for Railway Cars

By An Engineering Correspondent

Messrs. Luwa GmbH, Frankfurt am Main, German Federal Republic have developed a new self-contained air conditioning unit for railway cars. The unit, which is 2 ft. wide, 3 ft. 9 in. long and 6 ft. high, is especially suitable for coaches without sufficient space in the bogie to carry the components of an air conditioning equipment. The Luwa unit may be installed in the inside of the car.

The design of this new unit was based on various considerations. It was the aim to build a plant where all components are assembled in one housing. Moreover, a unit was needed for installation into cars which are already in operation and which are subsequently to be air conditioned. This new Luwa unit has also the advantage of being favourable in price.

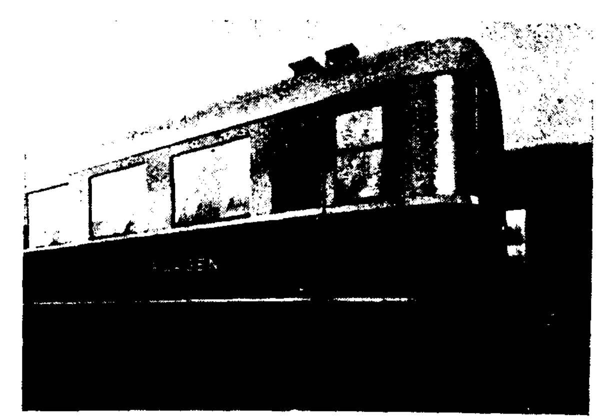


Fig. 1

As mentioned before, the unit includes all air conditioning parts. It is installed in the hall or in one of the rooms adjacent to the passenger compartments. The unit is divided into 3 parts. The upper part contains blower fan with drive motor, evaporator, hot water, electric or steam heating batteries and air filters. In the middle part a suction gas cooled compressor with drive motor and control box are mounted and the lower part includes condenser and condenser fans.

In order to obtain the relative small dimensions of the unit all drive motors and controls were designed for threephase current. The possibilities for installing the unit are shown on fig. 1 and more clearly on fig. 2. Fresh air is drawn in through a grill in the side wall of the coach (see fig. 1 and 2). It enters the upper part of the unit through regulating dampers which are

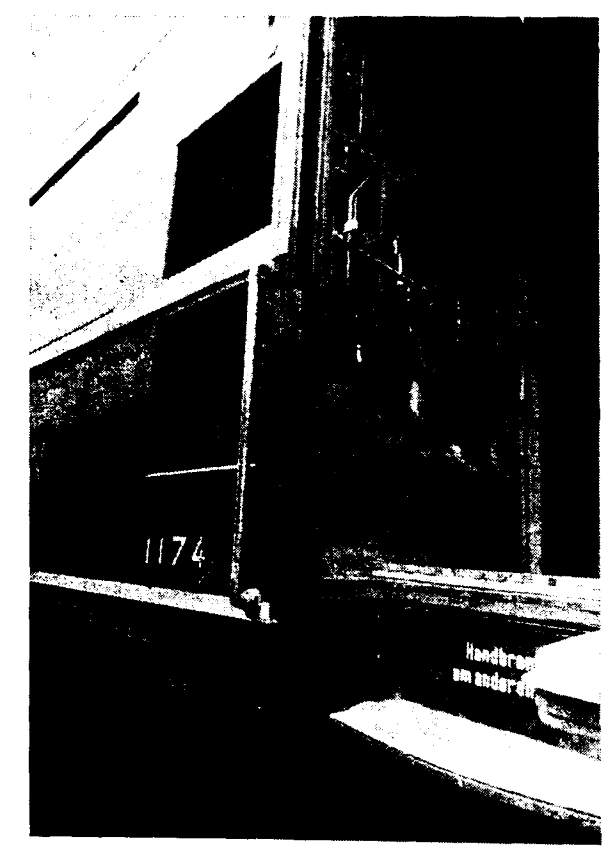


Fig. 2

set once for all before putting the unit into operation. Here the fresh air mixes with the recirculated air of the compartments, passes as mixed air the air filters, evaporator and heating battery and then flows into the ceiling duct via the blower fan. Slot-type distributors (fig. 3) or multiple-hole distributors in the duct supply the air to the various compartments. The exhaust air leaves the coach via the toilets or other adjoining rooms. The ratio between fresh air and circulating air is approx. 1 : 2.

The condenser cooling air, also, is drawn into the unit through the body side grills, passes the condenser fans and the condenser and is then discharged again through the coach floor.

Heating of the air conditioning unit is provided according to the requirements by a hot water, steam or electric battery. The whole unit is regulated by means of a central control device to which the basic heating of the car — either by steam, hot water or electric — can be connected, ensuring thus an automatic control of the entire coach.

The input of the unit at maximum operation is approx. 10 kW; the weight is 600 kg.

The unit is available with 2 different refrigerating capacities:

Model SKE 7 17,500 kcal/h

Model SKE 5 11,000 kcal/h

(at an evaporating temperature of + 10 deg. C and a condensing temperature of + 55 deg. C)

Fig. 3

The air conditioning unit is supplied by Messrs. Luwa GmbH ready for installation with all piping and wiring. The only thing the customer has to do is to mount the unit in the car and provide the central electrical connections as well as the connections for the air ducts.

ALL ELECTRIC LOCOMOTIVES SEEN TAKING OVER INTERCITY TRAFFIC

Delegates to the Tenth Pan American Railway Congress have been told that electric locomotives may in the future take over a bigger and bigger share of high speed intercity rail service.

The prediction came from D. R. MacLeod of the General Electric (U.S.A.) Locomotive & Car Equipment Department and was contained in a technical paper delivered to the Congress by the engineer.

MacLeod's paper traced the progress of electrification of railroads in the United States, something that his company, General Electric, has been intimately associated with for 65 years.

MacLeod's prediction about the possible future expansion of electrification was based on the belief that higher and higher speed intercity traffic will be required in the future. Diesel-electric locomotives that can supply the horsepower to attain the required speeds may be prohibitively heavy, the engineer said.

Trains of over a mile in length pulled by several diesel-electrie locomotive units and moving at 60 miles an hour are not uncommon in the U.S., MacLeod said. In the future, even more power may be necessary to meet speed and load requirements. Electric locomotives can supply this higher horsepower without the same kind of weight increases that would be necessary in more powerful diesel-electric locomotive designs. Recent design favors the rectifier-type electric locomotive for alternating current electrification. This type of locomotive uses mercury arc rectifiers to convert the alternating current supplied from the the trolley wire to direct current for the traction motors. Looking to the future, according to MacLeod, the rectifier-type locomotive using silicon rectifiers is a distinct possibility.

The French Railways Locomotives with Single-motor Bogies and Two-speed Gearing

By
Messrs. M. Blondet
Chief Engineer of the Traction Division
and
J. Boutefoy
Chief of Research and Testing Dept.
(both with Societe ALSTHOM, Paris)

INTRODUCTION

THE French Railways have, at present, ordered 205 BB type 16500 series single-phase 25 kV, 50 cs rectifier locomotives. At the end of July 1960, 60 of these locomotives were already in service and had totalled a distance of more than 6 million km (fig. 1).

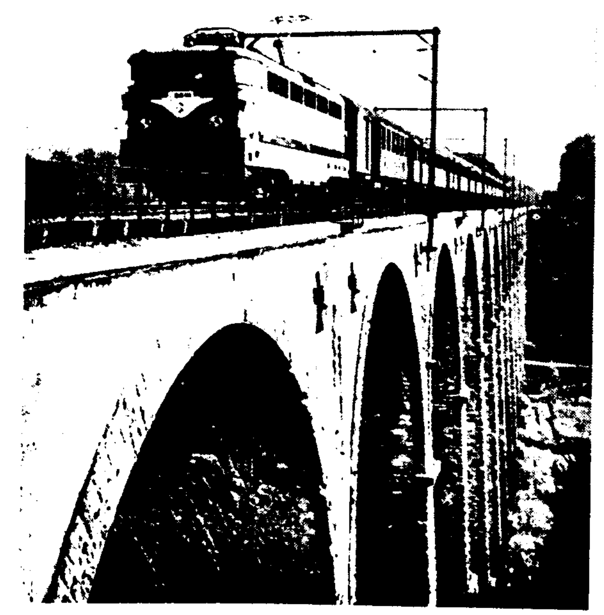


Fig. 1. French Railways Locomotive BB 16500 hauling a suburban train.

At first sight, their continuous horse-power (3500 ch), weight (68 tonnes), maximum speed (150 km/h) have nothing exceptional. However, these locomotives are quite revolutionary and, for the first time in electric traction, are endowded with three novelties which give them remarkable properties:

—a two-speed gearing;
—one single motor per bogie;
—bogies of small wheel base.

The description of these locomotives has already been given in various magazines (1). Our purpose in this article is only to recall the genesis and the interest of these novelties and to examine certain technical problems raised by their realisation.

INTEREST OF LOCOMOTIVES WITH TWO—SPEED GEARING

The traffic to be ensured on most of the Railway lines is a mixed traffic: passenger and goods.

Frequently, different types of locomotives are used for each of the two categories of service. In the case of electric locomotives, a certain interesting unification can sometimes be realised for the drivers and for the maintenance services by utilising passenger and goods locomotives which are identical except for the gear reduction.

But even under this form, the formula is not altogether satisfactory; in fact the operating engineers know quite well that:

—modern electric locomotives need only a highly reduced maintenance;

—these locomotives can be in service nearly 24 hours per day during very long periods;

(1) See: "Revue Generale des Chemins de Fer", Juillet-Aout 1959 - Articles by Messrs. Nouvion, Boutefoy, Horvilleur Gaudichon and Dumesnil.

—in order to fully profit by these advantages by reducing the total number of locomotives necessary to a minimum, it would be necessary to have universal characteristic locomotives capable of carrying out an outward journey with a passenger train, a return journey with a goods train, etc.

Such locomotives should be capable of developing high tractive efforts at moderate speed in goods service as well as moderate tractive efforts at high speed in passenger service.

Their nominal output approximately corresponds to the product of a high tractive effort (goods) and a high speed (passenger); hence, the output can be very high and much higher than that of specialised locomotives for each of the two traffics.

Nevertheless, if the circumstances are favourable, the problem can be resolved with one single type of "mixed traffic" locomotive. This is the case, notably, with the 100 BB Mixed Traffic 20200 series locomotives ordered by the Indian Railways (Eastern and South Eastern Regions), and whose coefficient of utilisation will be very high because of their aptitude to haul, without any difference, long distance and suburban passenger trains, as well as heavy goods and parcel goods trains (fig. 2).

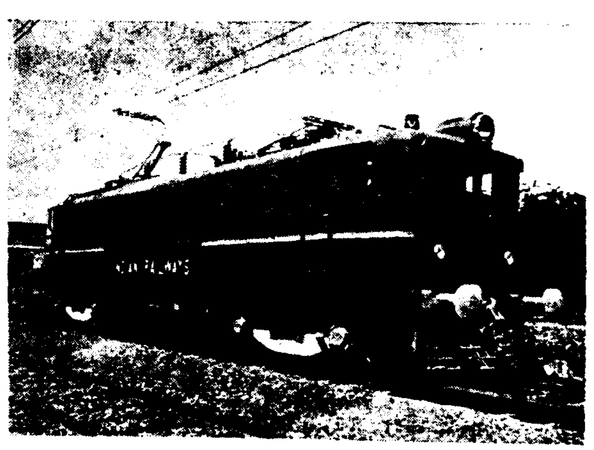


Fig. 2. Indian Railways Mixed Traffic Rectifier Locomotive (Group for Study and Electrification of Railways at single-phase 50 CS).

But in less favourable cases, especially when the ratio of balance speeds for passenger and goods is high and cannot be covered by the field-weakening of the motors, the total cost becomes too high and the solution of "universal locomotive" has to be rejected.

During the study of numerous projects, it has been remarked that the required outputs for the two typical services, passenger and goods, were very often quite close. The two corresponding points G (goods) and P (passenger) on the Effort—Speed diagram are situated more or less on the same hyperbola H given by the equation

$F \times S = \text{constant}$ (fig. 3).

The notch N of the equipment passing through P also has a hyperbolic form, but given by the equation

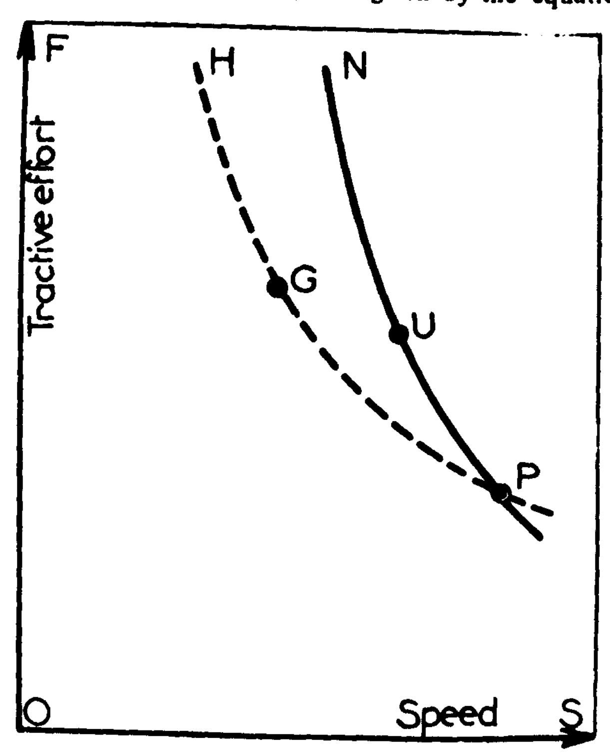


Fig. 3. Tractive Effort-Speed curve.

$F \times S^{\alpha} = \text{constant}$, with α nearly equal to 2 (2). Hence, the curve N is more "vertical" than the hyperbola H and the nominal output of the "universal" locomotive corresponding to the product of the coordinates of a certain point U situated above P on notch N is evidently higher than that of a purely passenger or goods locomotive.

The increase of output is sometimes considerable; an increase of 40% is not rare!

The only way of realising a truly universal locomotive avoiding this increase of output, which affects the

(2) See: "Une application de l'anomorphose logarithmique au trace des caracteristiques de traction", by Mr. M. Blondet, in Revue d' Electricite et de Mecanique, n° 80, janvier 1950.

big components of the equipment, consists in having recourse to a change of gear ratio. This was thought of since quite a long time, but to realise a two-speed gear box, shiftable even if only at rest, is not easy when it is a question of considerable power and couple.

The difficulty of designing an ultra-robust two-speed reduction gear capable of supporting enormous stresses—especially during wheel slips—had discouraged the most dynamic amongst the manufacturers.

Today this reduction gear exists, more than 120 units are in service on the BB 16500 locomotives and give entire satisfaction.

Before giving a technical description, the characteristics obtained will be indicated:

CHARACTERISTICS OF THE BB 16500 LOCOMOTIVE WITH TWO-SPEED GEARING

The reduction gear enables a gear ratio of 3.216 on the goods position, and of 1.88 on the passenger position to be obtained.

So the ratio of these ratios is $\frac{3.216}{1.88} = 1.71$

The maximum service speeds are 90 km/h on the goods position, and 150 km/h on the passenger position.

The T. E./speed curves are given by fig. 4, and the continuous ratings (3500 HP) are as follows:

Field Strength	Gear ratio: Goods	Gear ratio: Passenger
max.	19.2 tonnes at 48.5 km/h	11.3 tonnes at 82 km/h
min.	12 tonnes at 76.5 km/h	7 tonnes at 130 km/h

In order to accomplish the same performances with a single gear ratio, the rated power of the locomotive should have been approximately 5000 HP instead of 3500 HP.

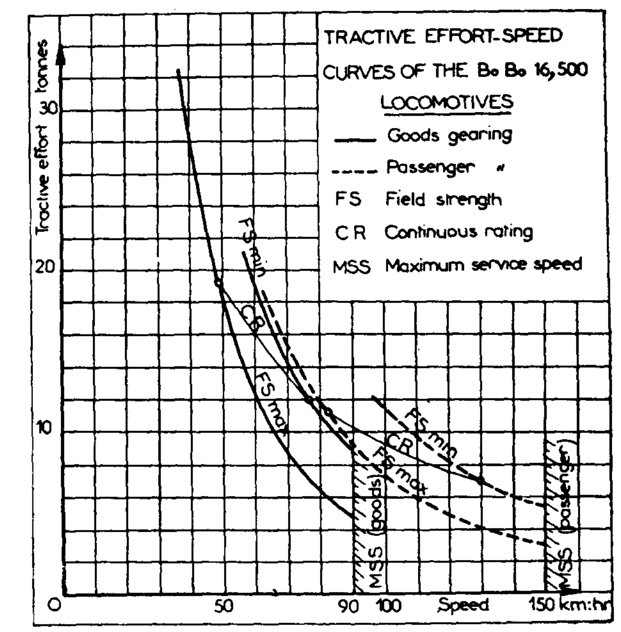


Fig. 4. Tractive Effort-Speed curves of the BB 16500 Locomotives.

In fact the savings in weight and cost on traction motors, transformers, rectifiers, ... allowed by this rating reduction more than compensate the additional weight and cost of the two-speed gearing.

DESCRIPTION OF THE TWO-SPEED GEAR BOX

The gear assembly is shown by fig. 5. Its principle illustrated by fig. 6 is as follows:

The traction motor torque is transmitted to the two axles of the bogie through:

—a resilient coupling;

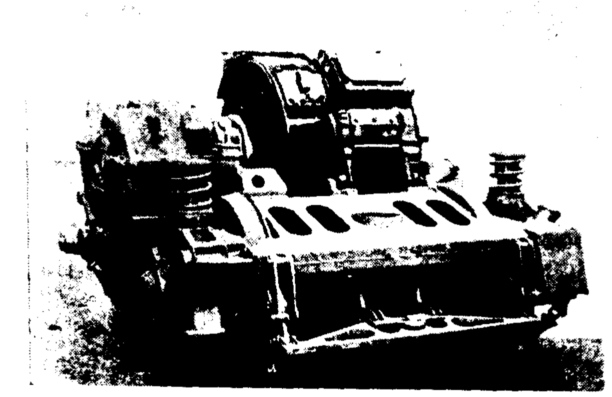


Fig. 5. Single-motor bogie, two-speed gear case side.

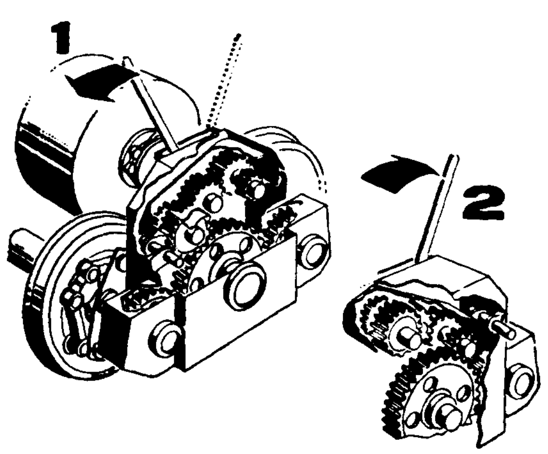


Fig. 6. Principle of the two-speed gearing.

—two sets of pinions mounted in a strong casing which can be tilted to the left (passenger) or to the right (goods);

—a set of three gear wheels: one intermediate wheel meshing with one or the other last pinion of the preceeding set and driving the two final wheels connected to the axles.

A hand operated lever is used to shift from one speed combination to the other.

Mechanical and electrical interlocks prevent any incorrect positioning of the tilting casings.

A change of speed requires less than 3 minutes.

All the shafts are mounted on grease lubricated roller bearings, the gears being splash lubricated with oil. Convenient seals prevent the mixing of the two lubricants.

SINGLE-MOTOR BOGIES

It has been known since a long time that the utilisation of a single traction motor per bogie is a light and economic solution:

—A motor of output 2 P is less heavy and less expensive than 2 motors, each of output P;

—The circuit, apparatus, wiring, ventilation, maintenance, etc. are simplified when 2 conventional motors are replaced by one motor of double the output.

But to this must be added:

—the facility offered for the realisation of a two-speed gearing by the presence of one single motor;

—the gain in adhesion that the rotational coupling of the four wheels of the bogie procures (as in the case of the Jeep automobile);

—the reduction of the lateral efforts on the track due to the reduction of the moment of inertia of the bogie around its vertical axis (one single motor placed in the middle of the bogie.)

The realisation of "single-motor" bogies, even with a single gear reduction, is also not easy. In particular, new or amplified dynamic phenomena due to the coupling of the axles have to be taken into account. For the BB 16500 locomotives, the manufacturer and the French Railways already possessed a certain amount of experience in this domain and this has enabled the undertaking to be brought to a succesful end.

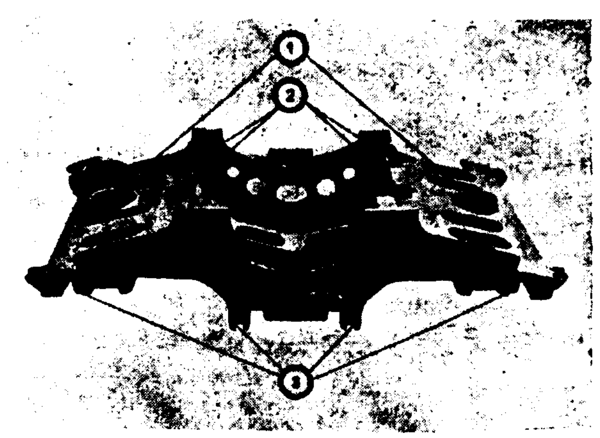


Fig. 7. Single-motor bogie frame (fabricated).
1 – Location of the 2 oscillating pivots
2 – Supports of the traction motor
3 – Housings for axle box linkages

On these locomotives, the utilisations of bogies with one single motor combined with the presence of the two-speed gearing has finally enabled:

—a gain of at least 12 tonnes on the total weight of the locomotive with respect to that of a conventional BB locomotive (2 motors per bogie, one single gear ratio) capable of the same performances;

—an improvement of nearly 10% of the practical utilisable adhesion at zero speed and of 20% at speed with respect to the conventional locomotives;

—the attainment, at speed, of lateral efforts on the track which are lower than those found on the best known locomotives.

We will not linger on the description of these bogies which has been dealt with in various magazines, especially in "Revue Generale des Chemins de Fer" of July—August 1959, which has already been mentioned, and which are sufficiently illustrated by the photographs in fig. 5 and fig. 7. The following well-known ALSTHOM devices can be seen on these photographs:

—silentbloc articulated links between axle boxes and bogie frame;

—silentbloc articulated links of the elastic coupling between gear case and wheels;

—2 oscillating pivots with rubber cones and spring-loaded lateral control, etc.

It should be noticed that the gear case placed on the outside of the wheels on one side of the bogie leaves considerable space for the housing of the traction motor and enables metre gauge locomotives to be realised, ensuring all the time the equilibrium of the loads on the two lines of rails.

BOGIES OF VERY SMALL WHEEL BASE

The diagram of the BB 16500 locomotives is shown in fig. 8. The reader will be struck by the very small value of the rigid wheel base of the bogie: 1.608 metres, which is very small compared to the conventional values of 2.5 to 3 metres.

A higher value than that chosen would have lead to the utilisation of a larger number of coupling gear wheels between the axles; the longer gear case would have had to be reinforced for it to conserve sufficient rigidity. This would have resulted in an appreciable increase in weight.

It could have, however, been feared that running through curves with such a bogie of small wheel base would be more difficult. In fact, when the bogie takes a curve, the first axle is applied against the outer rail while the second axle moves away from this rail and draws nearer the inner rail. More the second axle moves away from the outer rail, higher the attacking angle of the first axle with respect to this

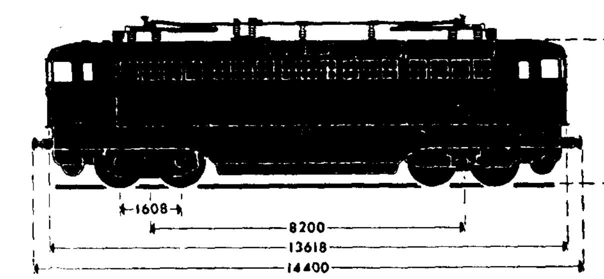


Fig. 8. Diagram of the BB 16500 locomotive.

rail. But, for the same transversal displacement of the second axle, lesser the wheel base, higher the attacking angle. Now, when the attacking angle of an axle is high, considerable wear of the flange is observed in service; eventually, there could also be risks of derailment.

Consequently, we were led to compare the method of running of two bogies through curves of given radius; on the one hand, the single-motor bogie having a wheel base L of 1.6 metres and on the other hand a standard bogie of wheel base 3 metres. We graphically traced the position taken by each of the two bogies in the curve, and have calculated the transverse reactions R between wheel flange and rails by the well known HEUMANN method. We, then, made the following observations:

—The attacking angle α of the first axle is always distinctly *lesser* with the bogie of *small wheel base*;

—The product R. α, which is generally considered as a criterion of flange wear, is also appreciably lesser with the bogie of small wheel base.

Moreover, the following table of comparison can be established:

Curve radius	Attacking angle α L = 1.6 m	Attacking angle α L = 3 m	Product R. α L = 1.6 m	Product R. α L = 3 m
500 m	5×10^{-3}	10.15×10^{-3}	32.2	55
300 m	8.3×10^{-3}	11.35×10^{-3}	53.5	61.5
150 m	16.7×10^{-3}	21.65×10^{-3}	107.5	119

These expectations were proved correct in practice, as, since their commissioning, the BB 16500 locomotives with single-motor bogies have shown that the flanges were wearing out extremely slowly.

It could also have been feared that the small bogie wheel base would not enable the locomotive to run at high speeds with complete safety. In fact, according to standard conceptions, a high-speed locomotive must have a large wheel base. Moreover, theory justifies these conceptions which are the result of experience stretching over many years of operation.

If 2L = bogie wheel base
2e = breadth of track
M = mass of bogie
I = its moment of inertia about a vertical axis,

according to the theory,

(a) the wave length of the side motion is given by:

$$\Lambda = k_1 \sqrt{L^2 + e^2}$$

(b) the max. speed V of the locomotive, i. e. the speed beyond which the side motion is no longer dampened, is given by:

$$V = k_2 \frac{L^2 + e^2}{\sqrt{I + M (L^2 + e^2)}}$$

The maximum speed thus calculated was already relatively high due to the low value of the moment of inertia I pointed out above; nevertheless, the maximum speed was not quite sufficient. It was therefore, necessary to find an additional element to stabilise the bogie; this result was obtained with the aid of an additional liaison between the bogie and the body, creating an angular return couple between these components. This liaison is realised by longitudinal elastic rods.

If C is the angular rigidity of the elastic return action produced by the device according to theory:

(a) the wave length of the side motion has a new value given by:

$$\Lambda' = \frac{\Lambda}{\sqrt{1 - k'_1 C^2}}$$

(b) the max. speed of the locomotive has also a new value:

$$V' = \frac{V}{\sqrt{1 - k'_2 C^2}}$$

In practice, the tests conducted on the French Railways tracks have shown that:

(a) the wave length of the side motion increased from 9 metres to 18 metres;

(b) the maximum speed of the locomotive was higher than the required maximum speed of 150 km/h. From the point of view of performance on line, it was as if the bogie wheel base was, not 1.608 metres, but $\frac{1.608}{\sqrt{1 - kC^2}}$, or about 3.2 metres.

Today, the new and novel arrangements of the BB 16500 locomotives have been approved by experience. We believe that these applications can be extended and we are convinced that their utilisation will stand out as a stage in the evolution of electric or diesel electric traction vehicles.

HIGH CAPACITY SUPER-CRITICAL STEAM TURBINE

The Kirov Plant in Kharkov has started the manufacture of the Soviet Union's first super-critical steam turbine designed by the plant's own engineers. This counter-pressure turbine will have a capacity of 100,000 kilowatts, working at a steam pressure of 300 atmospheres and a temperature of 850 degrees.

The spent steam will have an output pressure of 35 atmospheres, enough to drive three more 50,000 kw turbines. This will obviate the need for costly condensing devices.

Leonid Shubenko-Shubin, the plant's Chief Designer, believes that the commercial working and checking of the turbine's design principles will enable a start to be made soon in developing more economical 500,000 and 800,000 kw machines with super high parameters.

ITALIAN A. B. L. SHUNTERS

By Dott. Ing. Camillo Silva
Technical Manager of the Traction Division
S.p.A. ANTONIO BADONI - LECCO - ITALY

THE S. p. A. ANTONIO BADONI of LECCO (Italy) has started the construction of several type shunters since 1932; 300 of which are in service in the Italian State Railways and more than 530 in private industries.

Our production has started with gasoline engines of moderate power 30 to 60 HP and mechanical transmission passing through to Diesel engines and more recently to hydrostatic transmission. Hydrostatic transmission is the most modern system of hydraulic transmission and the Badoni firm is the pioneer in this interesting application in Diesel traction.

The hydrostatic transmission is different from the hydrodynamic one, as the former has the piston pump and motor instead of turbines; its efficiency is higher and its reliability from the point of view of easiness of control and foolproofness is unrivalled.

The basic element of the transmission is an axial piston variable delivery oil pump Hydro Titan system Thoma constructed by the Von Roll in Switzerland which is used as pump (primary) and as oil motor (secondary part): primary and secondary parts are quite separate mechanically, but with the hydraulic circuits connected through piping.

The pump is driven directly by thermic engine: the motor drives the jackshaft through gears.

The whole speed tractive effort curve is smooth and

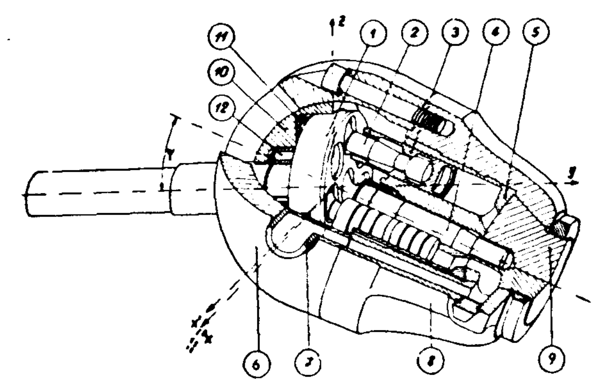


Fig. 1. The Hydro-Titan pump or motor.

stepless. The hydraulic unity, referring to fig. 1 has the following parts : the rotating masses comprise the driving shaft 1 with the swashplate to which are attached the seven piston rods and pistons 2 and 3, and a central rod 4. The further end of 4 is carried in a bearing in the distribution block 9 mounted in the casing 8. The distribution block butts up against the cylinder block 5 through a curved face.

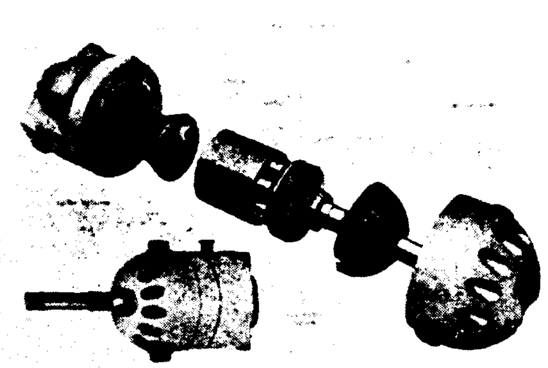


Fig. 2. The Hydro-Titan unity dismantled and enclosed.

Let into the casing 6 is the inflow trunnion 7 connected via cored passages with the distribution block.

The cylinder block is a single bronze casting with the bores of the seven cylinders parallel to the axis of the central bar 4. In several types of large dimension and heavy duty this block is in machined steel plated with "Tokat" bronze.

The block rotates with the shaft, trailed by the pistons and rods; the pear shaped housing formed of the parts 6 and 8 together with the pistons, piston rods and central rod, have angular feedom up and down vertically about the axis X, the swash-plate remaining vertical and bearing on the hemispherical block 10 which contains an axial roller bearing 11 and a vertical roller bearing 12 on which are carried the shaft and the swash-plate.

Rotation up and down about axis X on the trunnions 7 is limited to U = 25° each side. Fig. 3 shows an enclosed and "explored—" view of such a unity.

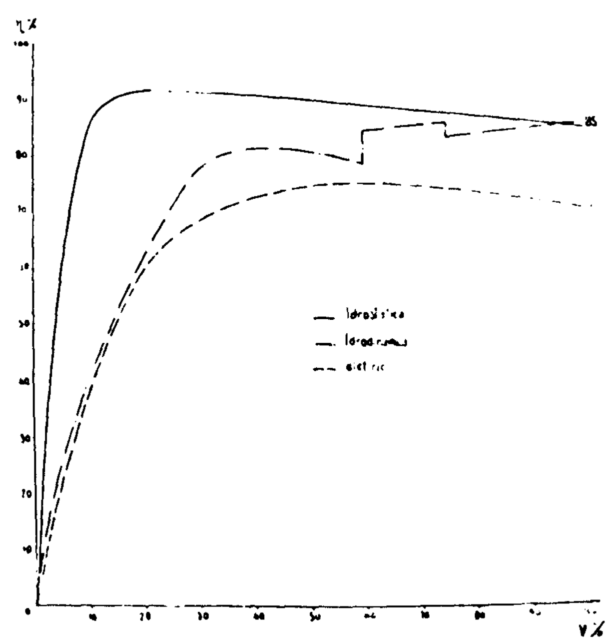


Fig. 3. Comparison between efficiencies of various types of transmission.

The strokes of the pistons vary in proportion of the angle U. At U = O the pistons have no reciprocating motion and no oil is pumped. At angles from 0° to 25° the pistons while the swash-plate rotates, work alternately suction and discharge, and the pumping capacity or power output is infinitely variable with the variation of the U angle.

Inner dead centre is when the piston is nearest to the distribution block 9 ; outer dead centre is when the piston is farthest away from that block.

While acting as pump, when the piston is moving from inner to outer dead centre, the oil is sucked in through the hollow pivot 7, the canal passages and the curved slots in the distribution block in to the cylinder space ; in reverse movement the oil is forced through similar passages to pipes, which conduct the oil to the hydraulic motor.

When acting as pump, the oil pressured is introduced in the cylinders and pulls the pistons giving motion to the swash-plate and shaft.

In other words, when acting as pump, the incoming oil is at low pressure and the delivery at high pressure, whereas the incoming oil to the motor is at high pressure and his exhaust at low pressure.

The unities are constructed in series in several sizes varying from the bore of seven cylinders in mm.

The sizes most in use are 12 — 16 — 20 — 25 — 32 — 40 — 50 and 63. Each size has a double displacement than the foregoing power absorbable from 12 size is 10 HP and from size 63, 450÷500 HP in traction services at high pressures.

It is obvious that for example, a 40 pump which feeds two 50 pumps correspond to a gear 1/4.

Several transmissions have pump and motor of variable delivery, but others—less expensive have only variable delivery pump and fixed motor at maximum displacement 25°.

In this case the field of speeds is less but still sufficient for industrial service.

Transmission is infinitely variable and reversible simply by varying the angle of pump from 0 to 25° in one way and from 0° to —25° in the other, not only but the transmission has—very powerful braking action right down to standstill at which point the transmission is blocked to a stop.

The transmission is completed by several gadgets which ensure the correct working : 1°) a low pressure (7 ate) gear pump ruled by a relief valve which feeds the low pressure circuit through two feeding valves ;

2°) a safety valve ruled at 250÷280 ate. completed by a disaeration valve which allows a small part of oil in circulation to discharge and pass in a cooler and a magnetic filter.

The control of the transmission is effected by the driver simply turning a handwheel almost always duplicated for the convenience in driving from either side of the control desk in the cab.

Upto 140 HP, shunters have final transmission by chain, mechanically controlled pump and fixed hydraulic motor.

More powerful machines have variable displacement pumps, final transmission by jackshaft and rods, and the locomotives from 350 HP have too servomotors fed by a small auxiliary medium pressure pump filled with a constant 50 ate. pressure device.

These more powerful machines have engine throttle control synchronized with a pump control thus the driver only has the handwheel to operate.

The efficiency of the hydrostatic transmission is very high in comparison with the other types: hydrodynamic and electric ones. Diagram Fig. 3 shows the average differences between the three systems.

The types of ABL shunters and locomotives fitted with the hydrostatic transmission now in production are :

A. B. L. type II°—(fig. 4)—This is a small shunter uncovered which is in use in many steelworks for auxiliary services and in small workshops. Its structure

Fig. 4. The ABL type II light Shunter.

is very plain and economic and consists of a steel plate frame which supports the whole machinery engine and the transmission line mounted transversally. The engine is a FIAT Diesel 305 watercooled : 35 HP at 3000 R. P. M. which drives a 20 size pump ; from the pump the pipes feed the fixed motor 25 which drives a plain twin gears reducer from which starts in a double drain drive for the 2 axles. Control is actuated directly by a screw moved by a horizontal handwheel.

The shunter has a length of 3.045 m (10'), a width of 2.20 m (7' 3").

Weight 4.9 Tons—Max. speed 17 Kmh (10, 4 M. P. H.).

Maximum drawbar pull 1200 Kg. (2640 lbs.).

Tare weight : 4, 9 tons.

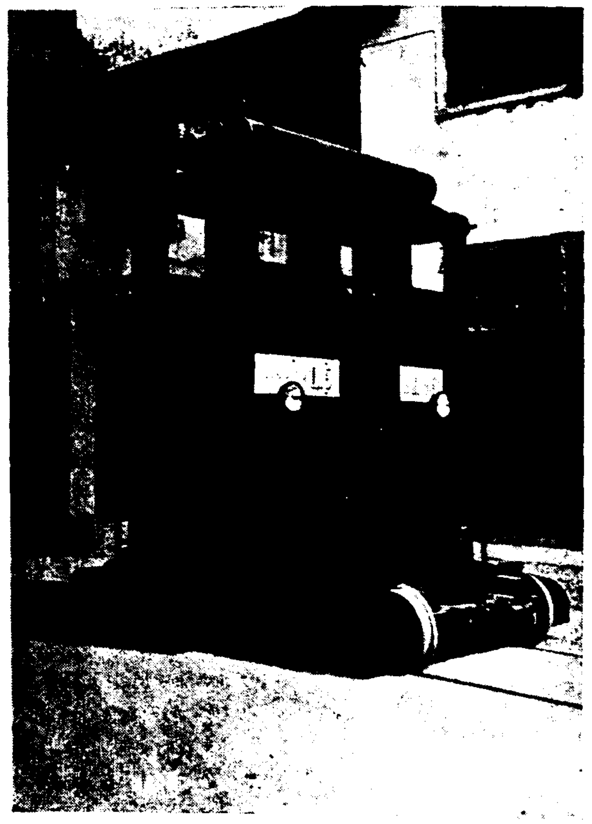


Fig. 5. The ABL type IV° N Shunter.

A. B. L. type IV°/N (fig. 5).—This is a more powerful but still small shunter of unusual form which originates from an old German patent of Breuer. The principle of this type (several hundred of which are still in service in the Italian State Railway and industries) let the weight of the engine to stay less than the necessary one for the drawbar, taking the remainder from a first wagon drawed by means of a screw ram which is carried from a swivelling arm and conical rollers.

The ram runs on a low platform placed above the wheel axle.

Two of these gadgets are mounted above the axles. The puss-pull gear too is unusual : a swivelling transverse bar supersedes the buffers and a simple adjustable coupling link controlled from the driver's cab ; an eccentric ensures the tension of the link. The engine transmission group is mounted transversally.

The engine is an O. M. Diesel aircooled CO IK — 55 HP at 2000 R. P. M. which drives a 25 size pump.

The connection pipes feed the fixed motor 25 which, as in type II drives a plain twin gears reducer—from which starts a double chain drive for the two axles. The control is actuated by two handwheels placed at the right and left side of the cab ; the control being transmitted to the pump by means of chains.

This shunter has a length of 3.415 m (11′ 4″.4), a height of 3.338 m (10′ 11″.8), a width of 3.150 m (10′ 5″.8).

Max. speed 15 Kmh (9.4 M.P.H.)—maximum drawbar pull 2300 Kg. (5100 lb.)—Tare weight 6.3 tons.

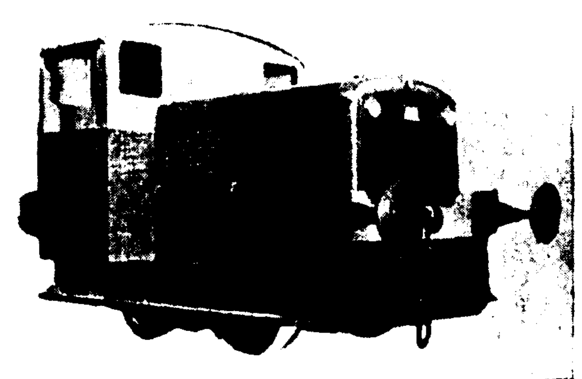


Fig. 6. The ABL type V° A Shunter.

A.B.L. Type V° A/364 (fig.6)—This is a more pewerful shunter in a small range of conventional form.

The frame is of fully welded plate structure, surmounted by a cab and casing. There is a frontal radiator followed by the engine and pump 32 ; the whole is placed longitudinally under the casing. The plain twin gears reducer is driven by a fixed pump 32 ; a double chain drives the axles which are mounted on helical springs and are provided with shock-absorbers.

The engine is a FIAT Diesel 364 A water cooled : 90 HP at 1800 R. P. M.; as an alternative an OM aircooled COIK—55 HP engine will be mounted on a lower version : the V°L.

This shunter has a length of 4.90 m (16′ 2″) a height of 2.70 m (8′ 10″.6), a width of 2.40 m (7′10″.6). Maximum speed 20 Kmh (12.4 M. P. H.). Maximum drawbar pull 4000 Kg. (8830 lb.). Tare weight 13 Tons.

A. B. L. type VI°/203 (fig. 7)—This medium duty shunter has the general layout similar to the previous

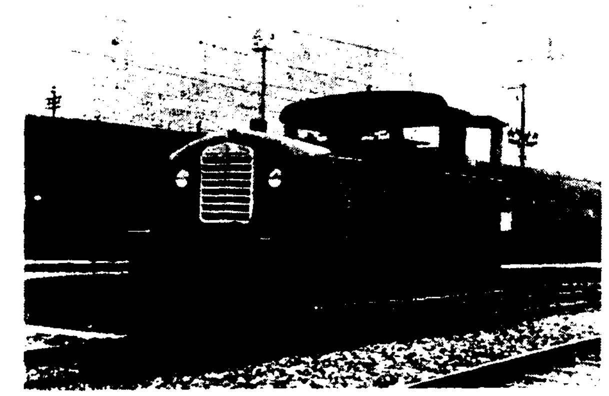


Fig. 7. ABL type VI°/203.

V°A type but is of bigger dimensions ; braking is air-operated and, in case of emergency is operated by a handwheel.

The engine is a FIAT Diesel 203 watercooled : 140 HP at 1800 R. P. M.; the pump and fixed hydraulic motor are both of 40 size. The length is 6.28 m (20′ 8″), width 2.80 m (9′ 3″). Maximum speed 20 Kmh. (12.4 M. P. H.). Maximum drawbar pull 6000 Kgs. (13200 lbs). Tare weight : 22 tons.

A.B L. type VII°B/CH2D-L (fig. 8).—This is an intermediate shunter suitable for average size industries.

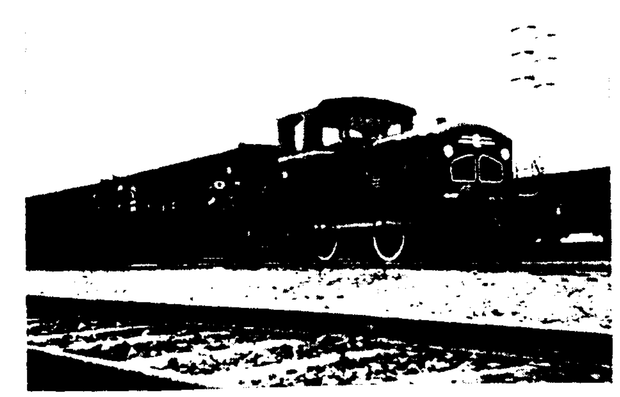


Fig. 8. The ABL type VII°B/CH2D-L Shunter.

The frame is fully welded plate structure surmounted by a cab and casing. Disposition of parts under the casing is inverse if compared with other engines : in the forward position is the reducer ; the hydraulic motor being mounted vertically ; the following parts are the pump, the engine and the radiator laterally mounted provided with a conveyor for the air expulsion.

The cab is provided with six windows of which four are fixed and two openable ; two sliding door are provided for access to the cab.

The reducer has a gleason and a cylindrical gear, the jackshaft drives the rods through two cranks ; the vertical motor is of 50 size and of variable capacity governed by an automatic servomotor.

The pump 40 is mechanically governed by two handwheels situated on control desk. Axle journals are mounted on laminated suspension spring. Braking is air-operated by emergency handwheel.

This shunter contains the most recent improvements in the hydrostatic transmission, for example all valves are comprised in a block which surmounts the pump casing.

Engine is a OM CH2D-L Diesel supercharged and watercooled of 230 HP. at 200 R.P.M., its length is 7.23 m (23′ 9″), its height is 3.45 m (11′ 4″. 3) and its width is 2.90 (9′ 6″.3). Tare weight 28 tons ; maximum speed 25 Kmh (15.6 M. P. H.). Maximum drawbar pull 9300 Kg. (20500 lbs.).

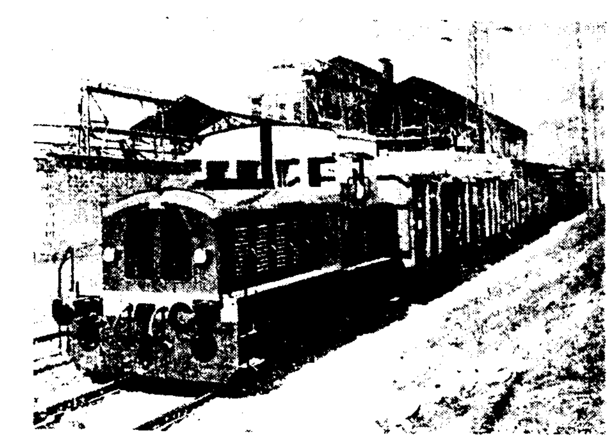


Fig. 9. The ABL type VII°/CB12 Locomotive.

A. B. L. type VII°/CB12 (fig. 9)—This is a heavy three-axle locomotive of 350 HP which is intended for shunting and transfer purposes having a sufficient speed. This locomotive is of normal appearance with a low casing to provide a good lookout from the cab.

The mechanical portion of transmission is by jackshaft drive situated between the second and third axles, crank and rods.

The frame cab and casing are of fully welded plate structure ; a small casing in the back contains only tools and clothes.

The radiator is frontal with a belt actuated fan in front of the engine.

The engine is a Carraro 12 cylinder V four stroke, water cooled with a top output of 350 HP at 1300 R.P.M.; it drives directly the 50 size pump.

The two hydraulic variable displacement motors are identical with the pump also in size 50; the ratio of displacement is 1/2.

The motors are mounted horizontally at the sides of primary shaft of—reducer which has two cylindrical gears.

As previously said, this locomotive has a system of control by pre-controlled servomotors fed by an auxiliary small Hydro-Titan pump of 11 size fitted with a constant (50 ate.) pressure device. The primary servomotor controls directly the pump and the secondary one the motors through control rods and levers. The servomotors are controlled by two cams which actuate a " program " in the movement of unities.

The two motors are at the start inclined at 25°, and they remain in this position until the pump has reached the 25° angle, then the motors decrease their angle until 6° : this ensuring the maximum speed of the locomotive.

The locomotive is fitted with an aboundant air plant to ensure a quick air - feeding of the wagons in the passenger trains ; a powerful compressor is provided and very large reservoirs are mounted under the roof of the cab.

This shunter has a length of 7.62 m (25'), a height of 3.60 m. (11' 10".2) and a width of 3.10 m (10' 2".4)—Tare weight : 36 tons. Maximum speed 55 Kmh. (34.2 M.P.H.),—Maximum drawbar pull : 7500 Kgs. (11500 lbs.). In another version the max. D. P. is 9500 Kgs. (21000 lbs.) speed : 44 Kmh. (27.5 M.P.H.). Seventeen of these locomotives are in service at the Central Station of Milan.

A.B.L. type X/CB12 (fig. 10) — This locomotive is an improved 1960 version of the foregoing VII°/CB12. The weight, power and general performance are improved, the alternative-gear sets are interposed

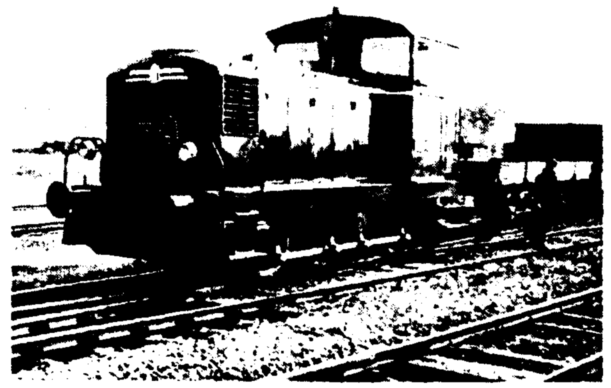


Fig. 10. The ABL type X°/CB12 Locomotive.

between the two motors and the jackshaft so that for shunting work a low gear giving a top speed of 34 Kmh. (21 M. P. H.) may be engaged ; the alternative high gear being for line service up to 65 Kmh (40 M. P. H.).

The frame, running gear, spring suspension and braking plant are the same as in the VII°/CB12. Also the air plant is the same but the reservoirs are mounted under the cab floor.

The cab and casing are higher than the previous one, the cab too is wider and is provided with four large windows giving an exceptional visibility till the buffer-heads ; in the rear side there are two supplementary small windows for the same purpose. Laterally, on both sides there are one large window with sliding glasses and a swivelling door with fixed glasses.

The new feature of the locomotive is the applying of 2 — 50 pumps instead of one driven by the reducer, such a disposition allows the pumps to turn more slowly than the motor, giving a large safety service and possibility of mounting a more powerful engine. These pumps are controlled by a pre-controlled servomotor, while the motors are automatically controlled by means of a pressure regulator.

The two motors are vertically mounted backwards, the pumps and the whole transmission ; piping, valves, etc. is entirely enclosed in a casing giving a great safety against oil leakage and a good protection against noise.

The reducer has two gleason gears and two cylindrical gears for the two alternative speeds.

The engine is still the Carraro XCB12 but developing 380 HP at 1500 R. P. M., but it is possible to mount a more powerful engine upto 450 HP.

Its length is 8.22 m (27'), its height is 3.90 m (12' 10") and its width is 2.84 m (9' 4")—Tare weight 38 tons—maximum draw-bar pull in low gear : 12000 kgs. (26400 lbs.).

All shunters and locomotives are fitted with sand boxes and electrical plant for lighting and starting with dynamo and storage batteries.

STANVAC ANNOUNCES IMMEDIATE CHANGE IN ORGANIZATION

It was announced in New York that the joint ownership of Standard-Vacuum Oil Company by Standard Oil Company (New Jersey) and Socony Mobil Oil Company, Inc., is being terminated. The international petroleum interests of Standard-Vacuum will be divided between them.

J.W. Sinclair, General Manager of Standard-Vacuum in India, said : " The proposed action will not fundamentally alter relations with employees, customers, dealers, suppliers or others having business dealings with Stanvac.

" Jersey Standard and Socony Mobil, two of the world's largest and most highly competitive companies, originally formed Standard-Vacuum in 1933 from their then-existing independent facilities in the East.

" In this area Jersey Standard was then engaged primarily in the production of crude oil and in the refining of petroleum products. Socony Mobil's interests were basically in the marketing of finished products.

" The two companies felt they could better serve the interests of the consuming public, as well as their own, through joint ownership of facilities from the well-site to the market place.

" As world conditions have changed and as the petroleum industry has developed, the two companies now feel that a realignment of Standard-Vacuum is best. Under the terms of the re-organization agreement between Jersey Standard and Socony Mobil, each company will be in position to serve separately the consuming public with its petroleum products," Mr. Sinclair said.

Presently Jersey Standard and Socony Mobil each own 50 per cent of the capital stock of Standard-Vacuum, which does business either directly or indirectly through affiliates, in some 50 countries and territories in South Asia, including India, South-east Asia, the Far East, Australasia and parts of Africa.

Those interests which Socony Mobil will acquire will be held through Mobil Petroleum Company, Inc., a new wholly-owned affiliate. The remaining portion will be held by Jersey Standard through ownership of Standard-Vacuum, the name of which will be changed to Esso Standard Eastern.

Standard-Vacuum's present interests in India will be retained by Esso. These interests include Standard-Vacuum's marketing businesses, its stock ownership in Standard-Vacuum Refining Company of India, Ltd., and its petroleum exploration activities in India.

Commenting on the organizational changes, Mr. Sinclair emphasized that all existing services and contractual obligations will be continued without interruption.

(Continued from page 27)

wire of aluminum, copper, iron and steel. It will then be possible to reduce greatly the thickness of steel cables and the expenditure of scarce metals.

WATER JET " CUTS " STEEL

With powerful compressors for research already in existence, designers are building machines for producing permanent pressures up to 30,000 atmosphere.

A jet of liquid released from a reservoir under a pressure of several thousand atmospheres can easily wash holes even in steel plates. In marine transport a water jet like that may perhaps be used for cleaning the submerged parts of ships from rust ; it may be used for cutting ice in the refrigerating industry, and for substituting sandblast equipment in foundries. High-pressure engineering has in fact vast prospects before it.

High Speed Diesel Engines

By J. M. Smith, B.Sc., A.M.I.Mech.E., M.I.Mar.E.
Bristol Siddeley Engines Ltd.

MOST noteworthy of the new diesel engines produced in Europe or, for that matter the world, in post-war years, were those made in southern Germany by a group of engineers who were trying to re-build the Maybach factory. They aimed to re-establish the name of Maybach in the forefront of high speed engine practice, as it had been since the beginning of automobile engineering. Before the war, the company had made high speed diesel rail traction engines of considerable reputation, but during the war its efforts were mainly concentrated on petrol engine production for fighting vehicles. Several of the features used in these war-time engines, particularly the crankshaft, were so successful that when ordinary business was resumed it seemed reasonable to offer conversion sets enabling similar features to be introduced in the pre-war rail traction engines. This policy was remarkably successful; old engines transformed by the conversion were vastly improved in reliability and durability, so the company naturally based its new work on engines for universal application on these same features together with the greatest possible performance and small weight and size.

Elsewhere, powerful engines for quantity production were generally of the medium speed class, employing large cylinder dimensions and being of considerable size and weight. These were used in rail traction for example with electric transmissions, but in Germany faith continued to be placed in hydro-mechanical transmissions with possibilities of lighter and cheaper construction, and for these correspondingly lighter weight engines were necessary. Thus Maybach set out to produce such engines that would rival any others in operational simplicity and economy. A comparison of the specific outputs in h. p. per litre, weights in lb. per h. p. and relative sizes of a Maybach MD engine with well known British and U. S. A. types is given in Table 1, and shows how bold their thinking was.

Their efforts were completely successful, undoubtedly because of the thoroughness with which the design was investigated. The highest mechanical efficiency, volumetric efficiency and combustion efficiency, were required. Running gear had to be simple and light

TABLE 1

Comparative Rail Traction Engine Ratings

	Maybach MD 865	E. E Co. Ltd. 16 SVT.	General Motors 16.567C
Rated Power (Traction)	1,540	2,000	1,900
Rated Speed R. P. M.	1,500	850	835
Cycle	4-stroke	4-stroke	2-stroke
Number of Cylinders	16	16	16
Bore × Stroke	7.28"×7.88"	10"×12"	8½"×10"
Capacity (Litres)	86	247	149
B. H. P/Litre	17.9	8.1	12.75
Weight, dry lb.	12,100	40,500	31,500
Weight/B. H. P.	7.87	20.25	16.6
Note—Later Intercooled Ratings, b. h. p.	1,920	2,400	2,400

TABLE 2

Rating Particulars

Engine	MD.	Rail Traction Rating*	Powers at Other Ratings†
4-cyl.	220	384 b. h. p.	277– 384 b. h. p.
	225	445 ,,	320– 445 ,,
6-cyl.	325	576 ,,	414– 576 ,,
	330	670 ,,	482– 670 ,,
8-cyl.	435	768 ,,	553– 768 ,,
	440	960 ,,	692–1,150 ,,
12-cyl.	650	1,152 ,,	828–1,152 ,,
	655	1,440 ,,	1,037–1,725 ,,
16-cyl.	865	1,540 ,,	1,105–1,540 ,,
	870	1,920 ,,	1,382–2,300 ,,

* U. I. C. and B. S. 2,953 conditions.

† Including Marine (Lloyd's approved) and Industrial Ratings.

yet strong, and total stress levels, mechanical and thermal, as safe as could be obtained by good design, suitable material and high quality workmanship. Many of the design features incorporated have been considered the ultimate in development for the particular functions concerned, e. g. separate overhead camshafts, whilst others, although radically new, e. g. the two part oil-cooled piston, immediately impressed engineers as expositions of functional design.

So notable was the success of the Maybach design that a licence to manufacture in Britain was acquired in 1958; the Power Division of Bristol Siddeley at Coventry is making a complete range of the engines and is now one of the largest engine suppliers to British Railways. The engines range from 250 to 3,000 b. h. p. at speeds up the 1,800r. p. m. with 4—and 6-cylinder in-line with the 8—, 12—and 16-cylinder Vee form types, each of which is available with pressure-charging or charging and inter-cooling. The whole range is based on a standard bore of 7.28-in. (185 mm.) and stroke of 7.88-in. (200 mm.). Further rating details of these remarkable 4-stroke engines are given in Table 2.

In Fig. 1, longitudinal and transverse section drawings are reproduced which show many of the special design features. The main engine structure is also illustrated in Fig. 2, which shows that there is no joint across the crankshaft main bearing bores and the structure can therefore be made extremely rigid; it is generally of welded steel construction. Outer races for the roller main bearings are assembled into the bores in the diaphragm walls between cylinders and

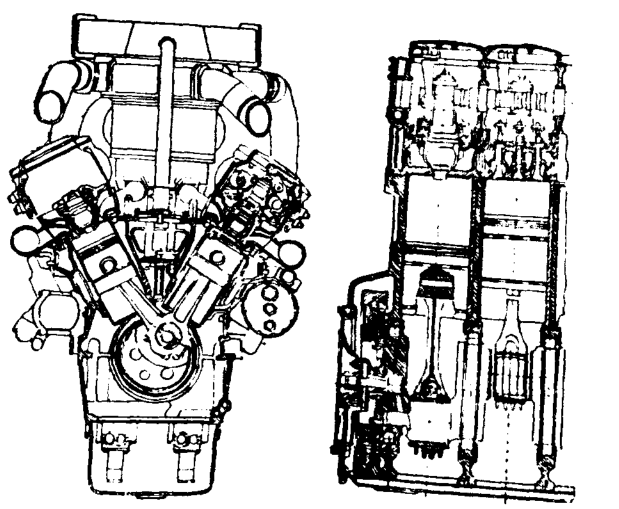


Fig. 1. Longitudinal and transverse sections of a Vee-form engine.

the crankshaft is introduced endwise into the crankcase tunnel.

In the forged alloy steel disc webbed crankshaft, large diameter discs replace the crankshaft webs and

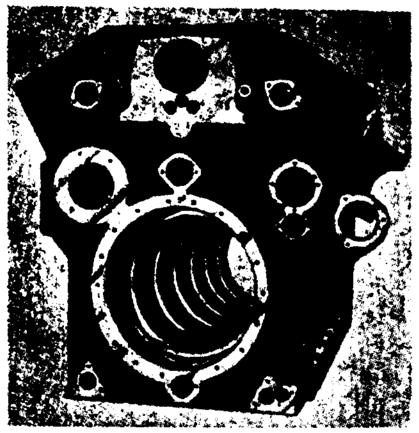


Fig. 2. Crankcase of a 12-V engine showing the crankshaft bearing bores.

main journals of a conventional crankshaft. The distance between cylinders is consequently reduced to a minimum and the over-all length of the engine is shortened. The rims of the crankweb discs form inner races for heavy duty roller main bearings, the outer races of which, as previously noted, are carried in the crankcase. This crankshaft design permits crankpins of larger than usual surface area, and the provision of larger and stronger big end bearings. All crankshaft bearing surfaces are hardened and the increased strength and rigidity contribute to smooth operation at high speeds and outputs. It is estimated that this crankshaft design is better suited than any other to withstand the heavy loads from gas pressure and speed effects at high power outputs. The comparatively small dimensions of the disc webbed shaft make questions of material, grain flow, surface hardness, and forging quality easier to solve than they are for the much larger crankshafts of slow running engines.

Fig. 3 shows the disc webbed crankshaft in comparison with the more ordinary crankshaft of a previous Maybach engine of equal cylinder size.

The data in Table 3 compares these further. The advance represented by the disc-webbed shaft is obvious. Owing to the absence of crankwebs, the crankshaft is very much stronger, particularly in bending, and has also greater resistance to twisting. It has been possible to more than double the engine output without detriment.

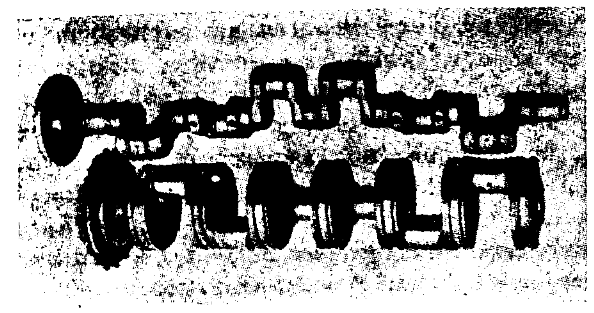


Fig. 3. Conventional and disc webbed crankshafts illustrated to show the increased strength and rigidity of the latter.

TABLE 3

Conventional and Disc Webbed Crankshaft Types

Crankshaft	Crankpin Dia:	b. h. p. output	r. p. m.	Relative Rigidity	Vibration frequency V. P. M.
Conventional	100 mm	650	1,400	1.00	5,870
Disc-webbed	110 mm	1,500	1,500	2.22	10,550

Vee-type engines of the MD range are provided with fork and blade connecting rods, as shown in Fig. 4, of which the main rod big end bearing is supported on the crankpin. The blade rod is fitted with a plain bearing and operates on the exterior of the main rod bearing: this gives a low speed oscillatory motion for the blade rod bearing which is therefore capable of sustaining high bearing pressures.

High output means fast rates of heat release and consequent piston temperatures must be controlled to maintain operating clearances. Adequate though not excessive cylinder lubrication must be maintained at all times. This is achieved in the Maybach design by a positive circulating oil cooling system which in association with thermostatically controlled water cooling of the cylinders maintains practically constant piston clearance.

The pistons are of two-part construction, the crowns being of heat-resistant alloy steel and the bodies of light alloy. Each part is machined from a forging and the piston crown is attached to its body by six small high-tensile and very resilient bolts. Cooling oil is forced directly to and through the

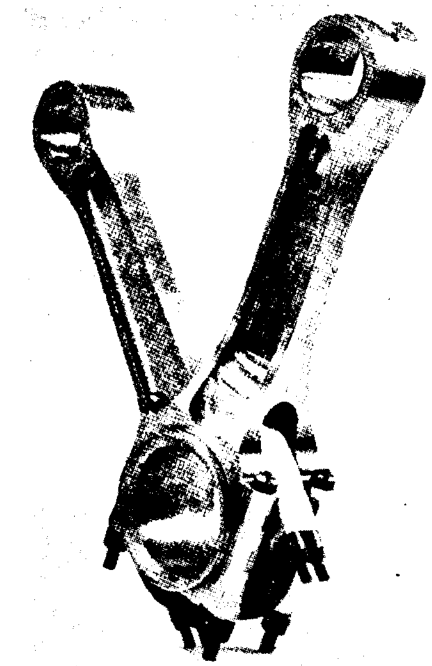


Fig. 4. Forked and blade connecting rods with bearings, for the MD Vee-form engine.

pistons by telescopic pipes, and then flows at high speed over the undersides of the piston crowns and around the sides, behind the piston ring grooves. It then flows freely from orifices beneath the piston crowns to lubricate the gudgeon pins and thereafter returns to the crankcase sump. Before re-circulation the scavenged oil is cooled in a special heat exchanger.

The piston cooling system ensures that their temperature control is as positive as that of cylinder wall temperature and allows the use of comparative lightweight, small clearance, cylindrical pistons. Only three compression rings are needed and they are carried on the removable crowns whereas the two

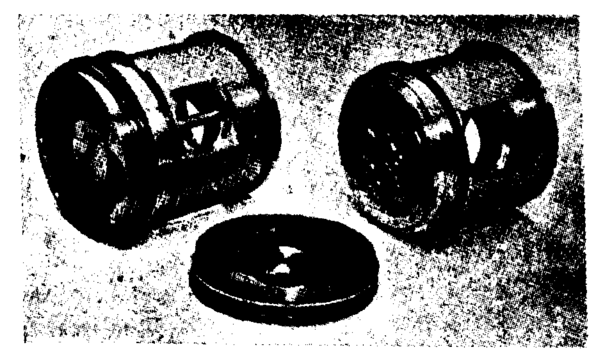


Fig. 5. Assembled and dismantled pistons of the two part, oil cooled type.

scraper rings per piston are carried on the piston body. Since the crown is of alloy steel, wear of the compression ring grooves, which is a very serious problem in light alloy pistons, is quite insignificant. The piston has a very large supporting length with the gudgeon pin arranged favourably in regard to the centre of gravity and these, with the other factors described, provide for good bearing conditions and give rise to very low rates of cylinder wear. Fig. 6 indicates the low values of piston temperatures measured for Maybach pistons.

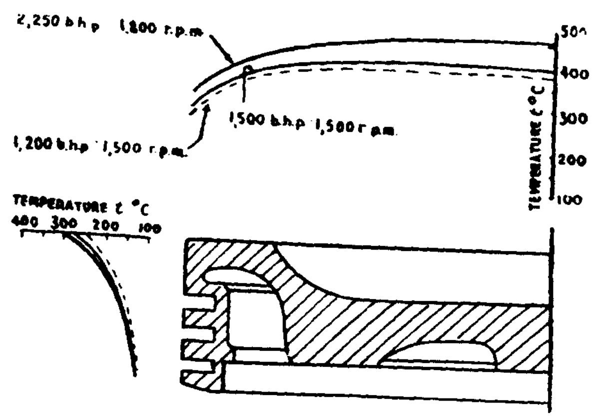
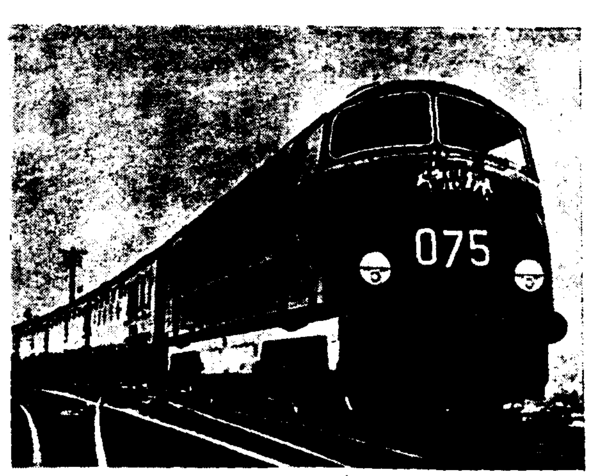


Fig. 6. A piston temperature diagram indicating the temperatures measured on the crown and crown lands in a 12-cylinder engine test.

The power output of any internal combustion engine depends on the amount of air that can be supplied for burning fuel. A very high volumetric efficiency is obtained in the Bristol Siddeley Maybach engine by the unusual feature of six valves in each cylinder head (three inlet and three exhaust) operated by overhead camshafts.



British Railways' (Western Region) locomotive D 804 is powered by two MD 650 engines.

Next to the piston the valves are probably the components most heavily stressed by pressures and temperatures arising from the process of combustion. By providing three valves per cylinder for each function in a concentric arrangement in the cylinder head, really adequate charging and exhausting are obtained without excessive valve size. The valve heating problem is therefore minimized so that thermal stressing is light and cylinder head strength is also well maintained.

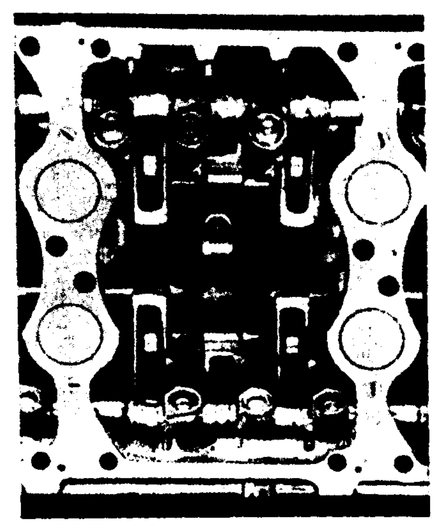


Fig. 7. Part of camshaft casing showing the valve and fuel pump operating rockers.

Due to valve arrangement it is also possible to accommodate an almost spherical pre-combustion chamber in a central position in the cylinder head. The passage between this and the main combustion chamber is through a heat resistant, highly developed design of nozzle body that gives the combustion characteristics required with low pressure loss. This kind of combustion chamber is capable of burning cleanly almost the maximum amount of fuel for the air charge and is suitable for high mean effective pressure operation. Very good results have also been obtained with the combustion system in development running on heavy fuel oils, which is still continuing. At present, commercial ratings are intended for operation on Grade 'A' fuel or, with rather smaller powers, on Grade 'B' fuel.

Reciprocating valve covers are provided for all valves which protect the valve guides against rocker arm side thrust. Replaceable valve caps of varying thickness allow accurate adjustment of the valve guide covers, enabling them to be brought to a uniform

height above cylinder head joint level. The valves are operated by overhead, inlet and exhaust camshafts through small rocker arms with small moving masses. The camshafts and rocker mechanism are housed in a single valve gear casing which for each bank of cylinders is a complete unit. Each valve rocker has an automatic hydraulic clearance adjuster for sustained and quiet functioning of the valve mechanism, whilst the camshafts are driven from the crankshaft by a train of helical gears. Camshafts and gears, and all wearing parts, are of hardened steel. Gear spindle bearings, etc., are of anti-friction type.

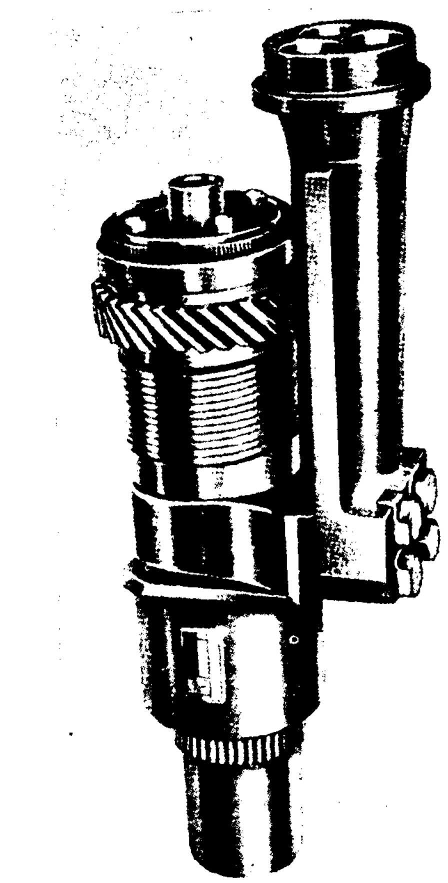


Fig. 8. The Maybach L'Orange fuel injector.

Each cylinder is provided with a Maybach l'Orange fuel pump injector unit, centrally located in the cylinder head and driven by the inlet valve camshaft through a rocker lever. The injector operates at low pressure, 2,000—5,000 p. s. i. in conjunction with a single orifice type of nozzle of large area, and the combination of injector and pump in a single unit avoids the use of high pressure fuel piping.

To obtain good combustion, an extremely rapid rate of fuel injection is required and in an engine of this size and speed, conventional injection systems using separate pumps and injectors would generate very high pump pressures, probably over 10,000 p. s. i., owing to resistance encountered in the injection pipes. Moreover, the dilation of injector pipes under these high cyclic pressures would reduce the rate of injection starting and stopping that is desirable.

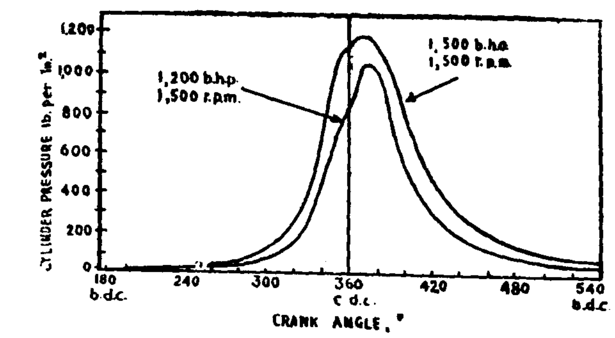


Fig. 9. Cylinder pressure diagrams for exhaust turbo-charged and turbo-charged inter-cooled engines.

The injection units are provided with a practically continuous through flow of filtered fuel. They are present in regard to delivery quantity and the injection timing adjustment is very simply made during assembly into the engine. No individual tuning for equality of cylinder outputs is required, so that injector replacement is a single operation that can be made without proof testing.

The forced feed lubrication system employed for the MD engines utilizes three separate circuits for

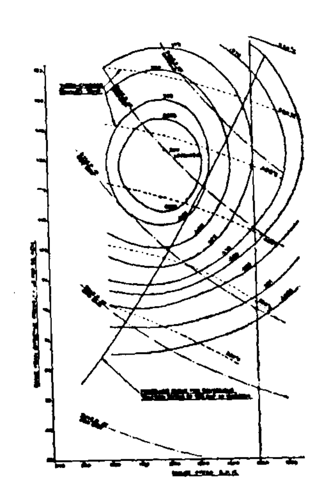


Fig. 10. Iso fuel field for 12-cylinder pressure-charged engine

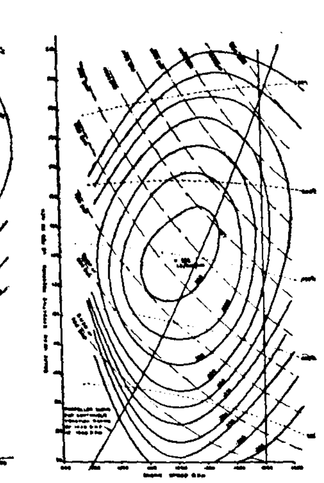


Fig. 11. Iso fuel field for 12-cylinder pressure-charged engine with inter-cooling

scavenging, main lubrication and piston cooling. In each of these, the degree of filtration applied is adequate to the duty, e. g., the finest standard being used for bearing and governor lubrication. The oil pumps are bolted to the bottom of the crankcase and driven by helical gearing from the crankshaft. The oil filters and heat exchangers are mounted on the engine frame, great attention being given to reduction of external piping and connections.

To ensure a fluid film for the bearings immediately on starting, a safety device has been introduced in the lubricating system of the main running parts and valve mechanism, whereby an oil priming pump is started immediately the engine starting switch is operated but the engine starter itself does not come into action until oil pressure has built up. A rather similar safeguard is incorporated to ensure that the cooling water temperature is at about 40°C before a start is made. Pre-heating enables the engine to be put on load quickly and also increases the service life by reducing cylinder wear and establishing correct lubrication conditions very quickly. Cooling is always indirect, that is the engine is circulated with treated water in a closed circuit, with heat exchange either to raw water or to air by means of a radiator. Coolant flow is maintained by engine driven pumps and cooling is always thermostatically controlled.

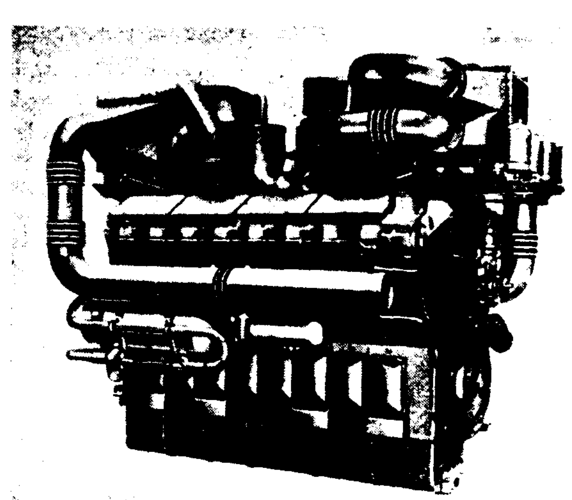
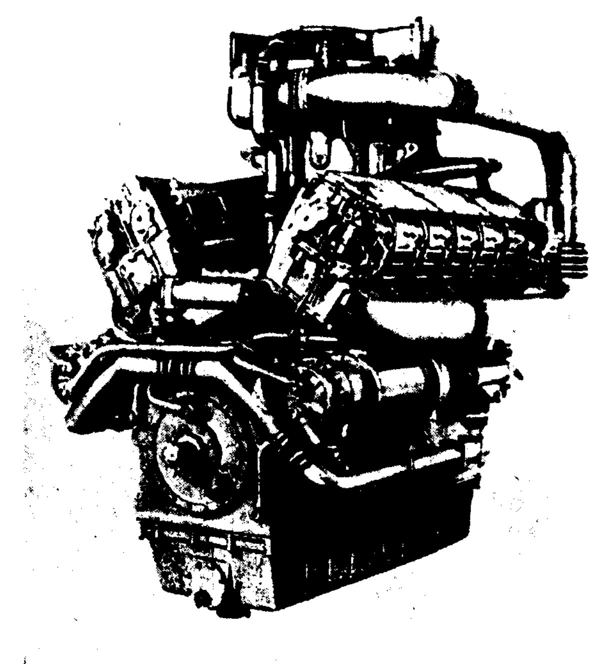


Fig. 12. The MD 1920 b.h.p. engine.

In Maybach engines as in other modern designs, the specific output is about 50 per cent above that possible with natural aspiration, because exhaust gas driven pressure-chargers are used. Engines of naturally aspirated type are not listed and would be relatively highly priced per b.h.p. The Maybach pressure-chargers have good overall efficiency and long bearing life and are arranged on the engine with vertical rotors, so that the exhaust connections from the cylinder head ports are as short and direct as possible. This conserves the pressure energy of the exhaust gas pulses and gives high turbine performance.



M.D.650

Although through exhaust turbo-charging the engine output can be increased, mechanical stresses are not greatly increased and thermal conditions are more favourable than with the naturally aspirated types, giving better fuel consumption values. This is explained by the fact that in the case of a pressure-charged engine the overall expansion ratio is increased, and work is obtained from exhaust energy that would otherwise be wasted. Also, inlet valves are opened earlier before t.d.c., and the exhaust valves closed later after t.d.c. to create a long over-lap period when both types of valves are open. Compressed air from the blower is thus allowed to escape through the combustion spaces into the exhaust system, thus cooling and scavenging the engine, and resulting in lower exhaust temperatures and greater power output. If pressure-charged engines are additionally provided with inter-cooling, i. e. if the aspirated air which becomes heated due to compression in the blower is cooled in a heat exchanger before entering the engine cylinders, the density of the air is raised. The cylinders therefore receive heavier air charges and a further increase in power of about 25 per cent is possible with-

out appreciable increase in exhaust temperatures or maximum pressures. Intercooled pressure-charged operation often appears to quieten an engine for, as may be seen in Fig. 9, the ranges of pressure around top centre are less rapid with the intercooled condition (1,500 b.h.p.) than the normal pressure-charged (1,200 b.h.p.) output.

The fuel field graphs reproduced in Figs. 10 and 11 show the quality of performance obtained from 12-cylinder engines operating under pressure-charged and intercooled pressure-charged conditions. These diagrams are particularly useful in enabling the performance of an engine to be determined under any desired conditions of load and speed in the operating range. Thus traction and marine engines have usually variable speed, and industrial generator drive engines, constant speed conditions.

Maintenance of a Bristol Siddeley Maybach engine is cheaper and easier than that of a low speed engine. All components subjected to wear, such as cylinder liners, piston rings, valves, bearings, and the like, cost less because of the small dimensions. As they are easy to handle and light in weight, the work necessary in dismantling and re-assembling is reduced. At times of overhaul, worn parts are replaced by interchangeable spares, ready for fitting, thus dispensing with reconditioning and adjustments requiring much time and technical skill.

The two-part pistons have the great advantage that during piston inspection, it is necessary only to remove the piston crowns with the associated compression rings. There is no need for the connecting rods to be dismantled as well.

Adjustment of valve clearance during operating periods between overhauls is not required at all because of the automatic control of valve clearance. Cylinder heads are attached by long high-tension bolts and seat on metal joints, thus no re-tightening of the bolts is necessary in operation. The unit injectors need only infrequent examination, once between overhauls, and as the main running gear of the engines requires no intermediate attentions, servicing is limited to fuel, oil and air filter maintenance and visual external examinations.

With regard to assembly of the engines after complete overhaul, the work of refitting a disc-webbed crankshaft takes only a few minutes after the main bearings have been fitted and no subsequent check of bearing clearance is necessary. When connecting rods with the piston bodies attached are assembled into an engine, there is no need for difficult checks and adjustments. The valves, with regard to their heights above cylinder top level, are adjusted to a nominal dimension by means of interchangeable caps and the assembled valve gear housing with its evenly adjusted rocker arms can be fitted on the cylinder heads without any subsequent check for clearance.

Routine for inspection and servicing is therefore simple and all but the most important overhauls can be done without removing the engines from their work site. Normally, the only reason for doing so is that at important overhauls after about 16,000 hours of service, extra space and handling facilities may be desired for the dismantling and re-building work involved. In many cases, however, users may prefer centralized maintenance, which is fully practicable and economical because of the light-weight and small size of the power units.

(Courtesy: Hawker Siddeley Technical Journal)

DUTY PROTECTION GIVEN UP BY STANVAC

Mr. J. W. Sinclair, General Manager, Standard-Vacuum Oil Company, announced that with immediate effect the Company has decided to surrender duty protection on all products covered by the Refinery agreement. Duty protection on gasoline was surrendered by the Company three years ago.

Mr. Sinclair went on to say that the duty protection was granted under the agreement under which the Stanvac Bombay Refinery—India's first modern oil refinery—was constructed. The purpose was to encourage outside investment in an industry which was practically non-existent in India, and also to protect, through the mechanism of increased margin, the nascent industry in its initial stages. Mr. Sinclair explained that this was in line with the common pattern followed in many parts of the world.

The decision to abandon duty protection, taken in keeping with the recent trends in the oil industry, coincided with the announcement of major organizational changes affecting Standard-Vacuum.

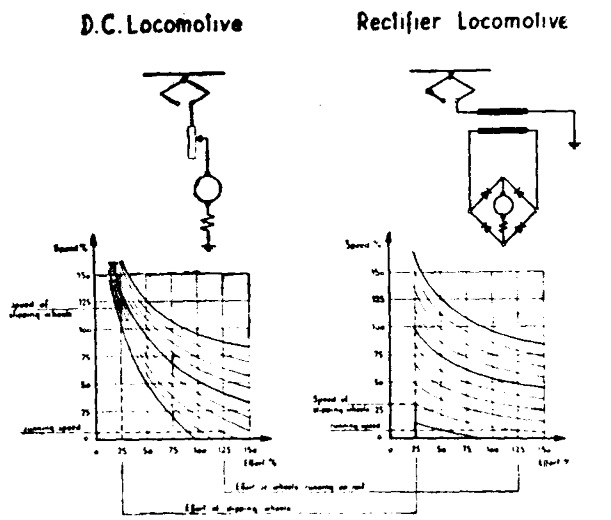


Fig. 1. Speed-effort curves for a rectifier locomotive and a D.C. locomotive.

high speeds the traction effort has to be increased by field weakening of the motors.

Locomotives for *several supply systems* practically can only be built as rectifier locomotives. This problem might be of little importance to India, where the 50 cycles system will be spread over most of the country, but it takes its importance in Europe where several systems meet within short distances.

These advantages justify the use of rectifiers and their auxiliaries in spite of some more control devices and maintenance compared to direct motor locomotives. As for the rotating converters, they lead all to much more complicated solutions.

SOME GENERAL TRENDS ON RECTIFIER LOCOMOTIVES

There are two possible ways of connecting the rectifiers. For mercury arc rectifiers the full wave centre tap connection is ordinarily used (Fig. 2). It needs a minimum of rectifier units which are all on the same potential. Semi-conductor rectifiers on the other hand are usually bridge connected, because the reverse voltage is only half of that of centre tap connected rectifiers. Besides, the transformer is of slightly smaller size.

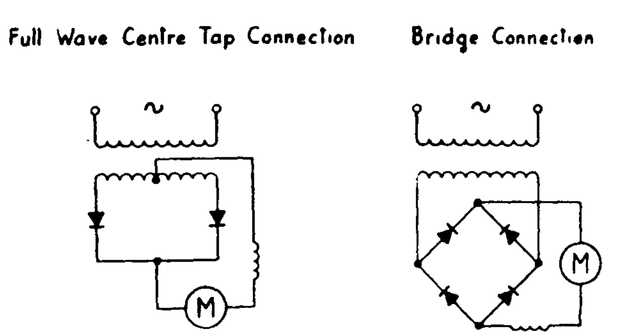


Fig. 2. Rectifier Connections.

As regards the connection of rectifiers and traction motors, block design is often used, each motor being supplied independently by its own rectifiers. In any case the traction motors are not series coupled, otherwise the exceptional adhesion qualities are lost. However, the bridge connection with centre tapping (Fig. 3) makes an exception, because the voltage of each motor is fixed by the centre connection.

Bridge Connection with Centre Tapping

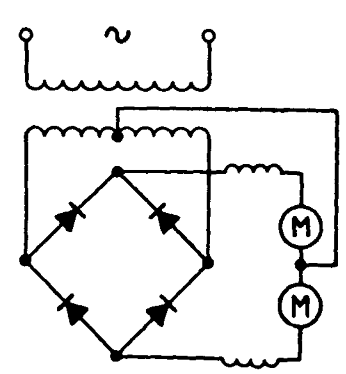


Fig. 3

For the supply of auxiliary machines different solutions exist. Often a single-phase three-phase Arno-converter is provided and the auxiliary motors are simple squirrel cage motors. In other cases there is an auxiliary rectifier supplying d. c. motors Besides there are solutions with single-phase motors either as 50 cycles commutator motors or as induction motors with auxiliary phase. However, the actual development in the rectifier locomotives is taking place on the rectifier itself. Hence, particular emphasis is laid on the different types of rectifiers in the following paragraphs.

THE RECTIFIER

The number and variety of different solutions for rectifier locomotives clearly proves that the evolution has not yet come to a standstill. In fact the development is going on along with the development of the rectifier itself. The rolling stock sometimes sets hard conditions on the rectifiers especially with regard to

robustness and service safety. Besides the rectifier has to be ready for full load and even overload at any time and under any weather and temperature conditions.

THE IGNITRON RECTIFIER

First of all the ignitron rectifier has to be mentioned, as it was the ignitron which led the rectifier locomotive to its outstanding success. Moreover, most of the rectifier locomotives in service are equipped with this kind of rectifier.

The ignitron is a pumpless single anode mercury arc rectifier with impulse ignitron repeated for every current leading half-wave (Fig. 4). Practically all ignitrons are water-cooled. The most delicate part of the ignitron is the ignitron

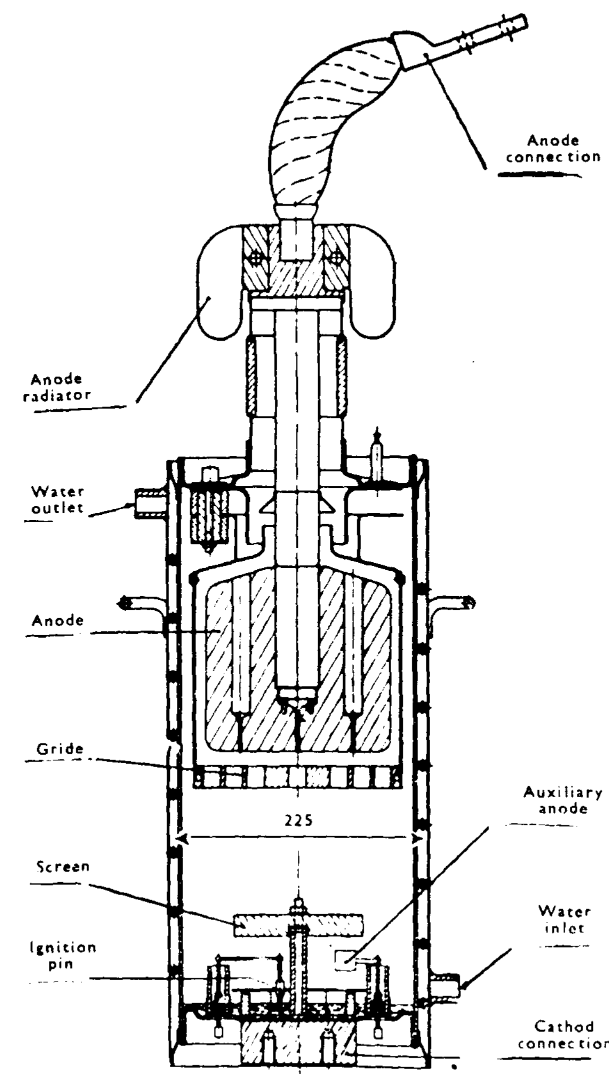


Fig. 4. Section of an ignitron rectifier.

pin. Most of the ignitrons therefore are equipped with two or even three pins. All the same, about 50% of the ignitrons need re-conditioning after six to seven years.

Water cooling has two main advantages. On one hand it leads to much smaller sizes than air cooling, on the other it increases the temperature time constant and makes it easier to keep the narrow range of admissible service temperature. However, it needs a special cooling device with circulation pump and control equipment so that it cannot be considered a really satisfactory solution for traction.

THE EXCITRON RECTIFIER

In opposition to the ignitron, the excitron is provided with a continuous auxiliary arc. Excitrons of all kinds have been tested on locomotives, but the general trend is now towards an air-cooled, pumpless steel tank rectifier. The development of the air-cooled excitron has been brought to a point where pumpless tanks are sealed practically once forever. This is due on one hand to a fine knowledge of vacuum problems and on the other to special experience in vacuum tight welding of ceramics to iron.

Besides the simpler cooling device, air cooling has another advantage; it allows higher tank temperatures as there is only one temperature drop from the rectifier to the ambient air, and not two as in the case of water cooling.

SECHERON EXCITRON RECTIFIER

All mercury arc rectifiers need a minimum of vapour pressure to light and maintain the arc. This is the reason why most of them need preheating for ambient temperatures below about 15°C. However, rectifiers built by Secheron are the only exception. Secheron rectifiers are air-cooled pumpless excitrons with rare gas filling (Fig. 5). The presence of a judicious quantity of rare gas makes preheating unnecessary, even at temperatures far below the freezing point. Special tests have been made some time ago at temperatures down to − 40°C, where even the mercury cathode was frozen. A rectifier under such hard temperature conditions was put suddenly under double its nominal load, without any sign of over-voltage.

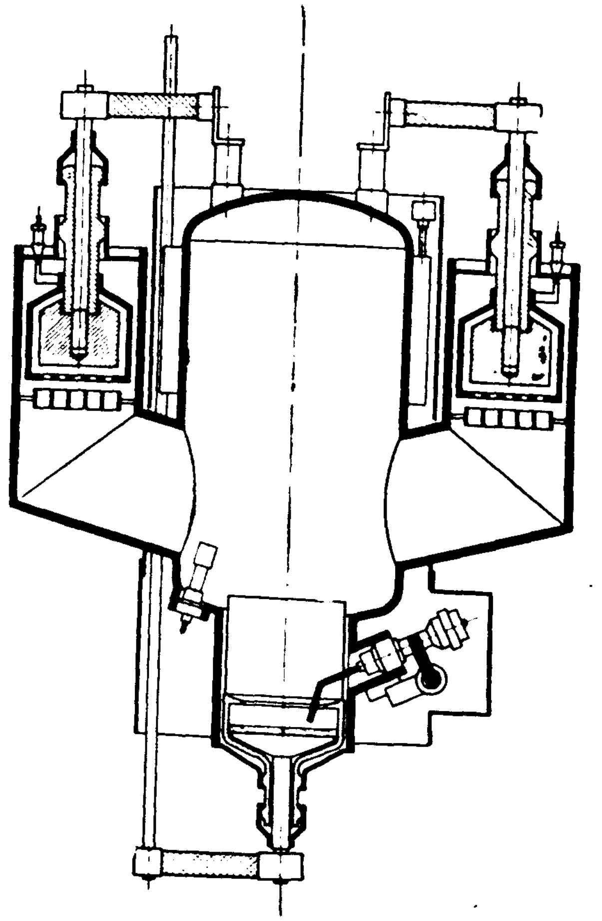


Fig. 5. Section of a twin-anode Secheron rectifier for locomotives.

On the other hand, interesting tests were also made at high temperatures to prove the high overload capacity of the rectifiers, as well as its suitability for tropical countries. Usually the temperature of the condensation dome should not exceed 70°C. A Secheron rectifier was heated up to 100°C by increasing the load without any danger of back-firing.

These qualities make the Secheron rectifier to be the ideal rectifier for electric traction It is to be noted that important tests on a vibration table were made to prove the mechanical suitability for traction. Four Secheron rectifiers are in service since two years on shunting locomotives of the Swiss Federal Railways. They fulfil the hard conditions of the shunting service to the complete satisfaction of the railway undertaking, so that another ten rectifier locomotives have been ordered. Even the French National Railways (S.N.C.F.), who are the very promoter of rectifier locomotives, have ordered nine shunters with Secheron rectifiers.

To these advantages of Secheron rectifiers must be added another quality valid for all excitron rectifiers; the grid control possibility opens new ways of voltage control, especially for regenerative braking

SEMI-CONDUCTOR RECTIFIERS

Semi-conductor rectifiers are ideal for locomotives as they are stationary elements without any wear. However, the old selenium rectifier never took an important place on locomotives because of its want of space and its important losses.

The germanium rectifier is much more interesting as per space and efficiency, but too much limited for the temperature. Therefore it never went further on locomotives than the test stage.

With the silicon rectifier, the situation is now changed. It combines the advantages of the germanium rectifier with a much higher temperature limit. A locomotive rectifier is made up of a number of cells coupled off in series and parallel (Fig. 6). Special care has to be given

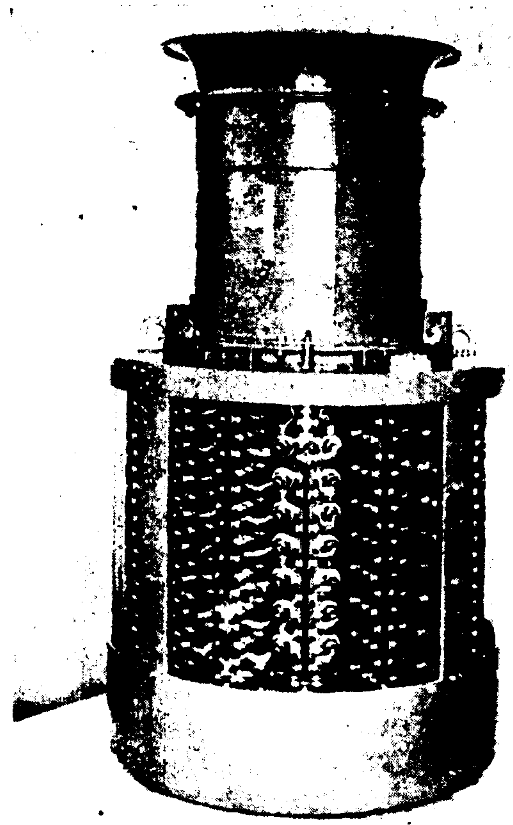


Fig. 6. Silicon rectifier elements built on the traction motor ventilation pipe.

to the voltage and current protective devices, as the extremely small heat capacity does not allow any overloads. These very hard conditions prevent the silicon rectifier from becoming a serious competitor to the mercury arc rectifiers for locomotives in the next years. Moreover the present rectifiers of this type do not allow re-generative braking.

However, it seems probable that the problems relating to the protection of the silicon rectifiers will be solved and that then, this kind of rectifier faces a glorious future for electric traction, especially if some kind of voltage control is made possible.

CONCLUSION

The early 1950's mark an important stage in the development of railway electrification. The experiences of the French National Railways have proved that 50 cycles electrification is practicable for the railways and thus opened the ways for 50 cycles electrification of all future big scale railway electrifications of the world. At the same time, the rectifier locomotive has gained the place of the standard locomotive, outclassing both the direct motor locomotive as well as the rotating converter locomotive.

A hundred rectifier locomotives are being delivered to India at present and others will certainly be ordered very soon. In a few years Indian Industry will build itself complete or part of rectifier locomotives and thus take active part in the future development of electric traction, on industrial frequency.

Basic Principles of Lot Sampling

The Indian Standards Institution has recently published IS : 1548—1960 Manual on Basic Principles of Lot Sampling which explains the various statistical concepts underlying sampling inspection schemes and lays down some of the basic principles of sampling lot by lot. The manual deals with sampling inspection technique as a means to solve two types of problems, namely (a) estimation of lot quality and (b) lot acceptance. Specific procedures necessary for sampling a particular material giving details of sampling implements, methods of preparing specimens, etc. are not covered by this manual.

Controlling the quality of products so as to maintain it at a given level and within specification limits is a major problem with all producers. To assist producers in tackling such problems in a scientific manner, the Indian Standard Method for Statistical Quality Control During Production by the Use of Control Chart (*Tentative*) (IS : 397—1952) was published outlining the control-chart method of controlling quality during production. Similarly, inspection of lots of products so as to get assurances about the quality of the purchase is a major problem with consumers. With a phenomenal increase in the manufacturing capacity due to the machine-age, inspection of each and every unit of production will be extremely uneconomical; in some cases, test methods being destructive in nature, inspection of each and every unit is not to be conceived at all. The only alternative method available is sampling inspection. To assist consumers in tackling their problems through sampling methods, wherever possible, there is a great need for a document explaining the various concepts involved in sampling inspection. This manual is expected to serve that need. It is also hoped that this manual would contribute towards increased use of sampling techniques by producers for purposes of improving quality.

* * *

NEW AUTOMOBILE REFRIGERATOR

A long standing requirement of refrigerator in the comfort of a car has now been achieved by an Indian manufacturer, overcoming the difficulty of carrying ice boxes, or bags, by introducing to the Indian market for the first time a light weight refrigerator which requires no compressors, condensers, evaporators or lavishly designed coils and hook-ups.

This automobile refrigerator is so designed, that it can easily be installed in cars, trucks, commercial vehicles, boats, tractors and indeed, every conceivable vehicle using gasoline or petrol. This refrigerator does not require any electrical or battery connection so that extra load is added to the electric consumption.

This refrigerator requires a simple connection from the petrol line and another to connect the intake manifold which, when pulling petrol up the small fuel line, a partial vacuum is created to produce rapid evaporation. As the fuel enters the refrigerator coils, it is passing from a liquid to a vapour gas. As this change occurs, heat is lost (dissipated). Then as this fuel in a gaseous state passes through the inside refrigerator coils of copper, it absorbs heat from the box. This fuel along with the heat is sucked into the intake manifold, to the cylinders and burned. Thus, not only is the refrigerator producing a cooling effect but the petrol used is not wasted, but burned in the normal manner. There are no controls, when the car is started, the refrigerator starts working.

EDITORIAL NOTICE

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

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

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

All published contributions are paid for at our usual rates.

Editor

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

JUNG
JUNGENTHAL

Since 1885
locomotive construction

JUNG-Diesel Hydraulic Articulated Locomotive with cardon drive, 600–785 mm gauge, 290 HP, supplied to the Indian State Railways.

Our manufacturing range includes:

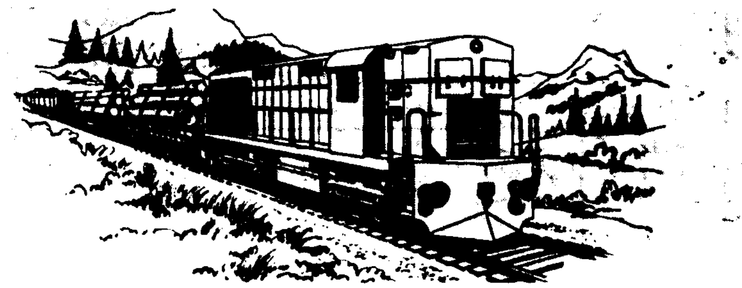
Diesel Locomotives
Electric Locomotives
Steam Locomotives
Storage Battery Locomotives
Compressed air and Storage battery Mine Locomotives
Repair work of Steam Locomotives and Boilers of any make
Locomotive-Spare parts of any kind
Forgings, rough and machined
Containers and Apparatus
General Engineering

Dept.: Machine Tools:
Vertical Turning and Boring Mills

JC

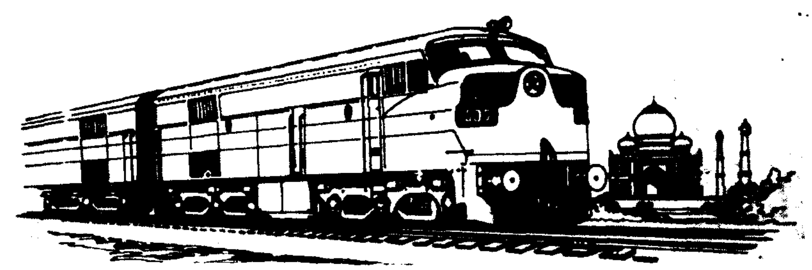
ARN. JUNG Lokomotivfabrik G.m.b.H., Jungenthal near Kirchen/Sieg
Germany

DL-560



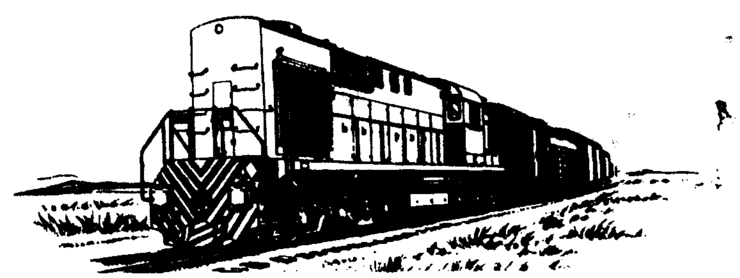
MOTOR MAINLINE HIGH-HORSEPOWER LOCOMOTIVE FOR RESTRICTED CLEARANCES, FROM 19.6 METRIC TONS PER AXLE, GAUGES: METER AND OVER. **2600/2400** HP

DL-500



FOR PASSENGER AND FREIGHT SERVICE, MEETING THE BERNE INTERNATIONAL CLEARANCE DIAGRAM, FROM 16 METRIC TONS PER AXLE, GAUGES: METER AND OVER. **1950/1800** HP

DL-541



MULTIPURPOSE LOCOMOTIVE MEETING RESTRICTED CLEARANCES, FROM 16 METRIC TONS PER AXLE, GAUGES: METER AND OVER. **1950/1800** HP

Horsepower ratings are under standard conditions

:ABLE ADDRESS: LOCOMOTIVE, NEW YORK

. the leading railways of the world, "locomotive" means .co...and ALCO means top motive power. ALCO is one the leading builders, supplying world railways with a ·mplete locomotive line. Illustrated are three ALCO ıodels designed specifically for world railway conditions.

ALCO locomotives have proven their reliability and economy of operation in over 200 million miles of service. They use the modern Model 251 engine—the engine that requires less fuel and eliminates much costly maintenance.

Since 1848, ALCO has been steadily serving the needs of railways the world over. For complete information on how ALCO can serve your motive power needs, contact the agent nearest you or cable: Locomotive, New York.

ALCO PRODUCTS, INC., 530 Fifth Ave., N.Y. 36, N.Y., U.S.A. · Cable Address: Locomotive, N.Y. **Foreign Associates and Licensees:** ALCO Products Export Co., Inc., 8 Grafton St., London; Montreal Locomotive Works, Ltd., Box 1000, Place d'Armes, Montreal; Associated Electrical Industries, Trafford Park, Manchester, England; A. E. Goodwin, Ltd., 315 Parramatta Rd., Auburn, N.S.W., Australia; Textile Machinery Corp., Ltd., 8 India Exchange Pl., Calcutta; Cia Euskalduna, Castellana 1, Madrid. Agents throughout the world.

ALCO