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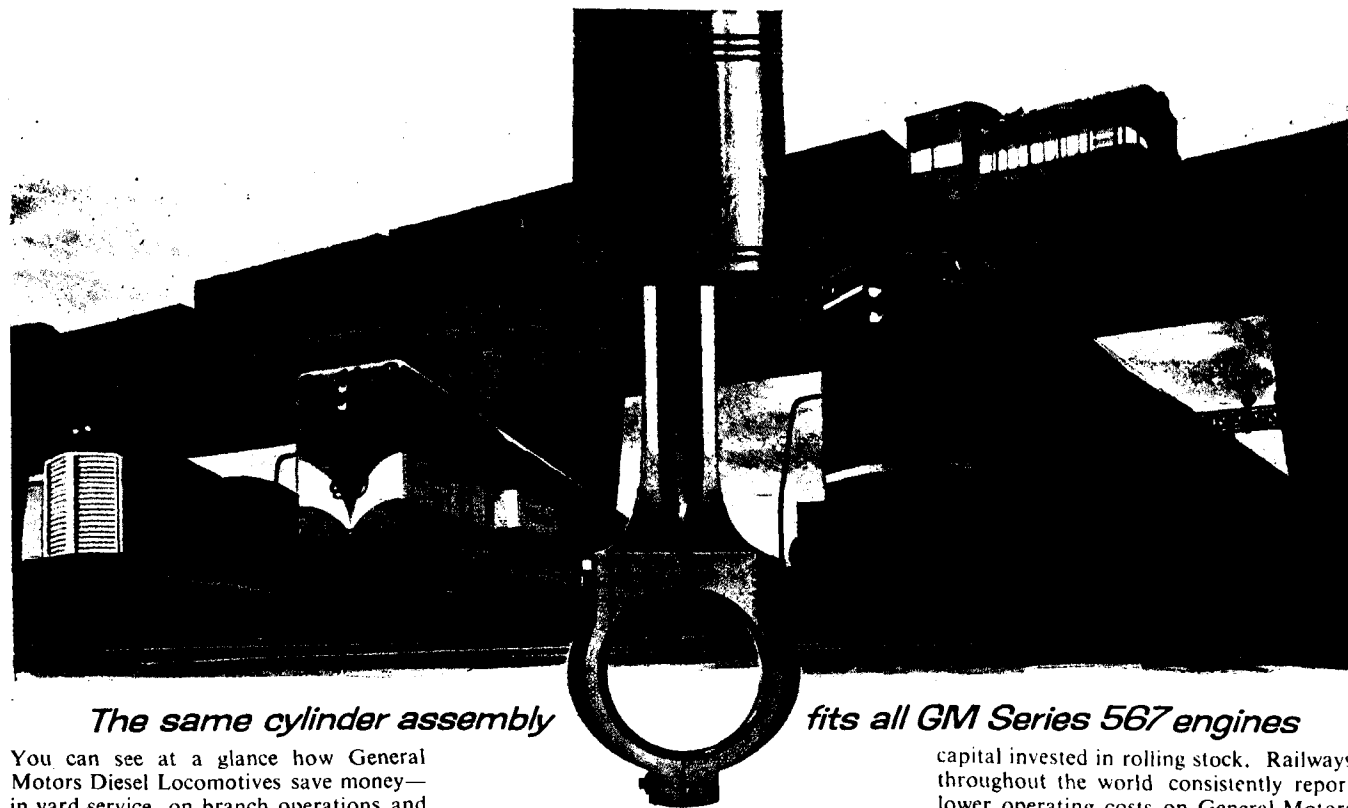
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Steel for Wagon Manufacture—Railways to Import One Lakh Tons

Railways are meeting the full demands of the coal transport almost from the beginning of September and 5,000 wagons a day are being moved to the Bengal-Bihar coal area. This was disclosed by a spokesman of the Railway Board who said that in the first six months the wagon allotment was 4,150 a day as against 4,550 indicated by the actual coal production. The main problem of the railways, he said, was the manufacture of wagons in the country. The railways would be importing one lakh tons of steel from abroad for various purposes, including the manufacture of wagons, with the resources available from the World Bank and Development Loan Fund.

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THE RAILWAY TRANSPORT PROBLEMS IN THE THIRD FIVE YEAR PLAN

WITH the third 5 year plan looming on the horizon it may be pertinent to assess the difficulties with which the Indian Railways will be faced during this vital period. There is an old English saying which says "To be forewarned is to be forearmed". So, if the Railways know the difficulties which are likely to confront them, then at least they will be able to focus their minds on how to overcome them.

Now if we take the *Passenger Traffic Problem* first, we know that Indian population is going up at the rate of 5 million per year so that the Railways must be prepared to handle a sizeable portion of that increase as times goes on.

As matters stand today, the passenger traffic is already a headache to the Railways. Why such large number of people travel by rail is anybody's guess, but travel they do. Whether they are going from their places of residence or returning to them each passenger expects for the money spent, that the Railways will transport him in reasonable comfort, safety and punctuality. The Railways do none of these three things.

The trains are so overcrowded that comfort is out of the question, except to Air Conditioned travellers, but they form a microscopic minority when compared with the bulk of the III Class passengers from whom the Railways earn the bulk of their income. The Railways cannot be said to be unaware of this problem. On paper they tell us of all the improvement they have made such as better fitted third classes, better lighting, better sanitary arrangements, better sleeping arrangements etc. etc. Granted all these amenities which look beautiful on paper and are there in actual fact. But what is the use when III Class Compartments which are supposed to carry 72 passengers to get the maximum advantage of these improvements are crowded with 100 passengers with all their luggage. The Railway Authorities will say what can we do, we have to carry these passengers, we are powerless. Their responsibility does not cease so easily.

At what rate are they building new coaching stock, 900 bogie coaches per year? But then the bulk of these go to replace old coaches whose age makes them unsuitable for economic repairs. What about additional Coaches to take care of the increase in population? Now with the Steel becoming readily available will it not be possible to step up the production of Steel Coaches to a standard design to a much higher figure.

What is being done to dissuade people to travel needlessly. What propaganda is being made to educate people not to carry so much bulky luggage when they have to travel. What arrangements are being made to have a separate luggage compartment in a III Class Bogie where passengers luggage may be kept so that it does not obstruct other passengers.

Regarding Suburban Electric Stock Passenger Traffic, the way people are carried is an absolute disgrace to any Railway. On the Bombay Railways the bulk of the passengers hardly

ever get a seat even in the First Class. The crowding is so heavy that people have to ride on foot boards and conduit pipes, continuously endangering their lives, while the Railway Authorities look on complacently. It is admitted that the city and suburban population has gone up 200 to 300 per cent with the growth of industries in and around the cities. But why have the Railways concerned not introduced Diesel Rail Car Services at peak periods and increase the density of the line capacities? And what do they intend to do for the future? Perhaps they just do not care because the Railways are monopolistic Service. These are pertinent questions but they must be answered to satisfy the travelling public.

With regard to the Goods Traffic undoubtedly much improvement has been made and the Railways carry many more thousands of tons of goods per year. But these improvements certainly do not meet the demand especially as the demand is a growing one.

Merchants are very dissatisfied with the way the Railway carry their goods. First of all there are considerable booking delays, as a result of which they have to resort to road haulage traffic. The advantage of the road haulage is that goods are delivered to the door of the party concerned without delay and in good condition. Once the merchants taste the advantages of road haulage they are hardly likely to return to Railways. Then the Railways are hardly careful with what they carry with the result that goods are damaged and the securing of claims from the Railway Companies is both long and tedious task. Though drives are being constantly made on the Railways to expedite claims yet the problem is far from satisfactory.

The greatest complaint against the Railways by the merchant community is that they just cannot get wagons for the carriage of their goods unless bribery and corruption are resorted to. Though wagons in plenty may be lying in the station yard the station master or the yard master who is in league will not allot them unless their palms are greased, and the highest bidder obviously is allotted the wagons first. Not only this, it has been known that high officials for a substantial consideration would be prepared to call the wagons from other stations, depriving the merchants there and putting them at the service of the merchant who was prepared to line his pocket.

It will be contended from the Railway side that the merchants are to be blamed for resorting to anti-social activities to serve their ends and it is said that if they complained to the authorities higher up drastic action would be taken. From the side of the merchants, the plea is "we dare not make a complaint against a particular railway servant big or small for fear of being black balled, and penalised in hundreds of ways" they feel that the lesser of the two evils is to submit, pay up and smile rather than complain, because one does not know who is corrupt and who is straight forward. The merchant community is fairly convinced that every man has his price and as long as they are prepared to pay that price they can carry on their business. Whereas if they went to the extent of exposing the black sheep they would be courting a hornets nest round their ears.

This is the state of affairs to-day, but what about the future, with the 3rd Five Year Plan in the offing the increase of load on the Railways is going to be of a very high order. Take one instance alone. The distribution of Coal is of the order 60 lakh tons per annum and as envisaged by the next plan this figure is to be increased by another 50 lakh tons per annum bringing the total figure to 110 lakh ton. This is nearly a hundred per cent increase.

On the Agricultural side the movement of food grains received from America is absorbing a great deal of our wagon capacity but if to this is added the increased agricultural produce of the country due to the use of chemical fertilisers the movement is going to be impeded.

Add to this the increase in the production of Steel which due to production of 3 steel plants is going to be of the order of 6 million tons per annum against our present production of 3 millions, here alone double the capacity will be required. When it is realised that practically every part of the country for its development is looking for a supply of steel and steel has to be transported from Bihar to North and South and West, well this is going to be a problem in itself.

If steel is made available when required for industries then the industrial development which is languishing at present for the shortage of this commodity is bound to go up by leaps and bounds. As everything industrial has to be distributed throughout the country the problem of transport is going to be a tough one, requiring all the Railway resources to contain it.

It is understood that the Railways are planning for much larger type of open and closed wagons to handle the heavier traffic which will be offering and also they are considering the building of powerful diesel locomotives to haul the extra load. More powerful couplings will also be required. So far the building of both the types of rolling stock mentioned above is in the experimental stage and in any case will only be partially utilised because of the existing 20 ton goods wagons and the steam locomotives built by the trade and by Chittaranjan and Telco Shops respectively.

It is an achievement of the Railways to connect the top half of the Metre Gauge System to the bottom half of which allows the flow of traffic from the extreme North to the extreme South wherever the system is in existence. But it is for serious consideration whether the Metre Gauge System is not now becoming absolute to meet the growing requirements of India and whether provision should not be considered for converting the Metre into the Broad Gauge at least in stages, so that the growing demand of railway transport is met.

The above writing has pin pointed the traffic and Transportation problems to be expected but interconnected with these are the Workshop problems, the Civil Engineering problems, the Signalling problems, the Labour problems etc., which it is not possible to Encompass in an article of this size.

Suffice it to say that the Railways which are the life blood of the nation have to bestir themselves if they are not to be bogged down in the tremendously increased volume of traffic which will be offering during the next 5 Years.

METHODS OF SAMPLING NON-FERROUS METALS

The Indian Standards Institution has prepared a draft standard for the Methods of Sampling Non-Ferrous Metals [Doc: ST/SMDC 4 (100)], which lays down the procedure for preparing samples for the determination of chemical composition. The difficulty in obtaining a thoroughly representative sample of non-ferrous metals and alloys lies in the fact that the impurities or the alloying elements tend to segregate in the process of solidification. Hence the procedure recommended in this draft standard for sampling of non-ferrous ingot, casting, slab, billet, sheet, etc., have been evolved with due regard to the existing knowledge of the type and extent of segregation likely to occur in the particular item.

GENERAL ENGINEERING SUPPLEMENT

External Lubrication of Locomotives

THE proper choice and use of lubricants form an indispensable part of the steam locomotive.

The lubricant in a bearing serves as important a duty as the metal surface of the bearing itself, which would promptly "burn out" if no lubricant were present. Not only is excessive wear produced in a steam cylinder by lack of lubrication, but also steam leakage results. The long life and service rendered by any machine or moving part is entirely dependent upon the selection of correct lubricants. Correct lubrication is the prime factor of profitable railway operation. Due to the economy of correct lubricants, these benefits are secured at little or no increase of cost per mile of operation.

The investment involved in the locomotives of any railway is necessarily large. Returns from this investment are largely dependent upon correct lubrication, which lengthens the life of every engine, reducing the rate of depreciation. Maintenance costs are largely due to necessary repairs of the worn parts. Correct lubrication reduces wear to a minimum.

The selection of the correct lubricant for any mechanism is governed by several factors which must be considered jointly. The size of the surface to be lubricated influences the quantity of lubricant required. Pressure and speed of movement influence the required body of the lubricant, heavy pressures and low speeds tending towards heavier body, and the reverse conditions tending toward lighter body. Temperatures have a direct influence upon body; high temperatures tend to render all lubricants more fluid and, therefore, require the use of a heavy bodied lubricant, while low temperatures call for one of light body. The method of applying the lubricant is also an influencing factor, in some cases making it desirable to employ a grease.

The main external parts of locomotives which require lubrication are as follows:—

1. Driving Journals, or axle boxes of coupled wheels.

2. Main and side rods or coupling bars.
3. Crossheads, guides valve motion, lever joints, pivots, etc.
4. Centre pins, centre castings, hub liners, shoes and wedges.
5. Truck journals or axle boxes of carrying wheels (engine and tender).

Driving Boxes or Axle Boxes of Coupled Wheels are subjected to heavy loads, not only carrying the greater part of the weight of the locomotive but also receiving the alternating thrust from the steam cylinder, transmitted by the main and side rods or coupling bars. The constant alternation of this thrust would eventually produce worn and heated bearings and a pound in the journal boxes unless they were properly cared for by adjustment and correct lubrication.

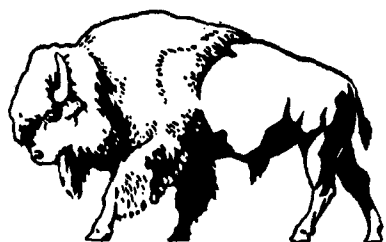
In the standard construction of locomotives, the driving axle boxes are generally fitted with an Automatic Driving Box Lubricator, which is adapted to the use of a hard grease made in the form of a cake to fit the lower half of the journal. This driving box lubricator is so designed as to hold this cake of grease constantly in contact with the lower surface of the journal at all times.

When desired, the driving boxes are constructed with an oil cellar, to be packed with waste or provided with an axle pad. When waste packing is used, attention should be given to the quality of the waste and the method of insertion.

Hard grease is in use in practically all locomotives in India for lubrication of Driving Journals. The grease is pressed and moulded to shape in the grease compressor, and the prepared block is introduced to the Keep. A perforated curved plate, curved to suit the journal, is placed over the grease block and a metal plate with springs fitted under it, feeds the grease on to the journal through the perforation in the plate. Usually a grease lubricated journal will

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run at about 240/250°F under normal operating conditions and though this temperature may feel hot to the touch, it reflects a normal operating characteristic. It is also the general practice to utilize plain brass bearings instead of white metal, where grease is the lubricant in use, although in an emergency, white metal may be resorted to as a temporary measure only.

Truck Boxes or Axle Boxes of carrying wheels are subjected to a practically constant load resulting from the partial weight of engine or tender carried by them.

These bearings are provided with oil cellarsin tended for the use of waste packing or axle pads.

Main and side rods or coupling bars are subjected to the alternating thrust transmitted from the steam cylinder. Effective lubrication is essential in order to prevent rapid wear that would result in objectionable pounding and heated pins and brasses. When fitted for the use of oil, either by hand oiling or by the automatic feed of oil cups, a recommended grade of lubricant will do the job.

Crossheads, guides, valve motion, etc., may be greased by means of a high pressure grease gun.

Centre pins, centre castings, hub liners, shoes and wedges: When the locomotive is taken into the shop for overhauling, the frictional surfaces of these parts should receive an application of lubricants, which is applied hot by means of swabbing or brushing. In addition to this, these parts may be lubricated on the road by hand, or by means of oil cups, with the correct recommended grade to suit operating conditions.

Contributed by Caltex (India) Limited.

MONO-RAIL TRACK

Another striking project, that is still at a very preliminary stage, has aroused a great deal of interest in Moscow. It concerns the building of a 1,800 km. mono-rail track between Moscow and the Caucasus, on which trains could run at a speed of 600 km. an hour.

Circular mono-rail tracks will be laid around Moscow too. This new type of transportation will be noiseless because of the high pressure pneumatic tyres on the cars.

July 1960

THE INDIAN RAILWAY ENGINEER

G.E.3

CZECHOSLOVAK TRANSPORT

By An Engineering Correspondent

TO an advanced industrial country such as Czechoslovakia, transport is of vital importance. The rate of Czechoslovakia's economic growth imposes a rising load on the country's transport system, especially on freight and passenger transport both by road and rail, which increases from year to year. It suffices to state that overall industrial output has grown by more than 300% during the past 10 years; moreover, in the sector of heavy industry, where the demand on transport facilities is particularly heavy, output grew as much as three-and-a-half times during the period cited. Understandably enough, the task of adjusting the transport services to meet these requirements has not been an easy one. In comparison with 1948, the rail, road, and shipping services carried 260% more freight (reckoned in tons) in 1959, while the number of passengers in trains and state-controlled bus services grew almost two and a half times during the same period.

This dramatic growth of transport output was made possible by the systematic guidance applied under the State plan to the development of all transport services, which was governed by the principle that each service should be assigned those tasks which it could master most economically. The necessary pre-requisites for purposeful direction and control of the transport system on such a comprehensive scale were created by the nationalization of all public means of transport in 1948.

The backbone of the Czechoslovak transport system are the railways. A railway network of considerable density and relatively even distribution ensures suitable connection between all important economic centres. The total operational length of the railways is 13,125 km, i.e. there are 100 km of rail track per each 1000 sq.km. of territory. In freight transport, the railways at present account for more than nine-tenths of the total transport volume in terms of ton/kilometres, and for 60.5% in terms of tons carried. Cargoes sent by rail are predominantly long-distance bulk goods. The greatest intensity in goods traffic is in the east-westerly direction, a circumstance arising out of the elongated shape of the country and from the distribution of raw material sources and industrial centres.

In terms of railroad output, Czechoslovakia has moved up into the ranks of the most highly advanced states in the world. Of particular significance in this

respect is the high traffic intensity—i.e. the degree of exploitation of the traffic capacity of the line—in Czechoslovakia. Thus, to give only one example, the intensity of train traffic on the Praha-Česká Třebová line is among the highest, if not the highest, in the world. Again, the average weight of goods trains in Czechoslovakia testifies to the economical use made of rolling stock by the Czechoslovak railways. In the past year, the average gross weight of freight trains was 979 tons, of transit goods trains 1200 tons, and of electric trains as much as 1439 tons. Peak loads are often higher, trains of over 2000 tons being no exception.

As regards passenger traffic, the average number of train journeys per citizen of Czechoslovakia is about 46 each year. Fares, moreover, are very low, and over two-thirds of passengers avail themselves of the benefits of reduced workers' or students' tickets. A feature introduced by Czechoslovak Railways, which is unique in the world, are the passengers' cultural centres which have been established at 120 of the most important railway stations.

In terms of economic significance, the public road transport service is second only to the railroads. With the sole exception of urban services, road transport is operated exclusively by the national corporation known as the Czechoslovak automobile Transport

Service (ČSAD). In the past year, this organization's road haulage output was 115 million tons of freight, the average hauling distance being around 17 km.

Aside from the ČSAD system, freight haulage is effected also by the trucks of production enterprises, though this concerns for the most part short-distance haulage for technical purposes rather than commercial transport. In tons carried, this form of factory haulage accounts for about twice the amount carried by ČSAD trucks. All freight haulage by road in the Czechoslovak Republic is controlled by so-called road transport direction centres which are distributed evenly throughout the territory of the state. The most important task of these centres is to ensure that vehicles carry two-ways loads on all trips exceeding 50 km.

A very dense network of bus services provides connections among practically all towns and villages in



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Czechoslovakia. With an annual passenger total of more than a milliard persons, the bus services represents the most widely used form of public transport. Last year, the total number of passengers carried by ČSAD buses exceeded that of the railways by 430 million persons.

Not the least important section of the Czechoslovak transport system is river transport. Even though the proportion of goods carried by river boats accounts for less than one per cent of the national freight total in tons, and for about 4% in ton/kilometres, the waterways are of considerable importance especially in regard to Czechoslovakia's foreign trade. There is a fairly sharp differentiation as to the character of goods carried along the various waterways: raw materials are imported into Czechoslovakia via the Danube, while the Elbe, Vltava, and Oder serve the export of finished products to the ports of Hamburg and Stettin. Passenger traffic by river boats, on the other hand, is of subsidiary significance, in the main only a matter of pleasure trips in the immediate surroundings of the capital.

Following a temporary period of stagnation between 1949 and 1954, caused by the policy of discrimination carried out by a certain western state, air transport has advanced rapidly in recent years. Czechoslovak Airlines planes now connect almost all the capitals of Europe, and fly as far afield as Egypt and India, with the opening of more long-distance routes planned in the course of this year. Czechoslovak Airlines /CSA/ were the second airline in the world to introduce scheduled services provided entirely with jet planes. During recent months the Czechoslovak fleet of passenger planes has been further enlarged by the introduction of the four-engined IL-18. This year's passenger total carried by Czechoslovak airplanes flying under the code letters OK will attain the figure of 680,000, or almost seven times as much as in 1948.

In addition to scheduled airline services, wide use is being made of non-scheduled, so-called aerotaxi flights. The Czechoslovak Super Aero and Morava L 200 aircraft for several passengers make daily trips between some hundred airfields throughout the country.

The most recent branch of the Czechoslovak civil air services is the use of aircraft for fertilizing crops and combating pests from the air. In the current year, the planes of the Agrolet corporation are to care for 600,000 hectares of land. Airplanes have recently been introduced also into geological survey work.

In the coming years a substantial increase is foreseen in the output of all branches of the transport system both as regards freight traffic and expansion of passenger services. The Third Five-Year Plan for the advance of Czechoslovakia's economy specifies targets for the transport services which include the attaining of a freight output by the public freight haulage service of 484 million tons, and 66.5 milliard ton/kilometres by 1965. The railways and public bus services are to carry a total of almost 2 milliard passengers.

In order to make possible the most efficient and economical fulfilment of these targets, high priority is to be given to the rapid completion of technical reconstruction in all branches of the transport system.

In rail transport, there is to be a decisive increase in the number of electric and diesel-electric locomotives available, and the electrification of main lines is to be completed so that by 1965 electric traction will account for 5% of the total rail transport volume and diesel-electric traction for 23%. On a number of main lines the permanent way will be reconstructed so as to carry increased axle loads and automatic security facilities will be introduced in stations and along the line.

The output and quality of road transport will be

favourably affected by the expansion of the fleet of vehicles and substantial increases in the numbers of bus trailers. The total length of dust-free road surface will be doubled, and the first section of a national motor highway, cutting across the territory of the state from Prague to the eastern frontier and linking up with the international highway system, is scheduled for completion.

The river fleet is to be augmented by new motor-driven freight boats for the purpose of increasing the proportion of the motorized boat capacity to 25%. Steam-driven vessels are to be almost entirely withdrawn from freight haulage. The length of navigable waterways is to be extended and navigation conditions improved as a result of the planned completion of new dams on the rivers Vltava, Elbe, and the Vah in Slovakia.

Modernization and technical reconstruction in the sector of air transport are to comprise the completion of the new runway system and air terminal control buildings already under construction at Praha airport, as well as the reconstruction of other important airfields. The Czechoslovak airlines fleet will be augmented by several dozen new aircraft, including long-distance airplanes of large passenger capacity.

Indian Railway Delegation to Brussels Meet — A.C. Electrification Problems to be Discussed

A four-member team led by Shri Karnail Singh, Chairman, Railway Board, will represent Indian Railways at the next meeting of the Permanent Commission of the International Railway Congress Association, which opened in Brussels, Belgium, on June 27. Shri Karnail Singh left Bombay on June 25 for Brussels.

The Commission, among other things, is expected to discuss a problem which is of vital interest at the present stage to the Indian Railways. This relates to the effect of A. C. electric traction on signalling and communication circuits, with particular reference to the means of overcoming interference to provide safety and good communications.

The three other members of the team are Shri H. D. Awasty, General Manager and Chief Engineer, Railway Electrification, Shri I. B. Bose, Chief Signalling and Telecommunication Engineer, and Shri M. Padmanabhan, Deputy Chief Electrical Engineer, both of the Railway Electrification Project.

Shri Awasty and his two colleagues are also expected to visit Russia, the U. K. and France for about a week in each country to study the solutions

found by these countries for problems such as those the Indian Railways are now facing.

The Indian Railways recently switched over from the D. C. system of electrification to A. C. traction, and projects costing about Rs. 145 crores are now under execution or in various stages of advance planning. The Indian team to the Brussels meeting is expected to discuss with experts from other countries who have experience of A. C. traction in their countries, solutions to certain complex problems that have arisen in India.

The A. C. system adopted in India employs 25,000 volts. This high voltage on the existing transmission lines interferes in the working of telecommunication and railway signalling circuits and causes dangerous conditions in handling. These effects can be reduced by using heavily screened cables instead of open transmission lines or by providing special transformers called booster transformers in the traction conductors, the choice being made according to local conditions. The technique adopted by the different countries varies and has become highly specialised. Exhaustive studies have been made in India also.

Electrical-Resistance Welded Steel Tube Industry in India

By An Engineering Correspondent

THE adaptability of Steel, the basic material of Modern Industry, has been nowhere more effectively proved than in the manufacture of Steel Tubes. With the rapid growth of new Industries, and the expansion of existing ones, the need for Steel Tubes of all varieties in India, has considerably increased; hence, the evolution of the two large scale Plants engaged in the manufacture of Tubes, and it is no accident that the two leading British Manufacturers are behind these ventures; neither would it be an exaggeration to remark that it is to mutual and infinite advantage that British technique and 'know-how' have been combined with Indian skill, capital and management.

In the past, Steel Tubing was considered as a material used primarily in the manufacture of Bicycles and Bedsteads, but since 1928, many developments and much research have taken place in Industry generally. These developments have involved the use of manipulated and formed tubes for a very much wider variety of purposes.

At the beginning of the Twentieth Century, a demand for Steel Tubes of high quality arose in the West, particularly from the Bicycle Industry, and the Boiler Trade. It came to be realised that the potentialities for demand would indeed be enormous, provided the Manufacturers could ensure a constant supply, together with a uniform quality at a reasonably low price. A solution was ultimately found by using the continuous electric-resistance welding process. An idea of the enormous importance of this new process, can be gained from the fact that Tube Products, Oldbury, (the pioneers of this type of tubing in Britain and Europe), have increased their output from a few thousand feet a week in the early 1930's, to five million feet per week, today. Tube Products of India, situated at Avadi, near Madras, is an associate of this famous British Tube Manufacturing Firm. A second Factory, located in Jamshedpur, engaged in the production of E.R.W. tubing, is that of Messrs. Tata, the wellknown Industrial Concern of this Country, operating in association with Messrs. Stewarts and Lloyds, of the U.K.

Tubes are made by very many different process, so

designed that the end product will be suitable for its eventual application. Although the E.R.W. tube is a relatively new product, welding as such, is not a new thing. All over the world, a common feature of any village economy is the Blacksmith carrying out manual welding in his smithy. This he does by heating two pieces of steel until red hot, and then hammering them together so that a weld is effected. This is the basis of the E.R.W. process, except that the steel is heated electrically. The E.R.W. tube is a precision made tube, with all its dimensions kept within precise limits, and with the bore being maintained concentric with the outside diameter. It also has a high grade surface finish and the best qualities of the E.R.W. tube need only the lightest of polishing processes, to render them suitable for chromium plating. The E.R.W. tube is used widely for the manufacture of bicycles, transformers, tubular furniture, automobile and motor cycle components, boilers, flush pipes, pumps, ladders, hospital equipment, tubular structures, etc., and is today even being used for the heat exchangers in the atomic power stations.

The E.R.W. tubing is produced from coiled strips; long coils of strips are fed through a series of rolls, and whilst passing, they assume the shape of 'U' and then 'O', with an eventual narrow gap at the meeting of the two edges. The actual welding of the seams is done by raising the temperature through a pair of rotating discs which feed electric current across the gap, heating it locally to welding temperature. Simultaneously, pressure is applied to close the gap and forge the weld. Any surplus metal known as upset, is removed and the tube is then straightened and cut into convenient lengths. All the operations are continuous and automatic.

After manufacture, tests are carried out to ensure that the weld is in all respects, stronger than the parent material. These tests take the form of expanding the tube over a cone and observing that the point where the tube bursts is away from the weld, subjecting the tube to high internal hydraulic pressures, sometimes to the point of bursting and again noting that bursts take place away from the weld. There are many more tests generally used in the E.R.W. tube trade,

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which are designed to ensure that the tube will be satisfactory for its eventual use.

For special applications where a particularly hard tube may be needed, the welded tubes are subsequently cold drawn on a draw bench.

Different qualities of steel may be used in the E.R.W. process. If a high grade finish is required in the tube, cold rolled steel is used. Tubes of this description would be used for high grade work, requiring enamelling or chromium plating. These tubes are called Bright tubes. In addition to Bright and semi-bright qualities, steels of various carbon contents can be used to give different mechanical properties. If a tube is required to be completely soft for further manipulation, e.g., bending, flattening, tapering, etc., tubes are generally annealed after manufacture. For a tube of equal mechanical strength, but whose surface finish is of less importance, e.g. automobile exhaust pipes, hot rolled strip is pickled and then subsequently made into E.R.W. tubing, which is known as semi-bright tubing.

E.R.W. tubes are extremely versatile. They can be bent, flattened, tapered, shaped and jointed, either by mechanical or welding processes. Joining by mechanical means can be effected by using threaded sections, bolts, rivets, compressed or sweated types of fittings, self, tapping screws, clip fastenings and various other methods dependent upon the form and material to which the tubes are to be joined. Welding methods are controlled largely by the thickness of the tube walls and design of the joint; Argon arc, Oxyacetylene, brazing or arc welding are the usual means employed.

The properties of the welded steel tubes today, have enlarged the demand and the scope, and tubes upto 60 ft. long are prepared for special purpose applications.

A major advantage offered by the E.R.W. Tube, apart from its relative cheapness, is its freedom from eccentricity. The nature of the process makes it simple

to produce a concentric tube as this depends on the accuracy of the rolling of a flat strip, which is normally within close limits. Concentricity is valuable in many ways; first of all, when high speed rotation is involved, as in the making of motor car propeller shafts, there is no need to secure individual balancing in order to obtain smooth running. This means a substantial saving in time and labour. Rockets now require tubes, and the speed or accuracy of flight is attributable to the material used.

Continuous practical research has yielded results calculated to inspire faith in E.R.W. Tubes, for which the demand is still growing. Customers' needs are taken into account by the Manufacturers, who, with their background of years of technical experience in tubing, are able to advise a customer on the best type and quality tubing for his particular needs.

Amongst the numerous and diversified Industrial uses to which tubing can be applied, its adaptability for use in the Sports sphere also, is quite well-known and cannot be discounted. All over the world there is a greater use of tubular sports equipment, such as tubular billiard cues, tubular bows and arrows, tubular golf shafts, etc., all these items of sports equipment have been used by the respective champions.

The development to date, of the Tubular Steel Industry in India, can be said to be very satisfactory. In fact, it is keeping pace with the ever-increasing demand of the other Industries. The indigenous manufacturers are in a position to meet the present and future requirements for E.R.W. Tubes, and with the expansion schemes under implementation, they are more than assured that it will be possible to serve the Industries' requirements fully. It is also certain that with the availability of good, cheap E.R.W. tubing, Indian Engineers will find far wider uses for this tubing, than they have found in the past, thus repeating the pattern of E.R.W. tube development, which has been witnessed in other parts of the world during the last thirty years.

ANALYSIS OF ANTIFRICTION BEARING ALLOYS

The Indian Standard Methods of Chemical Analysis of Antifriction Bearing Alloys (IS: 1409-1959) has been published recently by ISI with the object of prescribing the methods of analysis which shall be useful as reference methods. The standard lays down the procedures for the determination of tin, arsenic, lead and copper, bismuth, iron, cadmium, zinc, and aluminium. In its preparation, due consideration has been given to the facilities available in the country for such analysis.

STORY OF MARODA LINK

By Shri M. O. Chacko

Superintending Engineer (General), Bhilai Steel Project

THE iron ore required for the Steel Plant at Bhilai is obtained from two hills, Dhalli and Rajhara, situated about 60 miles away towards the South East in the State of Madhya Pradesh. A new railway line is laid by the S. E. Railway to connect Bhilai, the nearest railway station to the Steel Plant and the hills, and the ore is now transported in special hopper type wagons over the rail.

The different shops in the Steel Plant are connected by a network of railway lines which adds upto about 60 miles and this yard is now joined to the S. E. Railway main lines, through their marshalling yard at Bhilai from the Bhilai end.

When the Plant works to its full capacity of one million tons, a quantity of 7,000 tons of iron ore per day has to be moved from the quarry on the hill side when mechanised working also will be introduced.

With a view to minimise the wagon holdings within the Plant and improve the pace of wagon turn-round, it was decided to connect the Plant from the Open Hearth end, thereby shortening the distance of travel by about 3 miles. This new connection is from Maroda station on the Bhilai—Dhali Rajhara line and covers a distance of about a mile.

This alignment runs between two water reservoirs which supply water to the Plant and Township attached to it, where the ground level is low and covered by water throughout the year.

The normal method of forming the bank from borrow pits, either by machines or manual labour, had to be abandoned due to the peculiar lay of the land and uneconomical working.

It was then decided to form the bank for the rail track with the slag and refuse from the different shops by laying the track from the Open Hearth yard and

extending it progressively using it as a service track for transporting and dumping the material to form the bank. As the ground is under water of varying depths, progress was slow. The work was organised so that sufficient length of bank was formed each day to permit further linking of the track the following day, and provide sufficient space for dumping slag and refuse from the shops each day. The height and width of the bank formed each day was just sufficient to extend the track above the water level, when trains could be moved with safety.

The working season was limited in that the work could not be started till the water level in the area was lowest and the track had to be linked through to the opposite end before the monsoon rains commenced. This gave a working period of a month and half commencing from the middle of May 1960 to end of June 1960. The progress of work depended directly on the quantity of slag made available from the Plant. With the co-ordinated effort of the different departments of the Plant, the track was taken through to the Maroda station by the end of June and the new connection is programmed to be used as soon as the junction arrangements are completed at Maroda station.

With the onset of the monsoon, the water level began to rise and the track had to be lifted progressively to keep it above water all the time—a special track lifting machine of USSR make was used for this and lift upto half a meter could be done at a time. The machine clamped to the rails on both sides lifts itself up along with the track, permitting the inter space being filled by manual labour. This operation is repeated over each rail length for the complete distance till the finished bank is at correct level and desired section.

The illustration shows the work in progress and gives the picture of the entire length laid through water.

Steel Tubes in the Industrial Development of India

By An Engineering Correspondent

THE Steel Tube is an example of a design based on nature's precepts. The bamboo, the corn stalk and the bird's quill demonstrated to the primitive man the strength of a cylindrical shape.

In this mechanical age, man has adopted the Steel Tube in obedience to the natural law.

Steel Tubes are essential in almost every kind of Industrial expansion, for the provision of domestic amenities and for an increasing number of new end uses. Industry cannot exist without service pipes and mains. Locomotives, land boilers and ships need boiler tubes and many other types of pipework. The oil industry would stagnate without great quantities and varieties of pipes. Modern mining techniques rely on pipes for water and compressed air and for stowage and dust suppression.

As the industrial development of India progresses, more and more tubes are required, and in 1955 The Indian Tubes Company (1953) Limited commenced the manufacture of tubes at Jamshedpur. The first tubes to be produced at Jamshedpur were by means of the Fretz Moon process, with a capacity of 90,000 tons per annum of Screwed and Socketed Tubes, 1/2" to 3" nominal bore.

Screwed and Socketed Tubes are used mainly for carrying gas, water and steam but also increasingly as structurals, scaffolding, tubular point rodding and in the manufacture of materials handling equipment.

Since the Fretz Moon Mill was inaugurated, the Electric Resistance Weld Tube Mill, the Cold Rolling Mill, the Seamless Tube Plant and the Pole Plant have gone into production, and output has steadily increased. Last year it approached 100,000 tons and in 1960, with adequate supplies, this figure should be exceeded by a comfortable margin.

The Electric Resistance Weld Mill with a capacity of over 13,000 tons per annum meets the demand for quality tubes such as boiler tubes, cycle tubes, furniture tubes, transformer tubes, automobile tubes and electrical conduits.

The Cold Rolling Plant is capable of rolling strip as a raw material for the Electric Resistance Weld Mill, and has a capacity of 36,000 tons per annum. The excess capacity of this mill is used for the production of Cold Rolled Steel Strip and High Tensile Box Strapping.

The Cold Rolled Steel Strip has, again, a wide variety of applications, and it is used in the manufacture of cycle wheel rims, mudguards and a multitude of small pressings.

To meet the demand for large diameter tubes, a Rotary Forge Seamless Tube Mill with a capacity of approximately 30,000 tons per annum has also been installed at Jamshedpur. This mill meets the demand for commercial pipes in the range of 4" to 6" nominal bore and also supplies Hot Finished and Cold Drawn Seamless Tubes for Flue Tubes, Casing, Steam Lines, Linepipe, mechanical and hydraulic purposes. A certain tonnage of this production goes to the Tubular Pole Plant which has a capacity of 150,000 Poles per annum on a 3-shift operation.

A brief description of the various processes is given below :—

FRETZ MOON PROCESS

The raw material is Hot Rolled Skelp in varying widths and thicknesses, depending on the size and thickness of the tube to be produced. Coils of Hot Rolled Skelp are drawn through a leveller where the strip is flattened, through the shearers where the ends are trimmed and then through a flash welder where successive coils are welded together end to end to form a continuous strip. The strip is next heated in a continuous furnace to a temperature of about 1300°C and then passed through forming rolls which roll it into tube shape and weld the edges together. The flying saw, mechanically linked to the mill drive, cuts the continuous tube into the required lengths and, beyond the saw, a sizing mill ensures that the tubes are correct in diameter and within the tolerances which are a feature of this process.



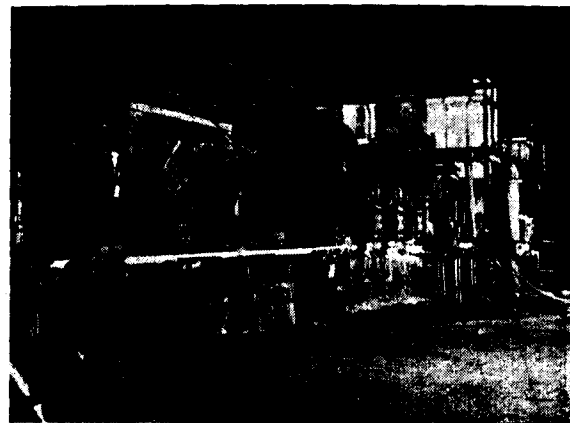
INDIAN TUBE ON THE RAILWAYS

This railway station is similar to hundreds of other stations all over the country. These objects have all been fabricated from steel tubes: the pillars supporting the roof, the guard rails along the overhead bridge, the tubular point rodding beside the track, the luggage trolley and mobile tea stall, boiler, super-heater and boiler flue tubes inside the locomotive and brake tubing throughout the train. If the train is air-conditioned, even more tubing is required. The Railways are the biggest single consumer of steel tubes in India today, but in every industry tubes have hundreds of applications.

INDIAN TUBE

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Manufacturers of Steel Tubes and Strip



Fretz Moon Tube Mill—Showing the flying saw cutting the tube.

Tubes are often required galvanised, and equipment of the most modern design is available including a galvanising bath, holding nearly 100 tons of molten zinc and magnetic roller discharge gear and equipment to remove excessive zinc deposits from the tubes.

Finally, the tubes, either galvanised or black, are passed on to the finishing shop which is equipped with a range of automatic and semi-automatic units to undertake the various processes required, viz. straightening screwing, socketing and hydraulic testing.

ELECTRIC RESISTANCE WELD PROCESS

For the manufacture of Electric Resistance Weld Steel Tubes, again, Hot Rolled Skelp is the principal raw material. This skelp is first cold rolled through a Cold Rolling Mill before being fed into the Electric Resistance Weld Tube Mill. The Cold Rolled Strip passes through a Rotary Slitter which takes off the side-trim to obtain a perfect edge for subsequent welding operations and then on through a series of forming rolls which form it into a tubular shape and with the edges pressed together. It is then passed under a high frequency Electric Resistance Welder. This Welder consists of an oiled cooled rotary transformer fitted with copper alloy electrodes which run on the surface of the formed and guided strip, one on each side of the seam. Power to the Welder is supplied at 300 K. V. A., 200 cycle frequency and the seam is welded at this point at speeds reaching 150 feet per minute on thin wall tubes. All traces of the bead resulting from the weld are removed from both inside and outside surfaces of the tubes by scarfing tools positioned after the Welder. Subsequent to the welding operation,



Electric Resistance Weld Tube Mill.

a cold sizing mill is employed, which controls the final size of the tube to the close limits required by modern specifications for boiler and other precision tube categories. The tube is then cut to lengths and depending on its final application, it can be subsequently annealed or normalised in a continuous gas-fired furnace.

The plant is provided with all the necessary ancillary equipment, consisting mainly of modern strip handling machines, e. g. coil crane, uncoiler, leveller, shears, flash welder and edge slitter, so as to ensure uninterrupted delivery of suitable strip to the mill to keep the process continuous. The finishing plant is also provided with necessary equipment to ream the ends of the tubes, where the tubes are subsequently welded together end to end, straightening machines and equipment to swell and reduce the ends of the tubes for subsequent use in boilers.

SEAMLESS PROCESS

The main producing plant consists of a Rotary Forge Mill (Pilger Mill) producing Seamless Steel Tubes in the range $3\frac{1}{4}$ " to $6\frac{1}{2}$ " outside diameter.

This range is covered by nine basic tube sizes rolled direct on the mill. Intermediate sizes and sizes from $3\frac{1}{4}$ " down to $2\frac{3}{8}$ " outside diameter are obtained by subsequent reduction in a Reducing Mill.

The raw material consists of Hot Rolled Blooms upto 30 feet in length which are flame cut into billets by equipment which cuts four billets simultaneously. After cutting, the billets are heated in a gas-fired rotary furnace of 10 tons per hour capacity to a temperature of about 1250°C .



Billet Piercing Machine—Seamless Plant.

After discharge from the furnace the billets are calibrated in a 2-roll mill to produce a tapered corner profile which ensures accurate fit in the container of the subsequent piercing operation.

The Hydraulic Piercing Press of 550 ton capacity transforms the approximately square billet into a cylindrical hollow or "bottle", which is then passed to the Rotary Elongator of 1,600 h. p. The inclined rolls reduce the diameter and thickness.

This operation produces a short thick walled tube

which is then fed to the 1,000 h. p. Rotary Forge Mill where it is forged on a mandrel into the final tube, which may be upto 70 feet long.

In the outlet conveyor system from the mill are located hot saws which trim the ends of each tube and where multiple lengths are rolled, split them into final tube lengths.

The Finishing Bay is provided with machines for straightening, cutting, threading, swelling and swaging, machining ends and testing hydraulically tubes of various categories.

In order to meet the demand for other quality products including flue tubes, where cold drawn finish and dimensions are specified, a separate bay is provided which is equipped with a 150,000 lb. Cold Drawbench and a Tube Annealing Furnace.

Adjoining the Finishing Bay, facilities are provided for production of Transmission Poles and small Lighting Poles.

The picture at the moment is that the Steel Tube Industry in India is comparatively highly developed and prospects appear to be almost unlimited as the industrial tempo quickens.

The present installed capacity of the Industry is around 175,000 tons a year of which about 140,000 tons are accounted for by the project at Jamshedpur.

At Rourkela, an unit is going up with a capacity of more than 100,000 tons a year for manufacturing welded pipe in the larger sizes, ranging from 8" to 20" diameter. Thus, the Third Plan will see India manufacturing substantial quantities of tubes in sizes ranging from $\frac{1}{2}$ " to 20".

Copper Sheet and Strip

The Indian Standards Institution has recently published IS: 1550-1960 Specification for Copper Sheet and Strip for the Manufacture of Utensils and for the General Purposes which covers the requirements for two grades of copper sheet for the manufacture of utensils and for general purposes, such as roof coverings, flashings, weatherings, gutters, damp-proof courses in buildings, etc. Grade 1 includes copper sheet and strip for pressing quality while Grade 2 includes the same for hand worked articles and general purposes.

The standard is one of a series of Indian Standards on copper sheet and strip. Another standard on copper sheet and strip for electrical purposes is under preparation.

BRITISH RAILWAYS ELECTRIFICATION CONFERENCE AND EXHIBITION

THIS exhibition will take place at Battersea Wharf from 3rd October to 7th October, 1960. It is devoted to products and materials for use in 25 kV 50 cycles a. c. railway electrification schemes, with the accent of contracts carried out for the British Transport Commission as part of their modernization programme. The BICC Group, largest contractors to the B. T. C. for the supply, design and installation of overhead equipment and various types of cables, will be exhibiting on Stand No. 15.

Their extensive range of individual exhibits can be divided into four main classifications.

OVERHEAD EQUIPMENT

A comprehensive selection of individual components installed on 25 kV a. c. electrification schemes throughout the country will include catenary and contact wires, all types of registration and supporting fittings, cantilevers, the latest types of insulation, different types of section insulators, turnbuckles and line fittings with rail bonds and miscellaneous items.

Inside the main entrance to the exhibition a section of track will be equipped, though not energised, for 25 kV a. c. traction, showing the practical significance of many of the items displayed on the Group stand. Adjacent to the track will be a 55-foot self supporting flood-lighting tower of the class developed by the BICC Group, on behalf of the B.T.C., for low level use in shunting yards and similar situations.

TELEPHONE CABLES

Samples of the specially screened aluminium sheathed telephone cables, installed on the Manchester/Crewe and Liverpool/Crewe routes, will be available for inspection. An interesting demonstration illustrates the protection afforded by cable screening against the effects of interference from the traction system. Sections of cable troughing and accessories may also be seen.

POWER CABLES

The most up-to-date 25 kV concentric track feeder cables are on show comprising:— (1) An oil filled, corrugated aluminium sheathed cable with a fully sectioned sealing end. (2) A gas-filled concentric cable and its associated straight through joint. Other subsidiary displays embody examples of aluminium and lead sheathed cables, rubber and plastic insulated and sheathed supply cables, train jumper cables and a complete assembly of a 25 kV pantograph cable with end bushing.

SIGNALLING CABLES

P. V. C. insulated and sheathed multicore cables are shown together with glo-ester straight joints, glass fibre dome type inspection joint, and other relevant accessories and also a selection of cabin wiring cables.

VISITS

Delegates to the Conference will visit electrification schemes on the Eastern Region of British Railways and will also be conducted on an extensive tour of Crewe Junction and part of the Crewe-Manchester route on the London Midland Region.

The delegates will be able to inspect practically every facet of the planning and implementation of these electrification projects. Throughout BICC Group equipment, planning and erection facilities will be in evidence and no doubt the mechanical aids to the installation of overhead equipment will arouse particular interest.

Invitations will also be extended to delegates to visit the numerous Group production units and laboratories engaged on aspects of this work. Among these are the factories at Prescott, Erith, Helsby, Leigh, Trafford Park, Hereford and Renfrew, and research laboratories at Wood Lane, London, and Tolworth.

The British Railways Electrification Conference and Exhibition will demonstrate the wide interests of the BICC Group in the development, manufacture and installation of equipment for the railway electrification.

BUFFERS, BRAKES, BUSHES, COUPLERS & SHOCK ABSORBERS SUPPLEMENT DAKO Railway Compressed-Air Brake

By Josef Danek
State Prize Laureate

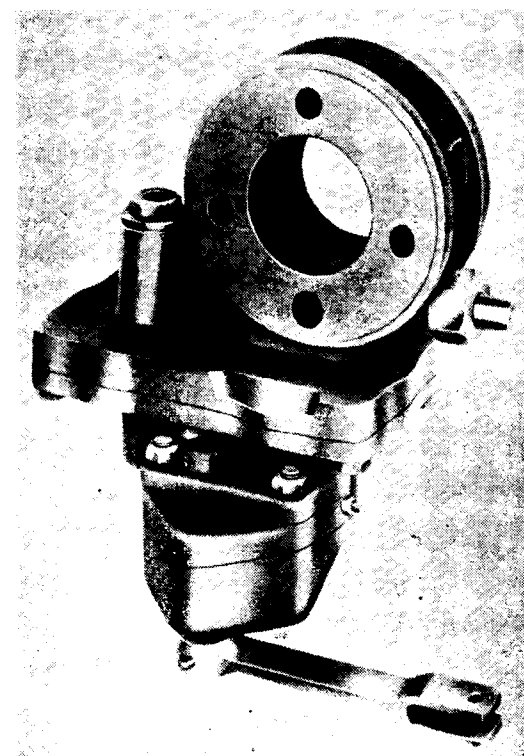
MORE and more importance is attached in railway transport to the question connected with perfect braking of trains. A railway brake must ensure not only safe and trouble-free operation, but it is necessary that a modern braking device should be one of the means making further technical progress in railway transport possible, such as increasing of the speed of goods-trains and passenger-trains, increasing of the weight and the length of trains and, last but not least, also shortening of the manipulation time before the train departure. A new DAKO railway compressed air brake has been developed in Czechoslovakia and with its latest variant—the distributor DAKO-CV—successful tests were carried out in the summer months of the year 1956 in the presence of the Brake Subcommittee of the International Union of Railways. Since the year 1956 the DAKO brake has been installed on all the new wagons of the Czechoslovak State Railways.

COMPONENTS OF THE DAKO BRAKE

In the design of the DAKO brake the experience gained in the production and service of the Bozic brake were made full use of. Most of the wagons used on the Czechoslovak State Railways since 1930 have been equipped with the Bozic brake. In Bozic brake design there were used for the first time solely rubber diaphragms instead of pistons with piston rings and valves instead of slide valves. From the point of view of simple production and reliability in service these elements have proved fully successful also in the components of the DAKO brake. From the performance tests of various alternatives of the DAKO distributor that have been carried out since the year 1950, the fundamentals for a suitable design of a distributor, which perfectly fulfils the high requirements of service and secures operating reliability, were gained, all this being achieved due to the simple design of the distributor and the low number of its parts.

The connecting flange of the DAKO-CV distributor is of the same size as the Westinghouse Lu type triple valve, Bozic distributor, Westinghouse and Knorr

quick-acting distributors, etc. It is screwed either to the flange of the auxiliary reservoir or to the support of the distributor. The arrangement of the DAKO brake on the wagon and the other accessories of the brake do not differ from the other brake systems normally used. It is possible to brake the load on the goods-wagons either by means of the usual change-over device for changing of leverage ratio or pneumatically by changing the pressure in the brake cylinder by using the DAKO-D complementary valve. The DAKO-D



complementary valve is placed between the flanges of the distributor and the auxiliary reservoir or between the flanges of the distributor and its support. The braking of the load can be controlled either automatically, in proportion to the load, or by hand, usually by means of a three-position change-over device.

Besides the DAKO-CV distributor the DAKO-CV 1 distributor is used. The difference between these two

types consists only in that the cover of the compensation mechanism of the DAKO-CV distributor, provided with a cavity and a retarding valve, is in the case of the DAKO-CV I distributor replaced with a simple flat cover. All other parts of the distributor are identical. The DAKO distributor is provided with the "goods-passenger" change-over cock. If the distributor is used for braking goods-trains or passenger-trains only, the change-over cock is replaced by a cover in which the respective calibrated holes are arranged.

In recent years trials with the DAKO fast train brake have taken place. Also in this case the DAKO-CV distributor is used which, in conjunction with other components of the fast train brake—namely with the additional valve DAKO-R and with the centrifugal governor, secures a short braking distance when braking at high speeds.

For the locomotives, the DAKO-L locomotive brake has been developed which can be used for engines hauling either the goods—, or passenger— or fast trains.

The National Corporation of KOVOLIS—HEDVIKOV, where the brake development work is concentrated, is working at present in co-operation with the Czechoslovak State Railways on solving other problems connected with perfect braking of trains.

THE FEATURES OF THE DAKO BRAKE

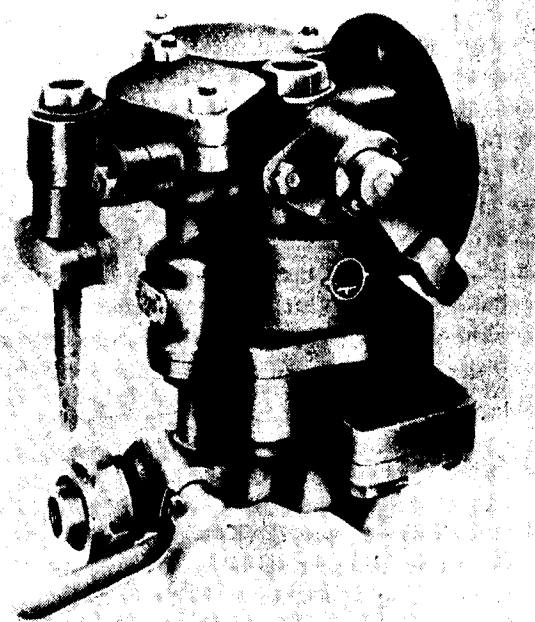
In the course of the international tests that took place in the year 1956 the DAKO-CV, as well as the CV-I brake, fulfilled all requirements of the International Union of Railways regarding the acceptance of the new brake for international service.

The values obtained during these tests were considerably more favourable than the limits prescribed by the U. I. C. Code leaflet No. 540 for important brake characteristics. Also during the test runs the advantageous qualities of the DAKO brake were proved. Even in the case of the most exacting ways of braking, for instance, after rapid braking of a long train travelling at a low speed and after the previous normal braking, the braking at all points of the test train was surprisingly smooth. The duration of release even of the long goods-trains was in most cases within the limit fixed for the release of a single wagon. In normal braking the trains were stopped exactly at the pre-determined place. In the course of the inexhaustibility tests, the exhaustion ascertained was less than

1 per cent both in the case of goods-trains as well as passenger-trains.

SMOOTH COURSE OF BRAKING

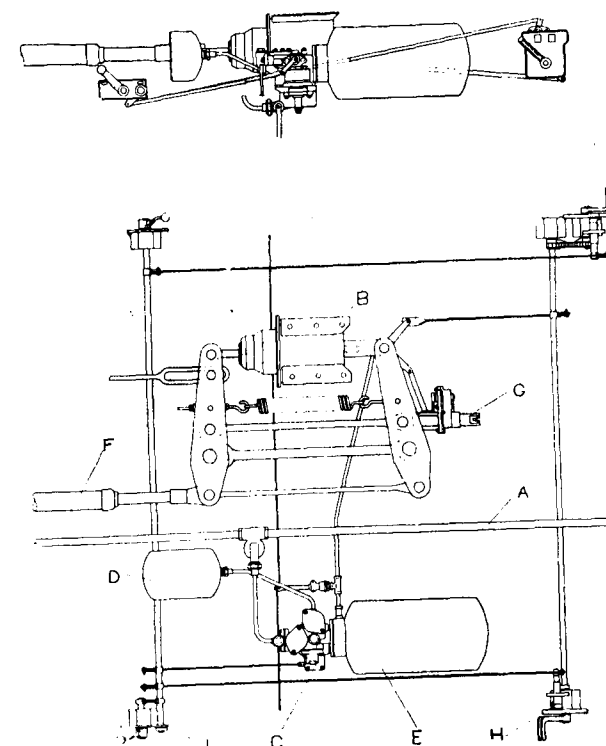
The reactions arising during braking are measured on various vehicles of the whole train by means of the shock testing ball apparatus. In every apparatus 10 balls are placed on variously sloped surfaces, both in the direction of travel of the train as well as in the opposite direction. The stronger the reactions the greater the number of fallen balls. Reactions involving up to five fallen balls are considered as being mild.



The smooth braking of the trial train with the DAKO brake was demonstrated best, for example, by the fact, that during the 88 tests the 315 results of the ball test apparatus were noted and the average number of the fallen balls in the direction of travel was 1.93 and in the opposite direction 0.63. The filling time of the brake cylinders of the goods-train brake complied with the new UIC regulation, i.e. 20 to 28 seconds. Smooth braking depends mainly on the velocity of propagation. The velocity of propagation was during all measurements on various trains with the DAKO-CV and DAKO-CV I distributors within 273 to 294 m per second and in the case of the brake with the DAKO-D complementary valve within 266 to 294 m per second. With regard to the necessary insensitivity of the brake this speed represents in fact the maximum that can be reached with a pneumatic brake.

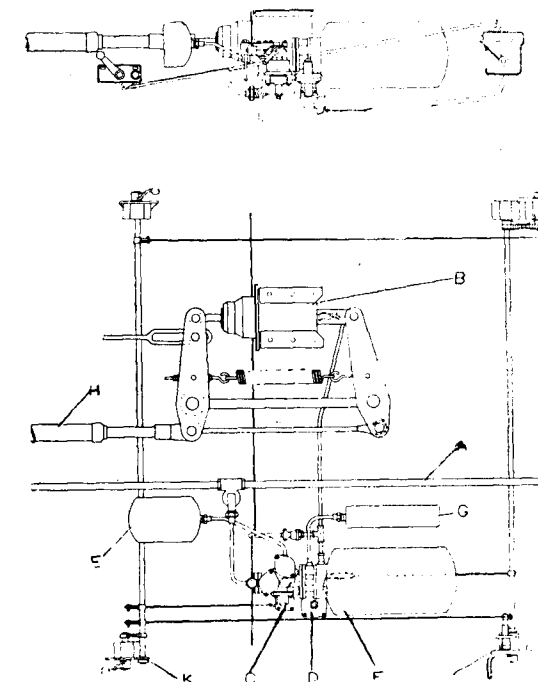
Even at a high velocity of propagation it is important that the increase of pressure in the brake cylinders of the last wagons on the train be sufficiently quick at the beginning of braking. Also in this respect gives the DAKO brake very good results.

On a train consisting of 75 four-wheel wagons with a length of the main piping of 837 metres the pressure in the cylinder of the last wagon rises to 0.5 kg per sq. cm in 3.58 sec. and to 1 kg per sq. cm in 8.1 seconds from the moment when the engine driver starts braking. If the brake cylinders are not yet completely de-aerated after the previous braking, the velocity of propagation during the rapid braking is practically the same as when braking from equalized air pressure in the brake cylinders is 0.2 kg per sq. cm or lower. An appropriate and uniform valve of the first stroke contributes also the smooth braking of goods trains.



General arrangement of DAKO brake on railway wagons with mechanical braking of the load.

- A - main brake piping
- B - brake cylinder
- C - distributor with brake release valve and cut-off cock
- D - control air reservoir
- E - auxiliary air reservoir
- F - automatic slack adjuster
- G - casing of "empty - loaded" change-over device
- H - "empty - loaded" change-over device
- I - "goods - passenger" change-over device



General arrangement of DAKO brake on trucks with air braking of the load and manual adjustment

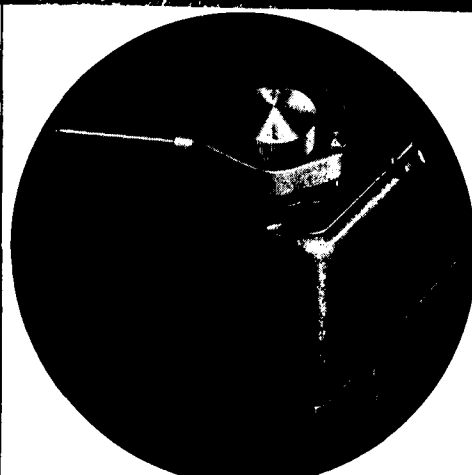
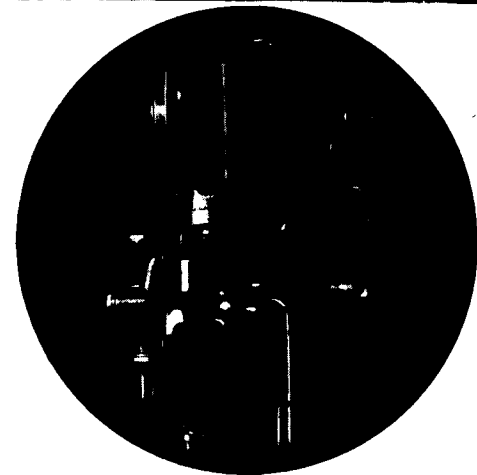
- A - main brake piping
- B - brake cylinder
- C - distributor with brake release valve and cut-off cock
- D - complementary valve type D
- E - control air reservoir
- F - auxiliary air reservoir
- G - auxiliary control air reservoir
- H - automatic slack adjuster
- I - "empty - loaded" change-over device
- K - "goods - passenger" change-over device

The UIC regulation states that the first stroke measured at the brake shoes should be approximately 10 per cent of the maximum effort on brake shoes. The brake with the DAKO-CV distributor has a first stroke of 8.9 to 11.6 per cent and the brake with the complementary valve DAKO-D has 8.1 to 12.2 per cent both when braking an empty or a loaded wagon. To attain this favourable value the DAKO-D complementary valve has a special mechanism that divides the first stroke into two parts. The first part—a constant one, corresponding to the pressure of 0.35 kg per sq. cm in the brake cylinder, serves to overcome the resistance of the springs and in the brake gear, whereas the second part—the variable one, which is proportional to the highest pressure in the brake cylinder, serves to develop the first stroke proper on the brake-shoes. The DAKO-D Complementary valve fills in the brake cylinder of the empty wagon during full braking to a pressure of 1.3 kg per sq. cm, whereas the highest

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THE INDIAN RAILWAY ENGINEER

B.5

pressure in the brake cylinder of fully loaded wagon is 3.8 kg per sq. cm. The value of the air pressure for an unloaded wagon can be, however, easily set to a higher value if required. This broad range of pressures in the brake cylinder when using the DAKO-D complementary valve makes therefore possible to obtain a three times higher effort on brake shoes on a loaded wagon compared with an empty wagon. This variant of the DAKO brake is therefore especially suitable for modern goods-wagons with a low empty weight and a large carrying capacity. The mechanism of the DAKO-D complementary valve producing a prime first stroke is very useful during the normal braking. On a train consisting of empty and loaded wagons, the brake shoes come in contact with the wheels of all wagons at the same reduction of air pressure in the main brake piping/this reduction being approximately 0.25 kg per sq. cm/, and only during further braking the effort on the brake shoes of the individual wagons differs in proportion to their load. If a brake system, working with a variable pressure in the brake cylinder, is without a mechanism similar to that mentioned above, the empty wagons are not braked during the small brake steps. This causes firstly increased reactions during braking and secondly an uneven braking of the wagons when travelling on gradient tracks.

INEXHAUSTIBILITY OF THE BRAKE

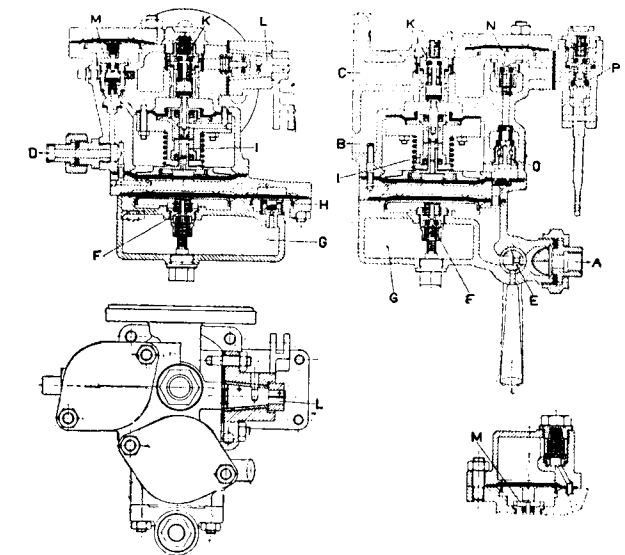
The inexhaustibility of a brake is a guarantee of safe operation on mountain lines. The UIC regulation determines the exhaustion, i.e. the reduction of the maximum pressure in the brake cylinders must not be higher than 15 per cent. In the case of the DAKO brake the exhaustion of 0.7 per cent on goods-trains and 0.8 per cent on passenger-trains have been ascertained. In the case of the DAKO brake the highest pressure in the cylinders is 3.8 kg per sq. cm and therefore complies with the prescribed value of UIC /3.7 to 3.9 kg per sq. cm/.

With the DAKO brake almost absolute inexhaustibility is obtained by means of separating the brake cylinder during full braking from the auxiliary air reservoir. At the same time in the auxiliary air reservoir is a somewhat higher pressure than in the brake cylinder. With regard to the inexhaustibility of the brake it is important that the reduction of pressure during the braking process should not take place in the control air reservoir. Also in this respect is the construction of the distributor well protected. The connection of the control air reservoir with other cavities of the brake takes place only when the

pressure in the brake cylinder drops to a value lower than 0.05 kg per sq. cm.

DURATION OF RELEASE OF TRAINS

With respect to inexhaustibility all modern brakes are gradual releasing brakes. If this fact should not be a hindrance when releasing long trains, it is necessary, during the releasing to supply the main brake piping with a higher pressure by applying these so called filling strokes. When releasing by means of filling stroke, the pressure in the control air reservoirs must



DAKO distributor - types CV and CVI - sections :

- A - for main brake piping
- B - for brake cylinder
- C - for auxiliary air reservoir
- D - for control air reservoir
- E - cut-off cock
- F - accelerator
- G - accelerator chamber
- H - outlet valve
- I - main control mechanism
- K - rapid-action filling valve
- L - "goods - passenger" change-over cock
- M - equalizing and cut-off mechanism
- N - change-over filling equipment
- O - non-return valve
- P - brake release device

not be increased, otherwise after the end of the filling stroke, an undesirable braking would occur. The longer filling strokes the brake permits and the higher the pressure which can be applied during these strokes the more easily can the brake be released even on long goods-trains, where a considerable leakage of

the whole braking system may occur. The respective UIC regulation determines that the goods brake must permit a filling stroke for at least 25 seconds at a pressure of 6 kg per sq. cm in the main brake piping. The passenger brake must permit a filling stroke for at least 10 sec. at the same pressure. The DAKO brake exceeds this limit a great deal. With different types of distributors it is possible to apply—when releasing goods-trains—filling strokes for 66 to 93 seconds and in the case of passenger-trains for 25 to 48 seconds with pressure of 7 kg per sq. cm and more in the main brake piping.

SENSITIVENESS OF THE BRAKE DURING GRADUAL BRAKING AND RELEASING

During the normal braking on the level or gradient tracks it is desirable that the pressure in the brake cylinder should react even on very small changes of pressure in the main brake piping.

With the DAKO brake a very fine grading of the effort on brake shoes in the course of braking as well as of releasing is possible. How this feature works out in service operation is best shown by the fact that during the trials of the DAKO brake the train was stopped in 26 out of the 41 tests of normal braking with zero deviation from the pre-determined sport. The test trains were in some cases as much as 1,100 metres long.

FUNCTION OF THE BRAKE IN HEAVY DUTY SERVICE CONDITIONS

In the above paragraphs we have made clear some of the properties of the DAKO brake. For railway service, however, it is very important that function of the brake be reliable in heavy duty conditions, especially in winter.

When designing the DAKO brake, the Czechoslovak State Railways have determined in their requirements, that the brake must function reliably even during a 3-years inspection period. From experience we know that most defects in winter are due to freezing of the condensate separated from the air. In this respect, the distributor spaces connected directly with the brake piping and the cavities communicating with them are mostly endangered.

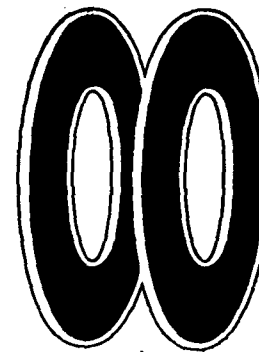
On the basis of service experiences a gravity draining arrangement of respective spaces and ports has been chosen in the case of the DAKO distributor, the brake piping being connected at the lowest spot of the distributor. When disconnecting the brake by means of the cut-off cock, which forms a part of the distributor, the condensate is drained through the air discharge opening not only from the distributor spaces connected directly with the brake piping, but also from the accelerating chamber placed on the lower part of the distributor. This construction has proved to be fully satisfactory in service. It is natural that reliable function of the brake must be secured even in the case of abnormally low temperatures that may occur in winter. Special freezing tests have been carried out with the DAKO brake which worked well even at the lowest temperatures reached during the tests, i. e.—56°C.

CONCLUSION

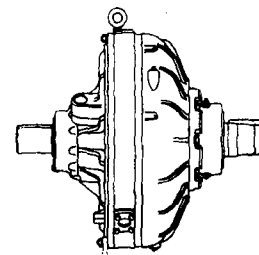
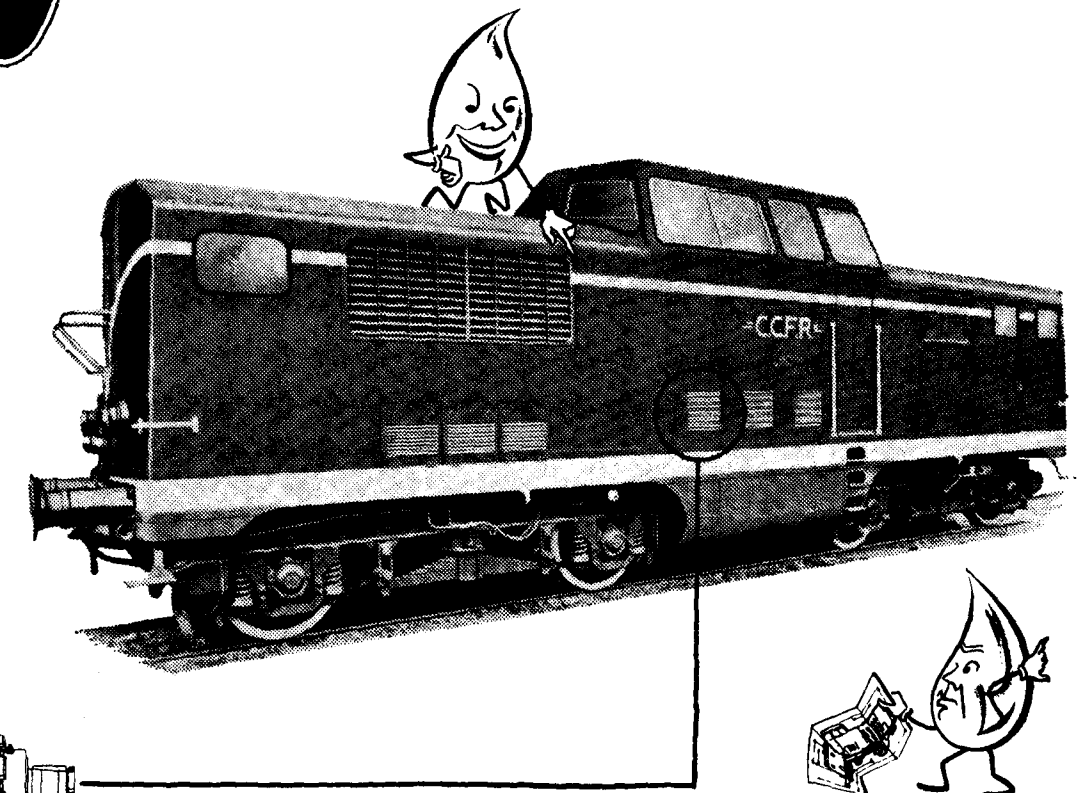
The advantages of the DAKO distributor are based not only on its functional properties, but also on the fact that the construction of the distributor is well adapted to the needs of railway service. The weight of the distributor is very low. If made of cast iron it weighs 26 kg so that its mounting on a wagon is easy. Its simple components and their restricted number make the installation and dismantling of the distributor during periodical brake revisions very easy.

NEW HARBOUR CRANES

A start has been made with the delivery of 63 new harbour cranes ordered by the South African Railways and Harbours at an estimated total cost of £ 1,896,000. The cranes are considerably higher than those at present in Union ports. The orders are for 58 cranes of 4-ton capacity and five of 15-ton capacity. Durban will get 23 of 4-ton and two of 15-ton capacity; East London four of 4-ton and one of 15-ton capacity; Port Elizabeth 14 of 4-ton and one of 15-ton capacity; Cape Town eight of 4-ton capacity; and Walvis Bay nine of 4-ton and one of 15-ton capacity. The cranes are being supplied by four different contractors. All the steelwork and part of the machinery will be of South African manufacture. (RG)



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Modernisation of Vacuum Brake Equipment

By An Engineering Correspondent

THE introduction of diesel traction and the extension of electrification on Indian Railways has coincided with the need to work much longer and heavier trains to meet the growing industrial developments now taking place.

New 80 and 90 ton wagons are coming into service and the problems associated with the braking of long trains composed of such heavy vehicles are being energetically studied, both by the Indian Railways Technical Staff and by private firms engaged in designing and producing Railway Brake Equipment.

Among the latter the firm of Gresham & Craven Ltd. have been particularly active, both at their Manchester works in England and at the Gobra works of Gresham & Craven of India (Private) Ltd. in Calcutta.

A new Test Rack to represent a train 2000 ft. long was set up at Gobra in the latter part of 1958, whilst the works in Manchester laid down a test rack to represent trains up to 4000 ft. long during 1959. A photograph of the latter is shown on Fig. 1 and the control position for operating this Test Rack on Fig. 2.

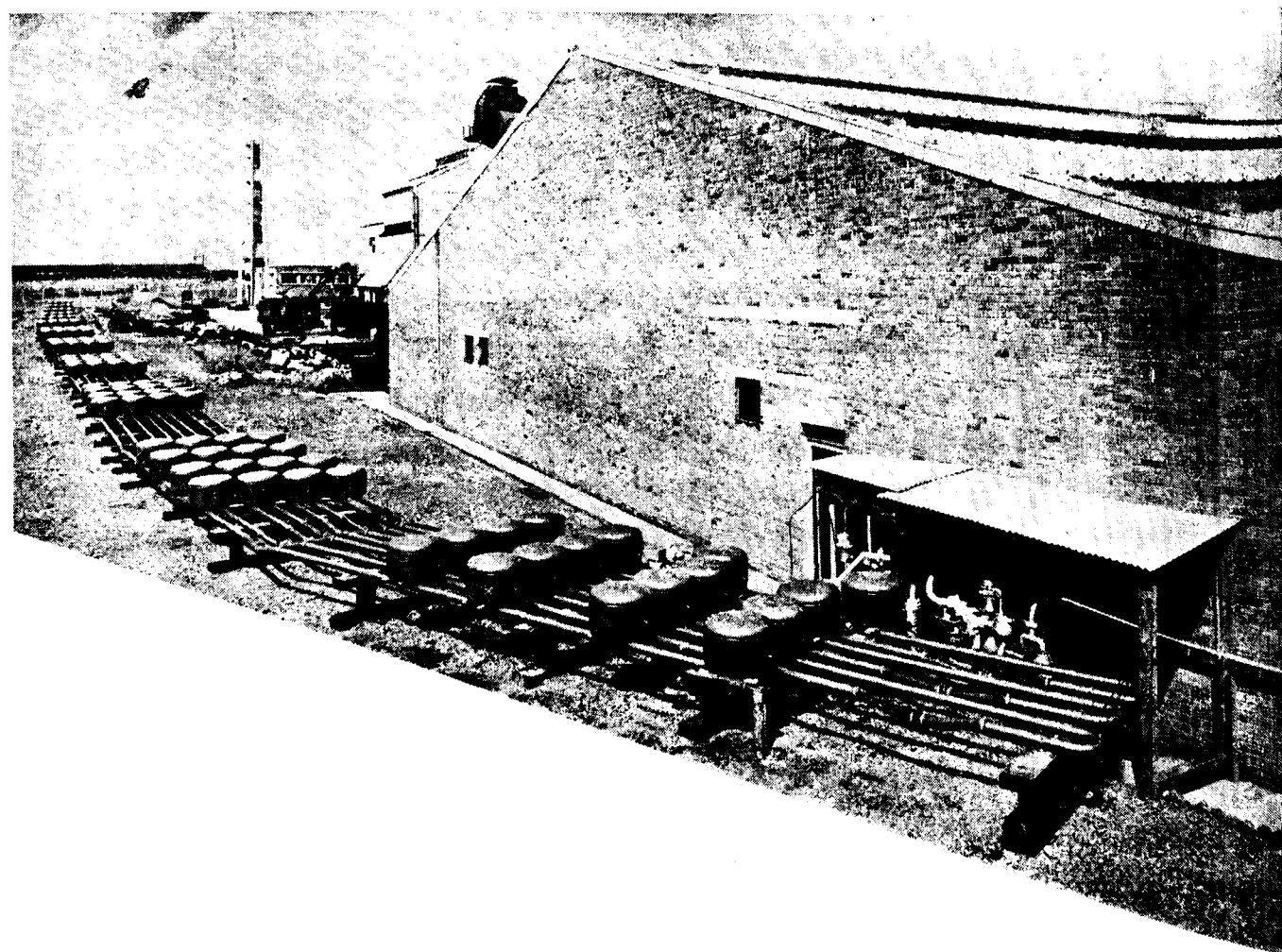


Fig. 1. Gresham & Craven Ltd. Vacuum Brake Test Rack 3" Train Pipe 4000 ft. long with 184 combined type 21" Brake Cylinders. Representing 92 vehicles each 43' 6" overall Exhauster capacity up to 680 c.f.m. available.

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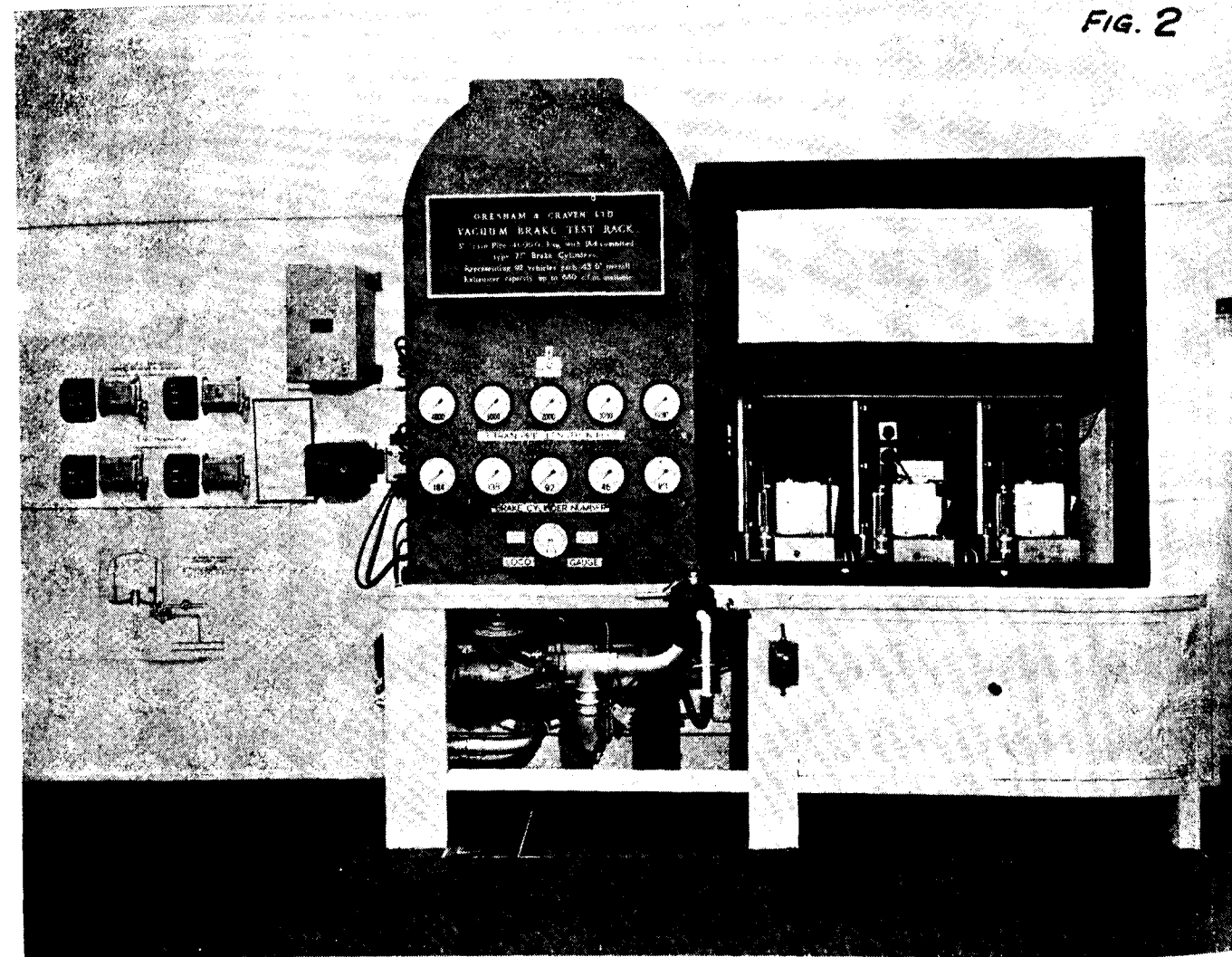


FIG. 2

Trials in India, both on the Gobra Test Rack and on the Railways have shown that the existing 2" bore train pipe is the limiting factor for train length when operating with vacuum brakes. If all the extractive capacity for providing brake power is concentrated at the front of the train the maximum practicable train length is about 2000 ft. and no advantage can be gained by using a total exhauster swept volume of much more than 300 c. f. m. capacity. The long delay previously experienced in getting the brake 'on' at the rear of trains of this length, which has been the main difficulty with the old standard brake, (where all the air admitted had to enter from one point at the front of the train) can now be overcome by employing Direct Admission Valves fitted to each brake cylinder. The problem of release times remains however but one solution already tried out in India with some success is to provide exhauster capacity at the rear of the train in addition to the front. With this arrangement air can be withdrawn from both ends of the 2" train pipe simultaneously and

total effective extractive capacity can be doubled to a maximum of 600 c. f. m. swept volume. This arrangement greatly improves release times and ability to deal with high leakage factors but there are certain operational difficulties, as the running and isolation of the exhauster at the rear of the train must still remain under the control of the driver at the front. This has involved the provision of telephonic communication between front and rear of the train to obtain the best results on trials so far carried out.

It has long been considered by many brake engineers that the ideal solution to the release problem would be an increase in train pipe size, to reduce resistance to air flow and thus enable larger exhauster capacity to be effectively used.

With this thought in mind and with the Indian Railways problem as the main objective Gresham & Craven decided to lay down their new Test Rack in Manchester

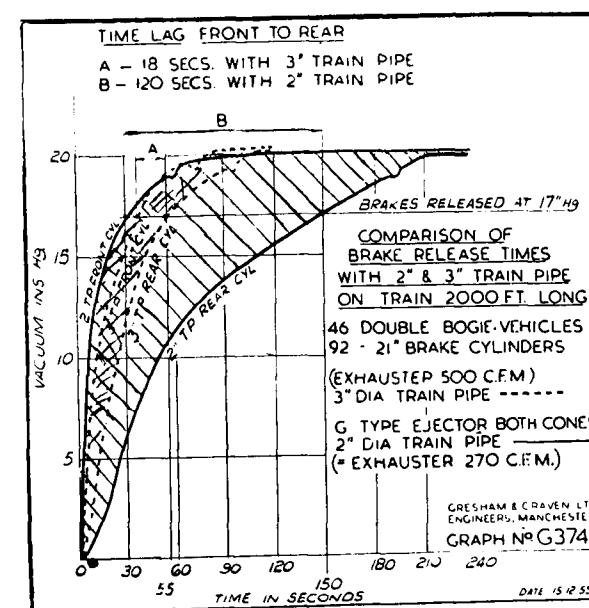


FIG. 3

with 3" bore train pipe. This Rack represents a total of 92 double bogie vehicles each 43 ft. 6 ins. long and fitted with two 21" vacuum brake cylinders. 3" hoses and couplings are provided between each wagon length.

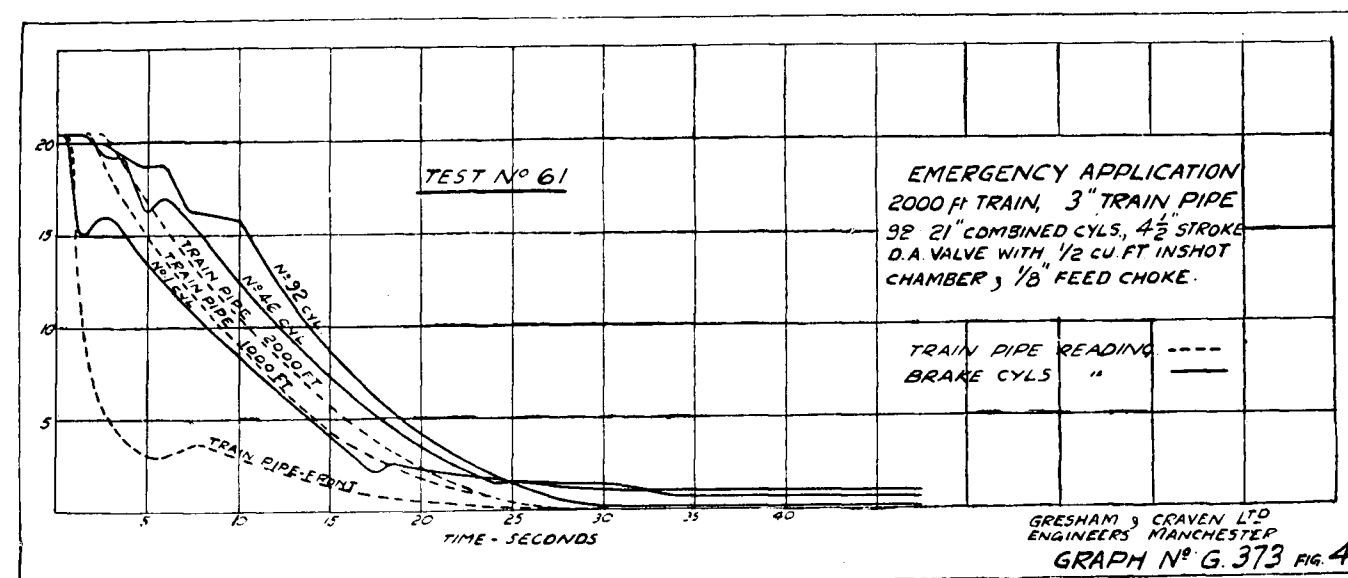
The total exhauster capacity available can be built up to 680 c. f. m. and this is concentrated at the front of the train. Direct comparisons have been made between results obtained on the 2000 ft. 2" train pipe rack at Gobra and the new 3" rack in Manchester and spectacular improvements in release times have been recorded.

These are shown graphically on Fig. 3. It will be noted that the release time for a 2000 ft. train after an emergency application has been brought down from over 2 minutes to 55 seconds simply by using a larger train pipe.

This solution does not involve the provision of additional valves or reservoirs and does not interfere with the inexhaustible principle which is the great safety feature of the vacuum brake.

As a further investigation, both the Gobra and the Manchester test racks have been fitted with Freight type direct admission valves with inshot features giving a rapid movement of the brake blocks to the wheels followed by a controlled brake power build up period to avoid shocks between vehicles. Results obtained during typical emergency applications on 2000 ft. and 3000 ft. trains are shown on Figs. 4 and 5.

To control the braking on very long trains and to enable the driver to graduate the brake 'on' and 'off' with precision the new 3" Test Rack has been equipped with Gresham's 'E. Q.' type drivers brake valve which can be seen on Fig. 2. This valve controls communication between the exhausters and the train pipe by means of a switch and suitable magnetic cut out valves and also controls the vacuum in a small equalising reservoir. This reservoir in turn is connected to the lower side of a large diaphragm operated automatic air admission valve.



GRESHAM & CRAVEN LTD. ENGINEERS, MANCHESTER. GRAPH N° G. 373 FIG. 4

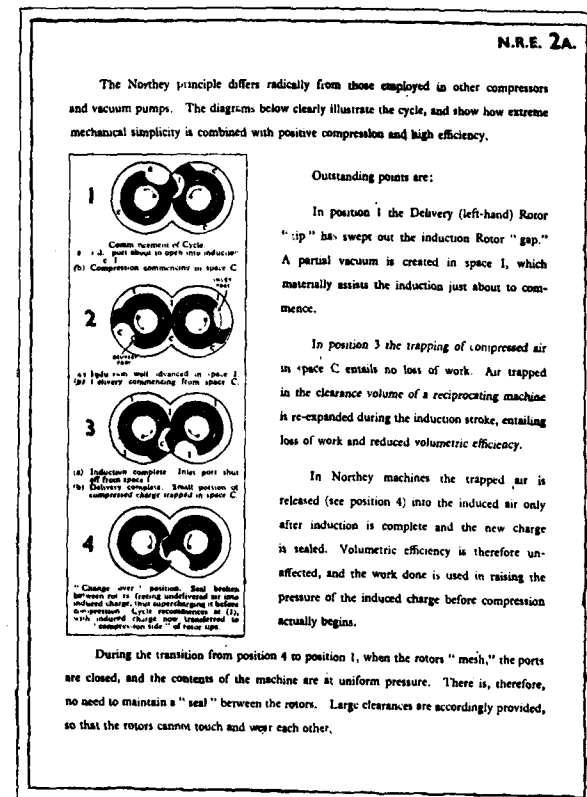
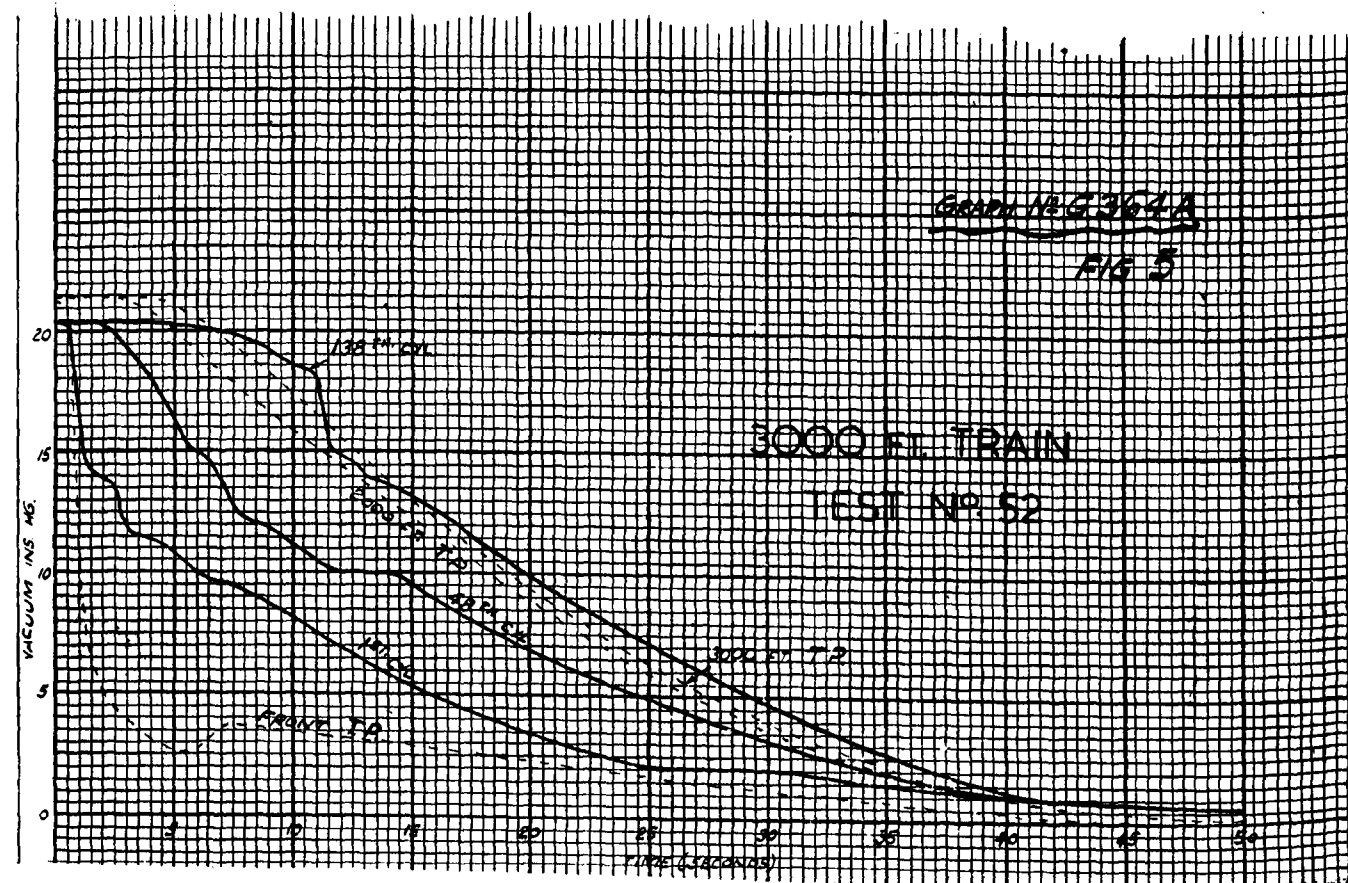


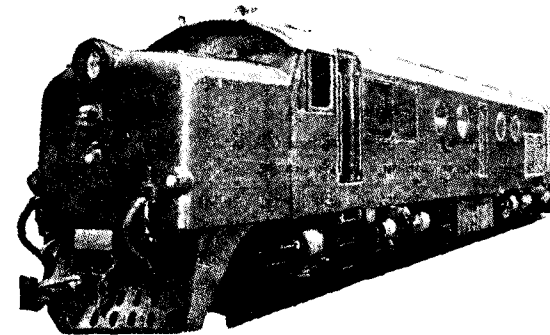
Fig. 6

The driver has only to set the required degree of braking in the small equalizing reservoir after which the automatic air admission valve repeats the same conditions in the train pipe.

This arrangement greatly simplifies the driver's task and automatically avoids over or under braking due to misjudgement of the quantity of air required to obtain a desired reduction of vacuum. A full emergency position is provided in the drivers valve which gives a direct atmospheric connection to the train pipe, in addition to operating the automatic air admission valve.

The exhausters used on the 3" test rack are Northey Rotary units which have no valves, pistons or sliding vanes and which require the minimum of lubrication. Many of these exhausters are now operating on the latest Electric locomotives in India and their principle of operation is shown on Fig. 6. Arrangements have already been made for future production of these exhausters in India by Gresham & Craven of India (Private) Ltd. for fitting to locomotives of indigenous manufacture.

Further advances made in recent years include the vacuum braking of large and small diesel and electric locomotives, using Gresham's 'Augmented' system which is now also being manufactured at the Gobra works of Gresham & Craven of India (Private) Ltd., Calcutta.



(Fig. 7.) Photo by courtesy of English Electric Co. Ltd. and Malayan State Railways.

In this system vacuum is used for all braking, both on locomotive and train and the size of vacuum cylinders on the locomotive is reduced by using the higher vacuum of 25" Hg. on the locomotive only during brake applications, although the normal standard working vacuum of 20" Hg. is used on the train.

This system is already established on many railways and a photograph of a main line diesel electric locomotive for Malaya is shown on Fig. 7. The bogie mounted, horizontal 14" vacuum brake cylinders can be clearly seen on this photograph. This locomotive weighs 96 tons and the twelve cylinders provide 75% braking. For still heavier locomotives double ended cylinders have been developed using one 11" piston to each brake block on the locomotive. Special drivers brake valves provide independent train and locomotive braking and a typical control desk mounting with either side control is shown on Fig. 8.

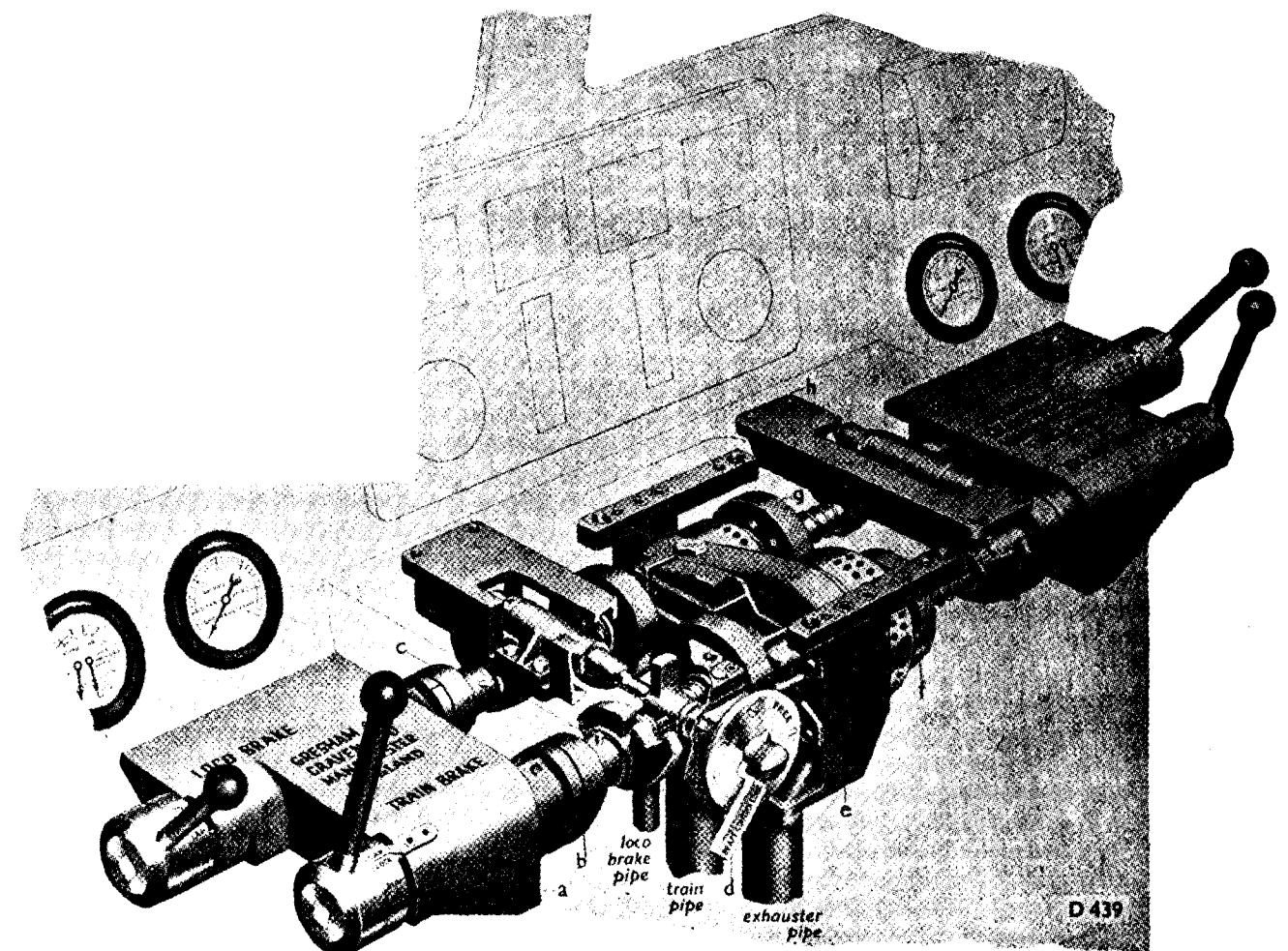
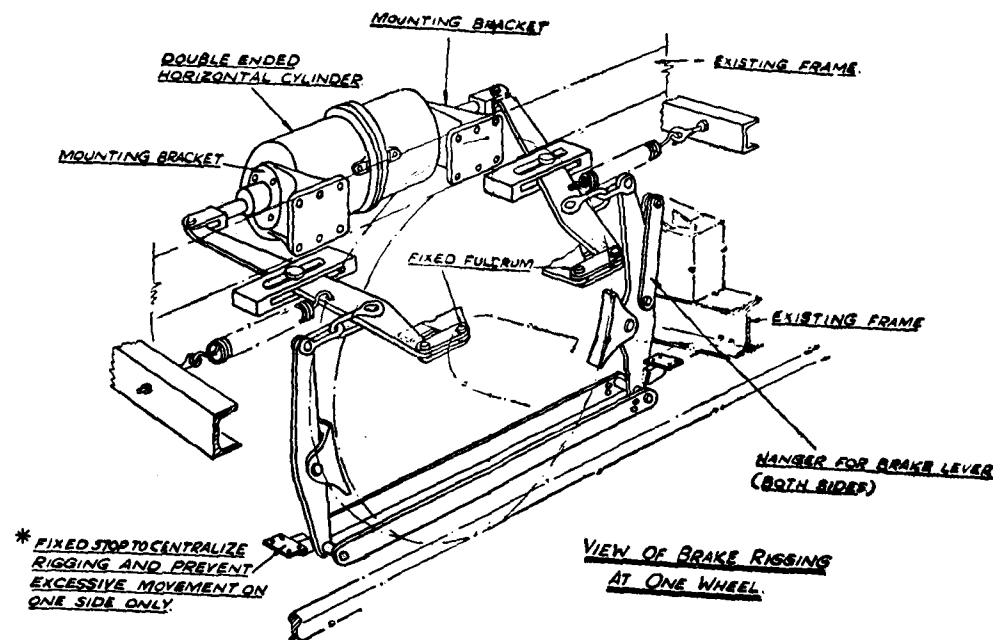
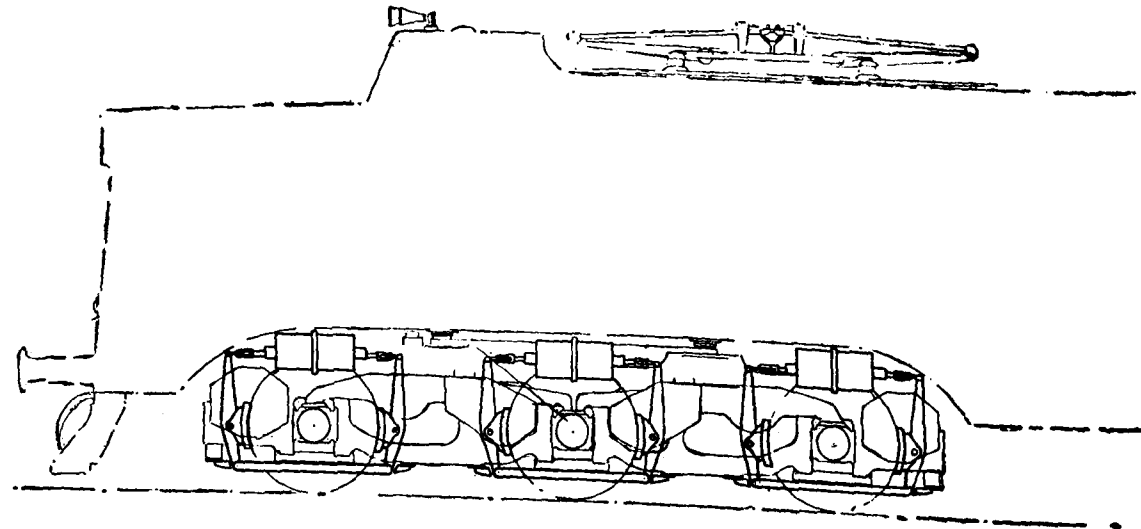


Fig. 8

VACUUM BRAKE RIGGING FOR ELECTRIC OR DIESEL LOCOMOTIVE USING ONE DOUBLE ENDED HORIZONTAL BRAKE CYLINDER PER WHEEL.

WEIGHT OF LOCOMOTIVE = 123 TONS
 FOR 80% BRAKING TOTAL FORCE EXERTED AT BRAKE BLOCKS = 98.4 TONS
 NOMINAL EFFORT OF ONE 11" PISTON AT 25" Hg. = 0.52 TONS. LESS 10% FOR RELEASE SPRING & RIGGING EFFICIENCY = 0.47 TONS
 TOTAL BRAKE CYL EFFORT FOR 12:- 11" DOUBLE ENDED CYLINDERS = $24 \times 0.47 = 11.3$ TONS
 OVERALL LEVERAGE = $\frac{98.4}{11.3} = 8.7$ TO 1



GRESHAM & CRAVEN LTD.,
 ENGINEERS, MANCHESTER

* ADJUSTABLE TO SUIT NEW & WORN BLOCK POSITIONS.

SHEET No. 2

DRG. No. S2601/B FIG. 9

DRAWN	
CHECKED	
APPROVED	
DATE	

A typical vacuum brake rigging layout for a main line electric locomotive is shown on Fig. 9.

Gresham's Augmented vacuum brake system is provided with interlock valves for regenerative or dynamic braking and can be supplied with 'deadmans' or 'vigilance' features.

Finally, reference should be made to the same firm's Quick Release Vacuum Brake system type A. I. V for multiple unit railcar trains which has been used on vacuum braked railways in many parts of the world.

On British Railways alone over 3000 vehicles are fitted with this system which employs two train lines and high vacuum reservoirs which are charged to 29" Hg. whilst the trains are running between stations, by small belt driven exhausters. There is no snifter valve in the system but a feed valve prevents vacuum in the main train pipe from rising about 21" Hg. During brake applications the exhausters and high vacuum reservoirs are isolated from the train pipe but when release is required the train pipe is connected to the high vacuum side by the drivers valve and air below

the brake pistons is immediately absorbed by the release reservoirs.

An extremely rapid release is thereby obtained although the exhausters may only be on idling speed. This system is only applicable to short railcar train sets where release reservoirs of ample capacity can be carried on every vehicle. Such vehicles can however be attached to standard rolling stock where their vacuum brake cylinders will function normally.

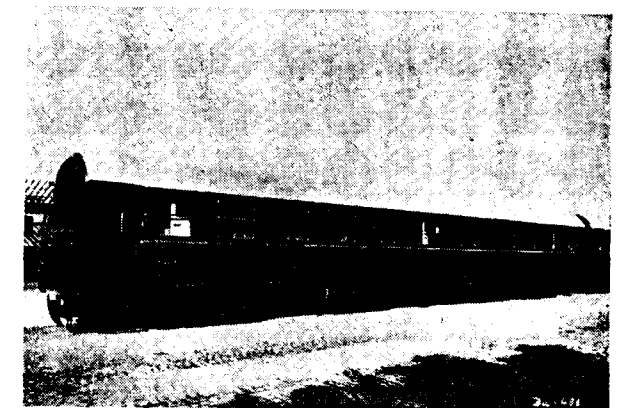
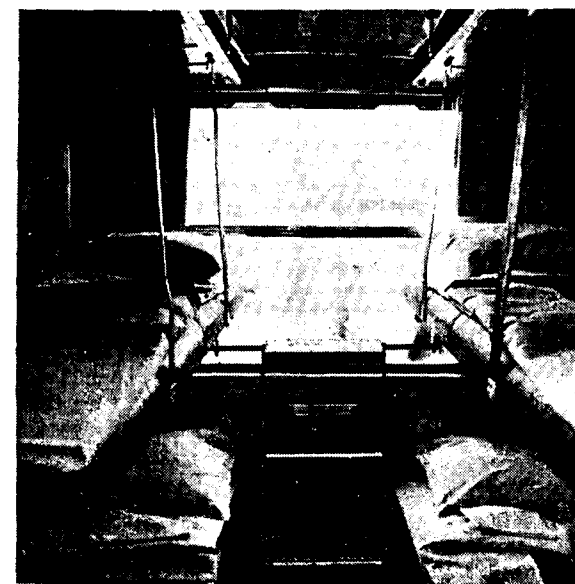
It will be appreciated from the above notes that the vacuum brake system, which has served Indian Railways so well in the past, is now the subject of very lively development. This follows a long period of stagnation brought about largely by the rigid standardization of vacuum brake equipment which took place in India more than 30 years ago. Fortunately there are now signs that the old standards are being revised and brought more into line with modern conceptions. New equipment and ideas are now being tried which should transform railway braking performance in the very near future.

Ba-c TATRA PASSENGER CARRIAGE WITH COUCHES

The development of international railway transport, the increasing volume of long distance travel and the necessity to improve the surroundings and comfort

of passengers without increasing the expenses incurred have led the Czechoslovak Wagon Building Industry to design a special type of passenger car with couches.

This type Ba-c carriage contains nine compartments, each seating 8 passengers in normal service. When the



compartments are converted for sleeping purposes, six passengers can sleep in each.

Its overall design and construction are identical to the well known range of Czechoslovak Ba Tatra passenger carriages.

The Ba-c carriage with couches together with the B Ra buffet car can be used with advantage for long-distance tourist excursions.

MODERN RAILWAY BRAKING EQUIPMENT

By An Engineering Correspondent

THE requirements of a braking system for modern rolling stock are set by the particular class of traffic concerned and a variety of brake equipments are available to suit the conditions.

In India the Vacuum Brake is universally used for locomotive hauled passenger and freight trains. Diesel and Electric locomotives to haul vacuum braked trains are generally fitted with Compressed Air Brake. A Vacuum Driver's Brake Valve is used for operating the brake, this gives direct control of the train brakes while the locomotive air brake works in unison with the Vacuum Train Brake. Alternatively, Vacuum Brake can be used on locomotives.

For Multiple Unit Electric Stock the Westinghouse Electro-Pneumatic Brake is used.

VACUUM BRAKE

The Vacuum Brake has always found favour on Indian Railways and in many other parts of the World on account of its simplicity, and it has been found capable of dealing with all normal lengths of trains encountered in the past.

Recent developments in industry have led to a great increase in the lengths of freight trains and development in the Vacuum Brake is taking place to meet the requirements of the longer and heavier trains. Similar improvements have taken place in the Vacuum Brake Equipment for Passenger trains.

The latest types of locomotive brake equipment for hauling vacuum braked trains are described later in this article, and the trend of development in the train brakes is aimed at obtaining more effective brake power at the rear of the train. With a long freight train it is essential to apply the brakes at the rear of the train as quickly as possible after those at the front of the train come into operation, and also to ensure that the brake power at the rear of the train, which is usually less than that at the front, due to leakage, is maintained as high as possible. Thus the maintenance of the brake equipment in good condition is of great importance.

Furthermore, with the larger capacity wagons now being used, an empty and load brake is a great advantage as with a brake system providing a single fixed maximum brake power which is based on the empty weight of the wagon, the brake percentage when the wagon is fully loaded is greatly reduced. To allow trains of fully loaded wagons to be safely operated at similar speeds to those of empty wagons, a changeover device can be included on each wagon so that, when loaded, additional brakeforce is provided.

The use of direct admission valves or quick service valves assists in obtaining rapid build-up of brake power throughout the train for both passenger and freight trains.

The use of slack adjusters to maintain short brake cylinder strokes is desirable, as a short stroke provides maximum brake power and reduces the time to apply or release the brakes.

LOCOMOTIVE BRAKE

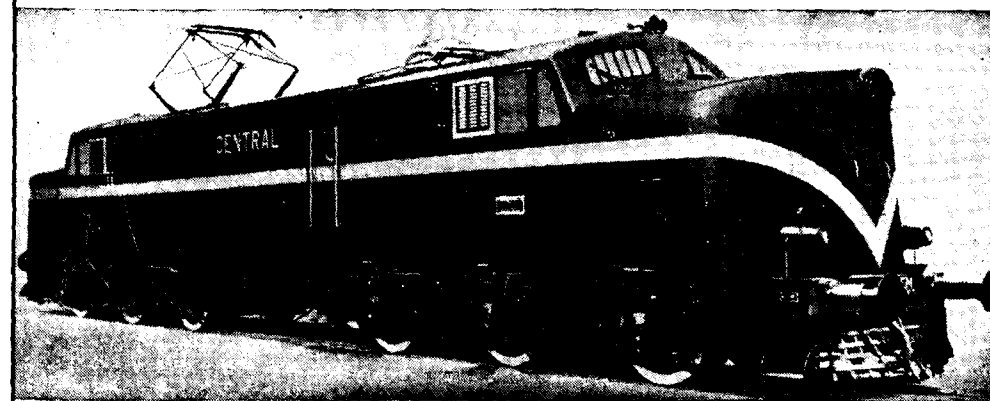
(a) *Westinghouse Vacuum Controlled Straight air Brake:*

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, Fig. 1.

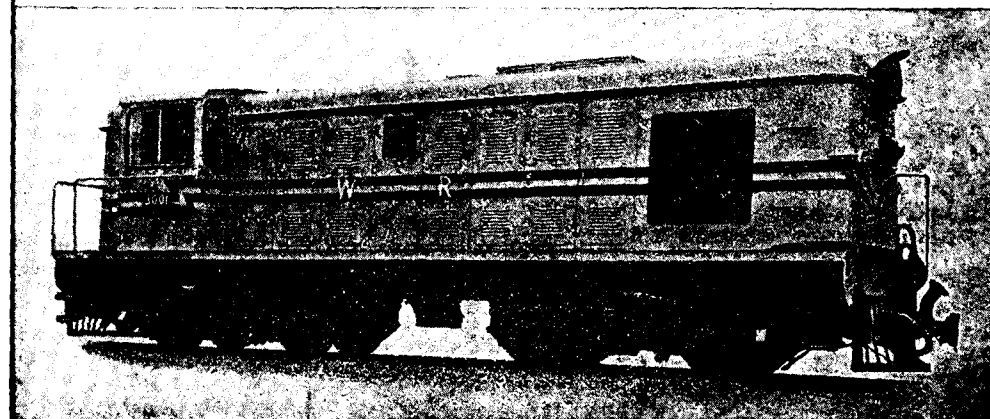
In this arrangement the locomotive compressed air brake is divided into two separate systems, one controlled indirectly by the driver's vacuum brake valve and providing an air brake application on the locomotive in proportion to the vacuum brake application on the train, the other under the direct control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

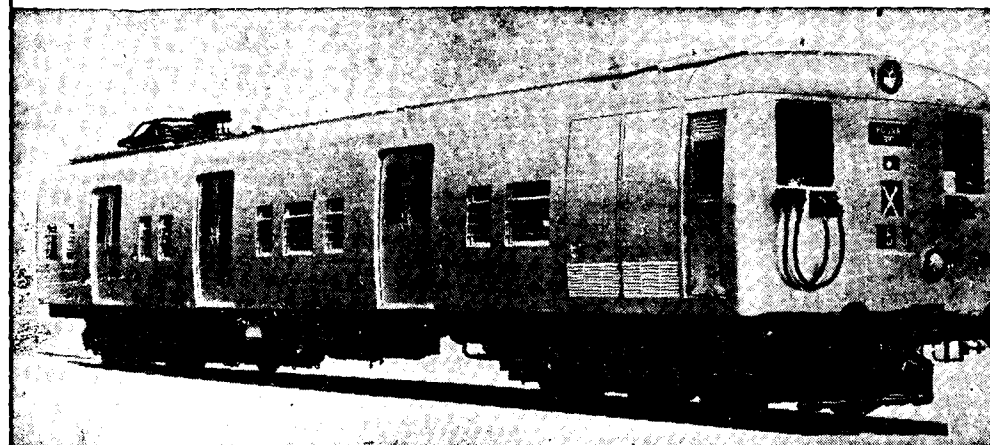
WESTINGHOUSE BRAKES ON MODERN INDIAN LOCOMOTIVES AND MULTIPLE UNIT TRAINS



One of seven electric Locomotives for Central Railway of India built by The English Electric Co. Ltd., with mechanical parts by The Vulcan Foundry Ltd., and fitted with Westinghouse Vacuum Controlled Straight Air Brakes.



One of twenty 625 h. p. diesel-electric locomotives built by North British Locomotive Company for the Western Railway and fitted with Westinghouse vacuum/Air Brakes.



One of many Motor Coaches built by Metropolitan-Cammell Carriage & Wagon Co. Ltd., for Indian Government Railways and fitted with Westinghouse Electro-Pneumatic Brakes.

WESTINGHOUSE BRAKE AND SIGNAL CO. LTD., 82, York Way, King's Cross, London, N. 1.

ASSOCIATED IN INDIA WITH: SAXBY & FARMER (INDIA) PRIVATE LTD., CALCUTTA

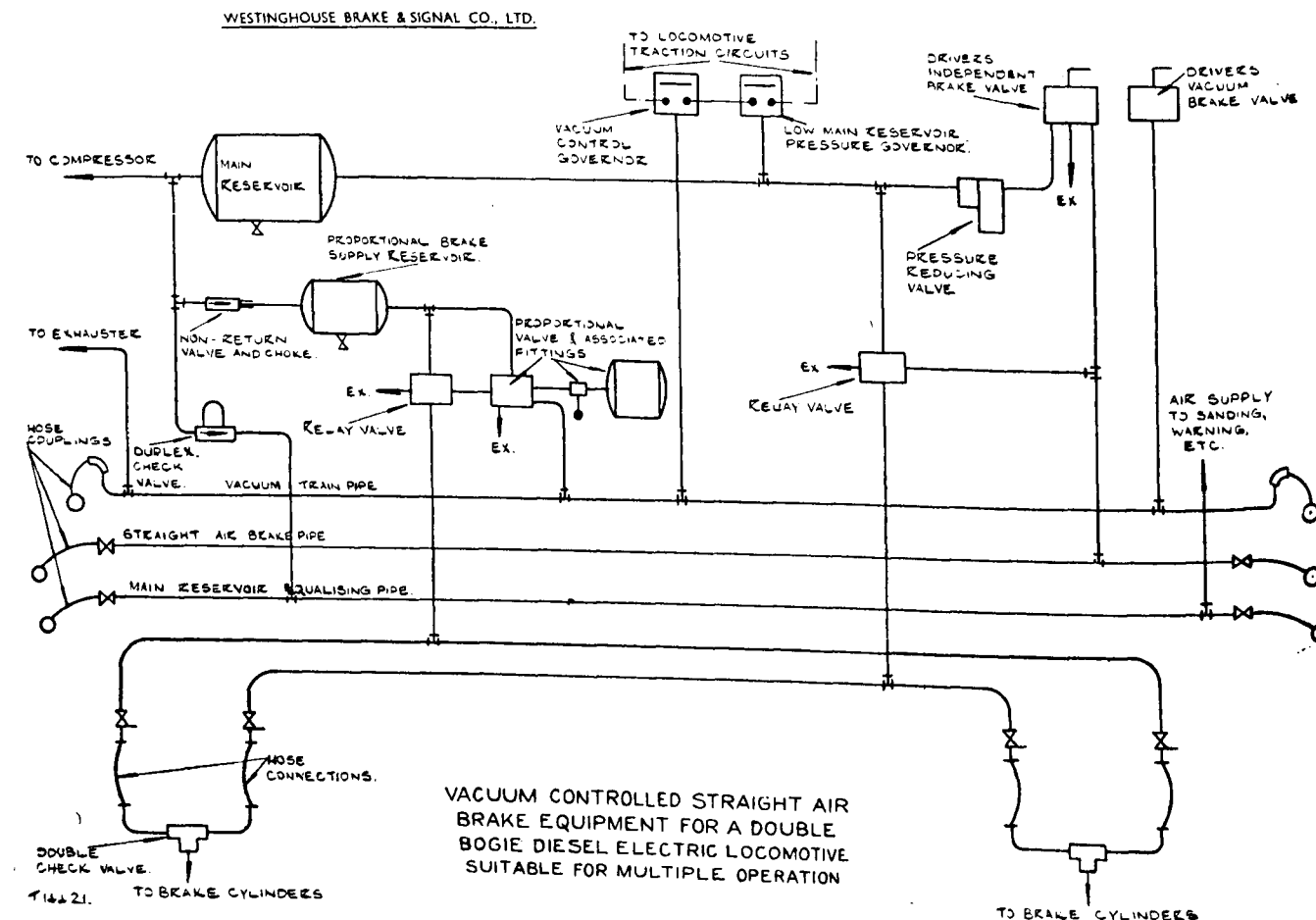


Fig. 1

the refinements necessary to ensure that if a flexible hose between the main frame and a bogie in one system fails, the alternative system is not impaired.

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

(b) *Gresham's Patented Improved Augmented Vacuum Brake :*

As an alternative to the combined compressed air and vacuum brake system, an augmented vacuum brake may be employed.

An arrangement of this brake system, suitable for a locomotive designed for multiple unit operation, is shown in its simplest form in the diagram, Fig. 2.

In this layout the exhaustor is connected to an exhaustor pipe and connection is made from this pipe to the vacuum train pipe via a two-pipe driver's brake

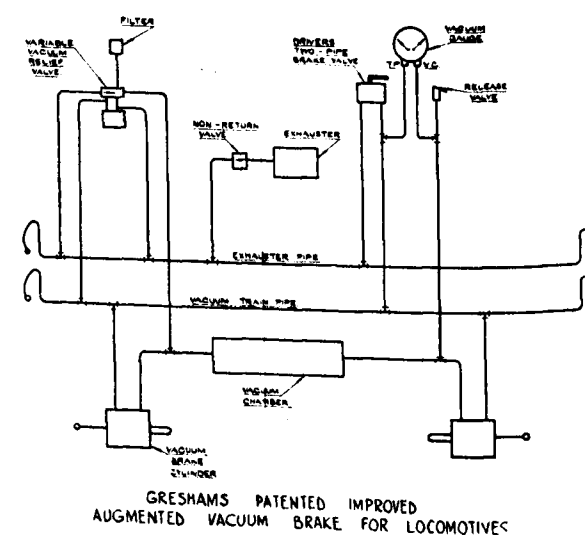


Fig. 2

valve. The exhaustor 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.

When the brake is released, the exhaustor 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 exhaustor 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 exhaustor in the exhaustor 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.

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 Fig. 3 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.

MULTIPLE UNIT STOCK—E. P. BRAKE

For intensive suburban service where multiple unit electric trains are used, a brake equipment with the most rapid response and sensitive control is necessary, and the Westinghouse Electro-Pneumatic Brake meets all the requirements of this type of service.

The brake has the following characteristics :—

1. The E. P. Brake acts simultaneously on all vehicles in a train and enables heavy brake applications to be made smoothly with consequent short stopping distances and comfort for the passengers.

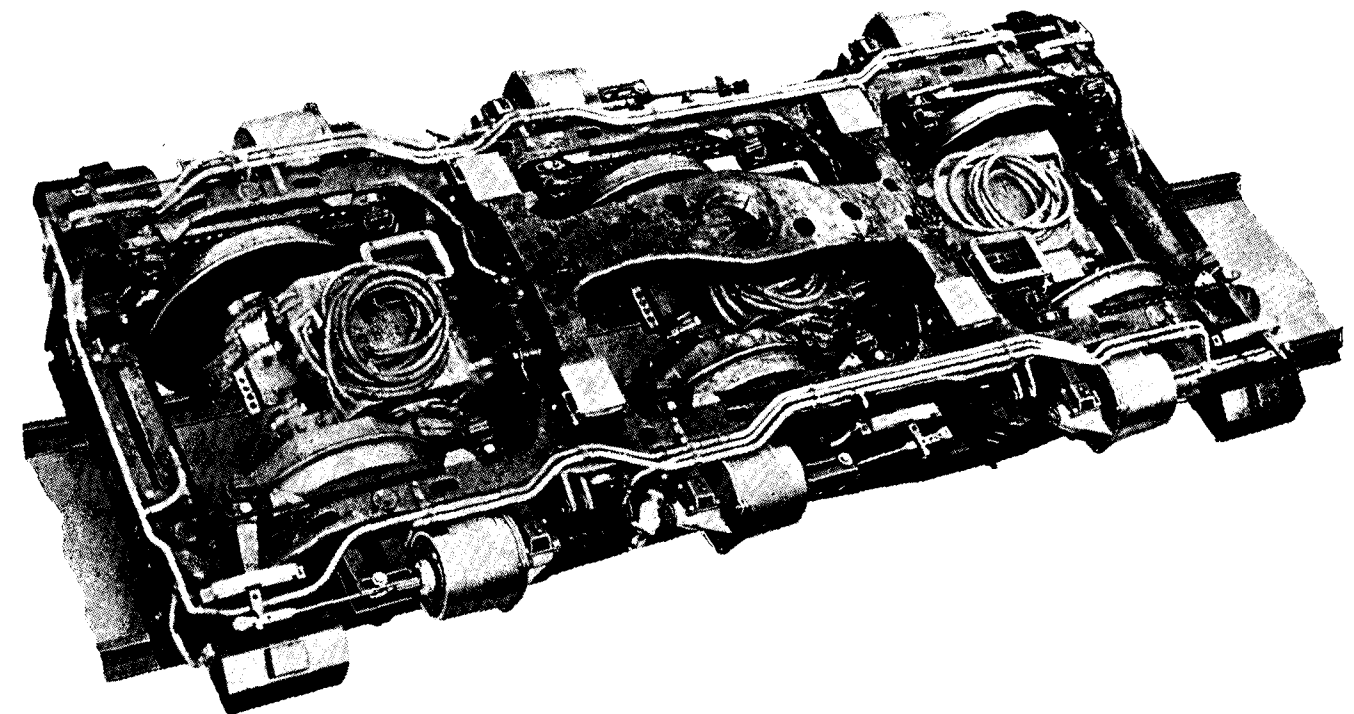


Fig. 3

2. The E. P. Brake provides rapid and sensitive control of application and release in any steps required.
3. The E. P. Brake is inexhaustible so that repeated applications and releases may be made, this being limited only by the capacity of the compressors and main reservoir system.
4. The standard Westinghouse Automatic Brake is incorporated in the E. P. Brake system and provides a stand-by service brake should the current not be available for the E. P. Brake. It also enables emergency brake applications to be made either by the driver, the guard, passengers, or by any accident which causes loss of air from the Westinghouse automatic train pipe.

The Electro-Pneumatic Brake is an electrically controlled air brake; this control giving instantaneous response and great reliability.

The brake is controlled from a Brake Controller in the driver's cab; this energises wires throughout the train to operate E. P. Valves on each coach. This controller provides very sensitive control of both application and release, and the brakes can be graduated on or off at will. It also provides for control of the Westinghouse Automatic Brake as a stand-by if current is not available for the E. P. Brake.

Each coach is fitted with an E. P. Brake Unit which includes two E. P. Valves. One, the application magnet valve controls admission of air from the main reservoir pipe which runs throughout the train to the brake cylinders; and, secondly, the holding magnet valve which controls the exhaust of air from the brake cylinder when the brake is to be released.

RAILCARS

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.

This system has been developed specially for use on diesel railcars on which the vacuum exhaustor is mechanically driven from the main diesel engine. Under these conditions the engine and therefore the exhaustor, operates at its minimum speed and

capacity when the car is standing in a station and unless special arrangements are made a rapid release of the brakes cannot be obtained.

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 exhaustor speed.

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.

Fig. 4 shows a Vacuum Driver's Brake Valve. Fig. 5 shows Driver's Brake Valve for Independent Locomotive Compressed Air Brake.



Fig. 4

WESTINGHOUSE CONTROLS

Pneumatic control is eminently suitable for the operation of engine speed and transmission controls etc. Systems using simple air valves and fittings are easily arranged for these purposes. They can give finely graduated control of position or precise positioning where required and can easily be arranged with safeguards and suitable interlocks with other equipment on the locomotive to ensure correct sequence of operation.

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 regards handling equipment manufactured in the United Kingdom these latter companies are producing locally an increasing diversity of Vacuum and Air Brake Equipment and Pneumatic apparatus.

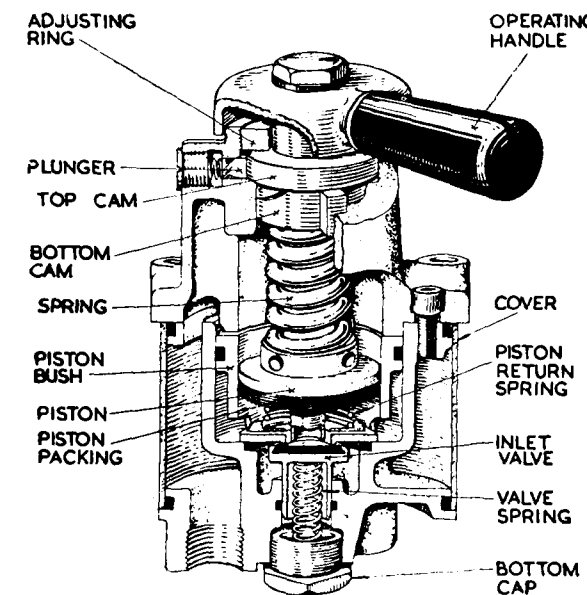


Fig. 5

EXPORT OF EQUIPMENT

About 50 countries purchase industrial equipment in the USSR through Machinexport, a Soviet foreign trade organization which sells equipment for the food, ore-mining, electrical engineering, textile, garment-making and other industries. Among the countries enjoying the services of Machinexport are France, Austria, Poland, Bulgaria, Italy and others.

The high quality of Soviet equipment attracts new clients. For instance, the French firm Ofmag (Paris) has signed a contract for the purchase of printing equipment. In their design, speed and quality of type setting Soviet printing machines are superior to the best models of printing equipment produced in the United States and the F. R. G. In high demand in the world market are also Soviet excavators. During special tests of excavators built in the USSR hundreds of foreign specialists noted the good performance of these machines.

This year Machinexport will take part in several international industrial exhibitions.

NEW MACHINES FOR AGRICULTURE

More than 400 new types of agricultural machines will be developed in the USSR in the current Seven-Year Plan.

A plant in the Ukrainian city of Dnepropetrovsk has turned out recently a number of new, highly-efficient sugar-beet harvester combines, which dig up the beets, clear them from the earth and load into cars, leaving it for the operator only to watch the work of the mechanisms.

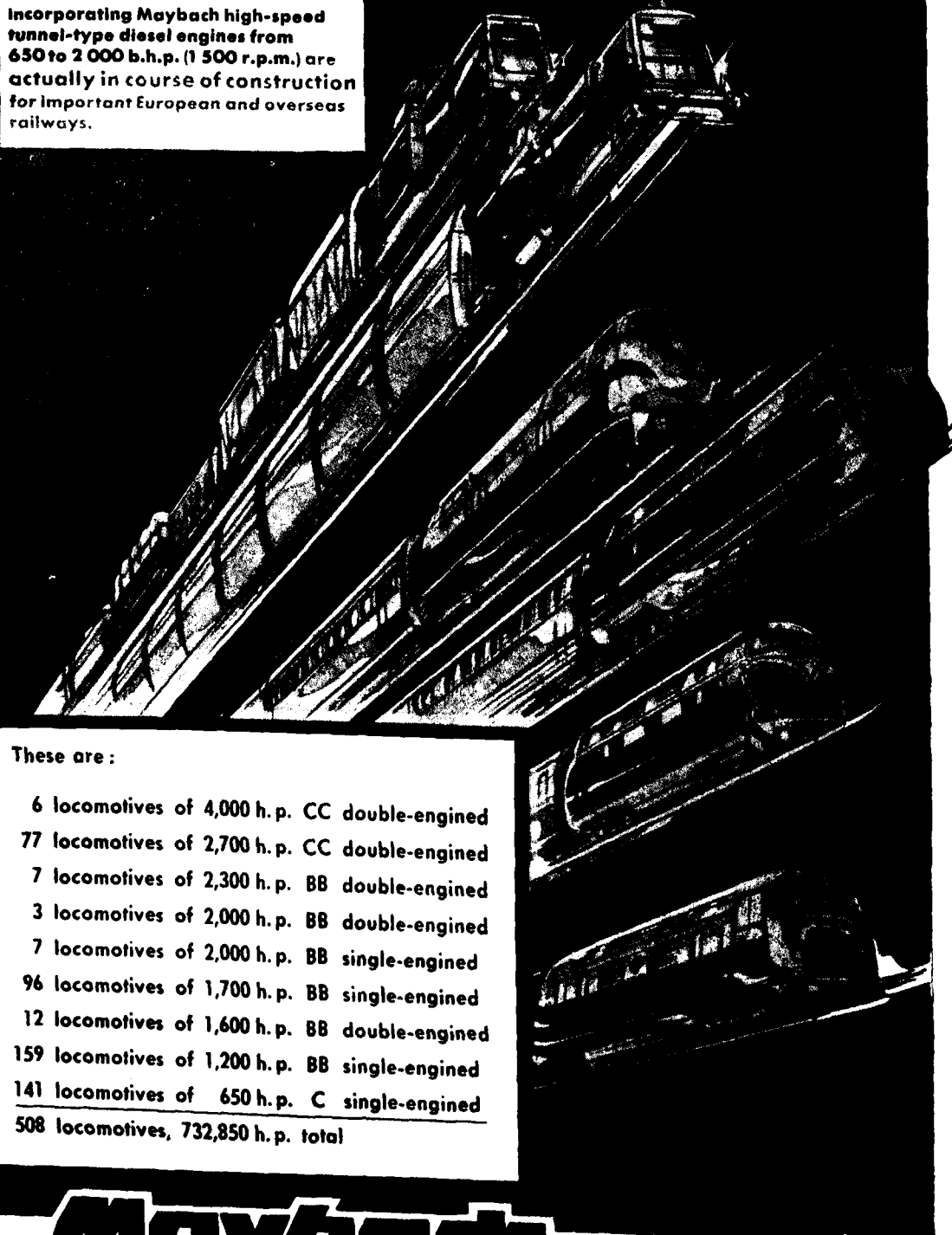
Automation is coming in for wide use in agriculture. Currently several experimental models of automatic tractors are being tested. They are equipped with a feeler which leads them along the previously ploughed furrow. They can also be operated by radio. In this case one man can easily control the work of 10 to 15 tractors.

In the near future integrated mechanisation will be extended to all branches of agriculture without exception.

* * * * *

500 diesel-hydraulic locomotives in powers up to 4,000 h.p. per unit

Incorporating Maybach high-speed tunnel-type diesel engines from 650 to 2 000 h.p. (1 500 r.p.m.) are actually in course of construction for important European and overseas railways.



These are :

- 6 locomotives of 4,000 h.p. CC double-engined
- 77 locomotives of 2,700 h.p. CC double-engined
- 7 locomotives of 2,300 h.p. BB double-engined
- 3 locomotives of 2,000 h.p. BB double-engined
- 7 locomotives of 2,000 h.p. BB single-engined
- 96 locomotives of 1,700 h.p. BB single-engined
- 12 locomotives of 1,600 h.p. BB double-engined
- 159 locomotives of 1,200 h.p. BB single-engined
- 141 locomotives of 650 h.p. C single-engined
- 508 locomotives, 732,850 h.p. total

MAYBACH

MOTORENBAU GMBH FRIEDRICHSHAFEN GERMANY

Diesel Engines, Steam, Electric, Diesel-Electric, Diesel-Mechanical, Diesel-Hydraulic & Industrial Locomotives Supplement

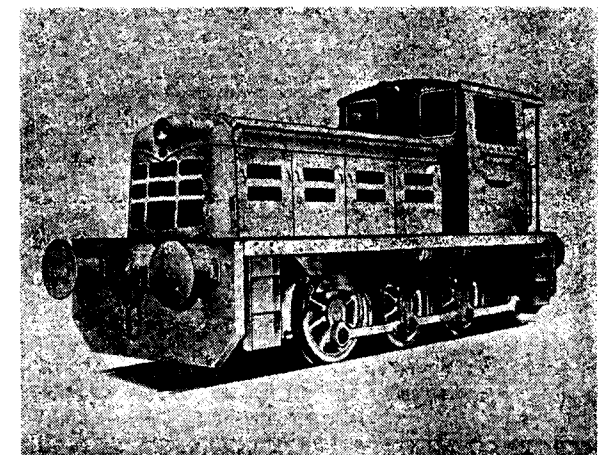
B.U.T. Diesel Traction Units—The combined experience and resources of A.E.C. and Leyland reflected in world wide railway applications

BRITISH United Traction Limited (B.U.T.) was formed by A. E. C. Limited and Leyland Motors Limited to design, develop and market diesel train and shunting locomotive power equipment. Leyland and A. E. C. together with their associated companies (which include Albion, Maudslay and Scammell) provide a backing for B. U. T. in research, design, development and production probably unique in the application of high speed diesel engines to railway traction.

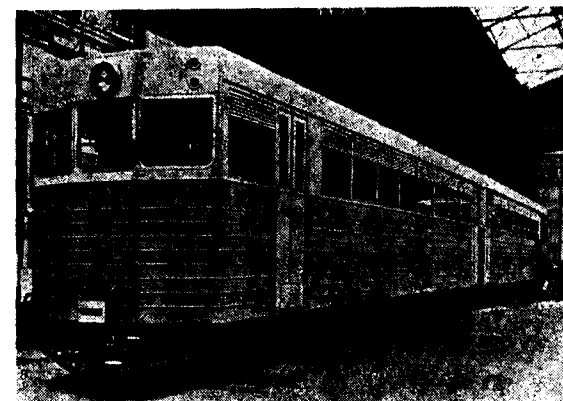
Well over half-a-century ago, Maudslay were supplying petrol engined rail coaches to the Cape Government Railways, whilst early in the 1930's A. E. C. and Leyland diesels began to appear on the railways of Britain. The advent of A. E. C. bogie

traction with the working of the units over millions of miles of operation, together with the very valuable assistance and collaboration of the railway officials concerned, has resulted in accumulated knowledge of inestimable value in designing new installations.

As far as possible B. U. T. units incorporate engines and transmissions which are basically inter-

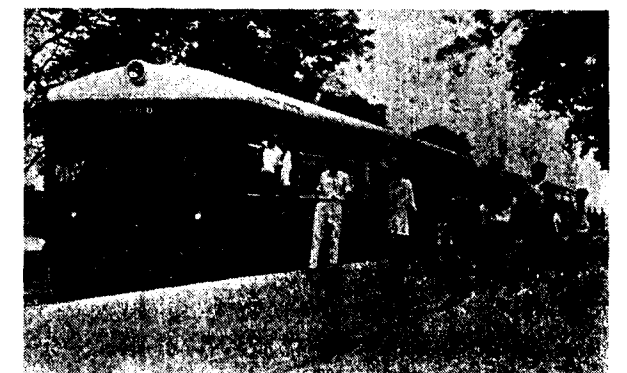


0-6-0 Fowler shunting locomotive with B.U.T. vertical 230 h.p. diesel engine.



B.U.T.-engined diesel railcar for Venezuela National Railways. 3' 6" gauge.

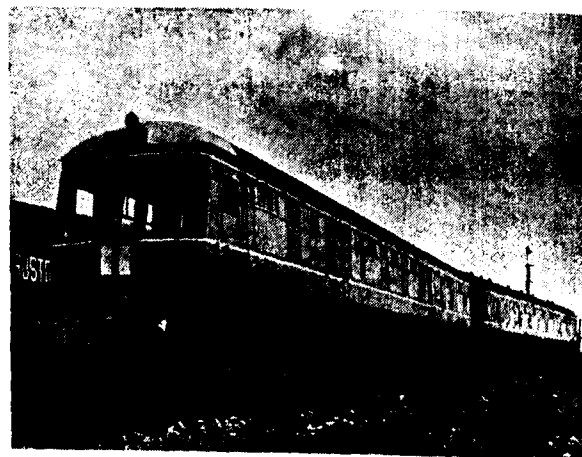
cars on the Great Western Railway, together with Leyland railbuses on the London Midland and Scottish Railway initiated years of successful operation and considerable operating experience was gained by the two manufacturers, who not only built the cars but actually maintained them for the railways, the considerable fleet of streamlined G. W. R. local and express railcars being dealt with on contract mileage terms for well over twenty years. This close connec-



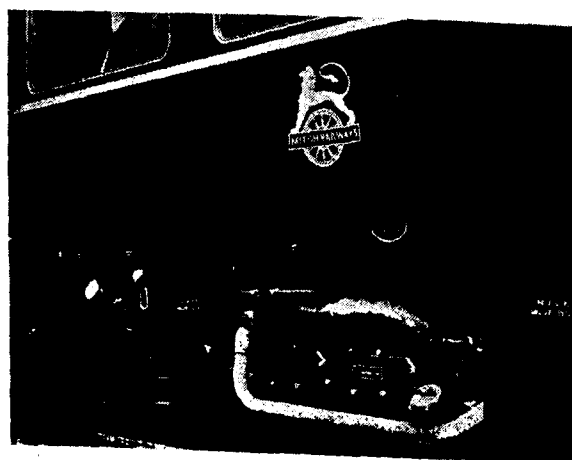
Southern Railway (India) four-car train with 8 B.U.T. 200 h.p. under-floor diesel engines, and transmission units. (5 ft. 6 ins. gauge).

changeable with those used for automotive and industrial applications, the units being adapted where necessary to cater for the specific peculiarities of rail traction. Full use is thus ensured of the large economic productive capacities of A. E. C. and Leyland and enables all units to be built to the highest standards and competitively priced. Spares too become more widely available with a maximum degree of interchangeability and in addition, the A. E. C. and Leyland world-wide network of service depots ensures on the spot service and parts for all railway operators.

The range of power units in both horizontal and vertical form includes engines up to 360 h.p. Engines are produced at the Southall, Leyland and Glasgow factories and are of four-stroke type, brief

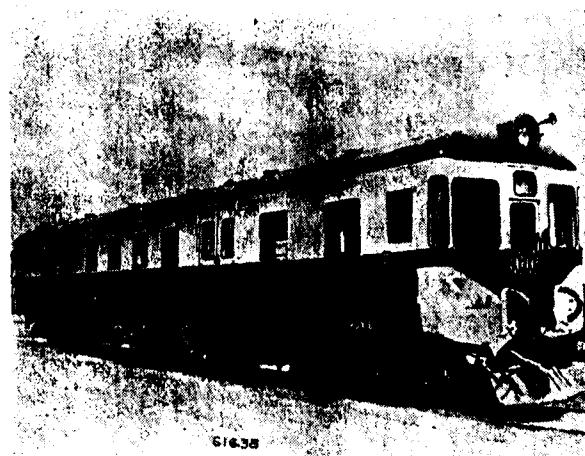


British Railways two-car set with two 230 h.p. B.U.T. diesels and B.U.T. transmission and control equipment. (4 ft. 8½ ins. gauge).

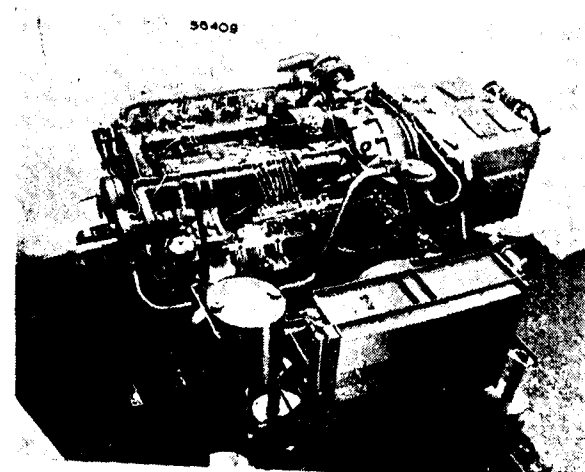


Close-up of installation of B.U.T. 230 h.p. horizontal diesel in British Railways 63' 6" car.

details of typical units are shown in the table. A full range of literature on both power and transmission units is available on request. Thousands of these engines are in service throughout the world (over 3,000 on British Railways) in such widely diverse



Western Australian Government Railways (3 ft. 6 ins. gauge) bogie car of Class ADX. One of ten built in 1959/60. Two B.U.T. 150 h.p. flat engines together with transmission and control units are used.

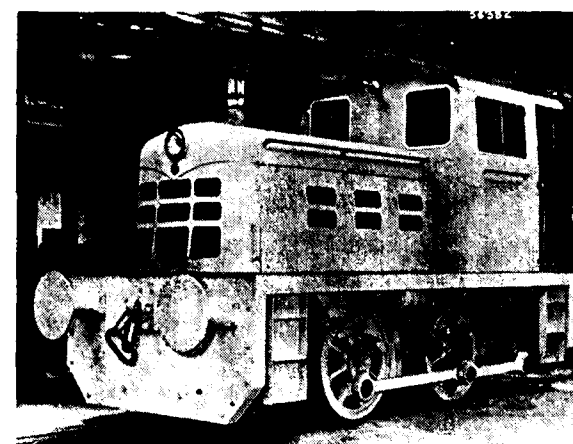


B.U.T. Series RETS 501 turbo-charged 6-cylinder 275 h.p. horizontal engine and transmission unit. A number of these engines have been fitted to Ulster Transport Authority railcars for 5 ft. 3 ins. gauge lines in Northern Ireland.

locations as Norway, India, Portugal, Brazil and Australia. The engines are installed in railcars, railbuses, multiple-units and shunting locomotives along with mechanical hydro-mechanical, hydraulic and electric transmissions. B.U.T. supply with their engines, any type of transmission dependent on

operating conditions and requirements of the rolling stock designers. The B. U. T. electro-pneumatic control system enables cars to be operated singly or as multiple-unit trains of motor and trailer cars, including up to six twin-engined motor cars in any one formation.

Due prominence is rightly given to "After-Sales" service, but British United Traction can and do, afford a "Pre-Sales" service to railways and carriage builders. In the past British United Traction have undertaken the manufacture of complete railcars and have therefore a full understanding of the difficulties which face carriage builders contemplating the installation of diesel power equipment and enables

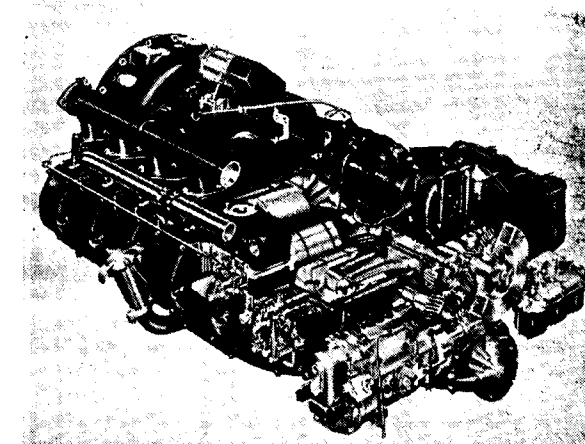


Fowler 0-4-0 shunting locomotive with B.U.T. diesel engine.

advice and assistance to be given to all rolling stock designers concerned with the design of diesel trains and shunting locomotives.

Among recent applications of B. U. T. power and transmission equipment the 5' 6" gauge railcars operating on the Southern and Northern Railways of India are notable, each car being fitted with two B. U. T. 200 h.p. engines, 4-speed gearboxes and reversing final drives. The Indian cars, constructed in Australia under the Colombo Plan arrangements are 73' long and 10' 6" wide. In Western Australia the Government Railways are placing in service ten diesel cars of the ADX Class all fitted with twin B. U. T. 150 h.p. engines, gearboxes, final drives, control and allied equipment—these cars will join the considerable fleet of B. U. T. engined ADH and ADG railcars which this railway have operated over a number of years.

An attempt to provide more versatile diesel rolling stock has been successfully achieved on Ulster Transport Authority lines (Northern Ireland) by the introduction of diesel passenger railcars capable of being used as light locomotives. The employment of B. U. T. turbo-charged diesel engines in conjunction



B.U.T. Series AH 1100 horizontal 275 h.p. diesel for rail traction duty. This engine has been supplied to Netherlands Railways diesel-electric railcars.



Typical British Railways 4-car multiple unit train at Newcastle. These trains feature B.U.T. 150 h.p. horizontal diesels, transmission and control equipment and can be operated in multiples up to twelve cars.

with torque converters, epicyclic 4-speed and bi-directional gearboxes driving both axles of one bogie has enabled virtually constant horsepower at all track speeds to be achieved. U. T. A. utilise these multi-purpose units on express passenger, mixed traffic and freight duties.

TYPICAL B. U. T. HORIZONTAL DIESELS

TYPE	CYLS.	B. & S.	DISPLACEMENT	COMPRESSION RATIO	POWER OUTPUT	MAXIMUM TORQUE	APPROX. WEIGHT
A220	6	130×142 m. m.	690 cub. ins.	16—1	150 b.h.p. @ 1800 r.p.m.	480 lbs/ft @ 1300 r.p.m.	2082 lbs.
RE902	6	140×165 m. m.	926 cub. ins.	15—1	230 b.h.p. @ 1900 r.p.m.	708 lbs/ft @ 1150 r.p.m.	2828 lbs.
AH1100	6	156×156 m. m.	1083 cub. ins.	16—1	275 b.h.p. @ 1900 r.p.m.	890 lbs/ft @ 1300 r.p.m.	2912 lbs.
RETS902	6	140×165 m. m.	926 cub. ins.	15—1	275 b.h.p. @ 1800 r.p.m.	840 lbs/ft @ 1200 r.p.m.	3000 lbs.
AHTS1100	6	156×156 m. m.	1083 cub. ins.	16—1	360 b.h.p. @ 1900 r.p.m.	1180 lbs/ft @ 1200 r.p.m.	3000 lbs.

Diesel shunting locomotives featuring B. U. T. vertical engines have recently been delivered to several important industrial users including Fisons Limited, South Durham Iron & Steel Company and Kettons Portland Cement Company. One of these units is illustrated.

In the Australian Commonwealth, Queensland Railways, already operators of B. U. T. engined railcars, will shortly take delivery of ten 2000 Class cars which will have 150 b. h. p. horizontal B. U. T. diesels and transmissions, whilst in West Africa, Nigerian Railways are shortly to receive from England some 2-car diesel sets, each motor car fitted with twin 230 b. h. p. B. U. T. diesels and allied transmissions.

Close co-operation with railway and private carriage builders has been maintained on all these contracts and after sales service and spares facilities are ensured through the extensive chain of A. E. C. and Leyland branches.

Transformers used in Vibrator Power Supplies

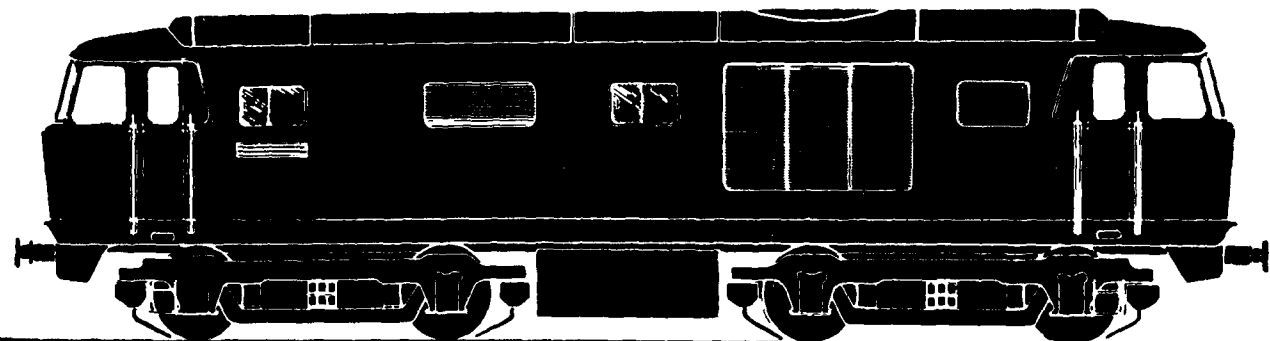
The purpose of ISI: 1496—1959 Specification for Transformers Used in Vibrator Power Supplies, prepared recently by ISI, is to lay down a uniform basis for the design and performance of transformers used in vibrator power supplies employed in storage battery-operated electronic equipment, such as receivers, small transmitters, audio amplifiers, etc.

This standard lays down the requirements and the methods of tests of transformers used in vibrator power supplies for radio receivers, amplifiers, small transmitters and similar devices. It covers transformers for use with vibrators operating on frequencies from 98 to 122 c/s and delivering DC up to 300 volts at not more than 300 mA. The standard, however, does not cover dimensional requirements.

The transformers covered by the standard are of two grades, namely Grade A and Grade B.

Grade A—Grade A transformers have a permissible rise of temperature of 20° C on load above a surrounding temperature between—25° and 70° C.

Grade B—Grade B transformers have a permissible rise of temperature of 40° C on load above a surrounding temperature between—10° and 55° C.



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A.E.I. Equipment for first 3000 Volt D.C. Railway Electrification in India

By **R. Subramanian**, B.Sc. (Hons.), D.I.I.Sc.

Associated Electrical Industries (India) Private Ltd.

THE electrification of the Howrah-Burdwan Main Line of the Eastern Railway has the distinction of being the first 3000 volt D. C. Electrification on the Indian Railways. Associated Electrical Industries (India) Private Ltd. are proud of their contribution to this important suburban electrification, which is calculated to bring much-needed facilities to Calcutta's travelling public after a century of steam locomotion. Their role in this scheme includes the supply and erection of substation and track cabin equipment, electric traction equipment for the multiple unit stock and electric signalling equipment. All the equipments incorporate the accumulated experience, aggregating over a century, of the A. E. I. Group of Companies in the design and manufacture of all classes of electrical plant for use all over the world.

The 66-mile Howrah-Burdwan Main Line is equipped with 6 rectifier substations and 3 track cabins, the entire equipment for which, with the exception of the outdoor 33000 volt A. C. Switchgear, has been supplied by A. E. I. This large installation uses pumpless steel tank air-cooled rectifiers which have now become well-established for traction service.

The installed capacities and other basic details of these stations are as follows :—

Station	Installed Capacity	No. of Outgoing Feeders
Belur Substation	3-2500 KW units	10
Sheoraphuli ..	3-2500 KW units	7
Bandel ..	2-3000 KW units	6
Pundooah ..	1-3000 KW unit	4
Memari ..	1-3000 KW unit	4
Gangpur ..	2-2500 KW units	8
Howrah Track Cabin	—	11
Konnagar ..	—	6
Burdwan ..	—	4

The Substations receive power from the Damodar Valley Corporation system, over the Eastern Railway's transmission lines, at 33000 volts, 3 phase, 50 cycles A. C. It is then transformed and rectified to 3000 volt D. C. by the transformers and rectifiers in the substations. The outgoing D. C. supply to the overhead equipment on the tracks is controlled by 3000 volt D. C. high speed circuit breakers. At the track cabins, similar high speed circuit breakers are provided to sectionalise and parallel the overhead equipments of the various tracks.

The rectifier transformer is of the outdoor, oil-immersed naturally-cooled type and weighs approximately 34 tons. The 33000 volt primary is connected in star, while the 3000 volt secondary is a 12-phase quadruple zig-zag winding. The transformer tank also houses a tertiary winding to provide a 400-volt 3-phase A. C. supply for the rectifier auxiliaries, a no-load voltage rise suppression unit and special current transformers for protection of the rectifier against back-fire.

Each rectifier unit consists of two pumpless, steel tank, air-cooled, six-anode mercury arc rectifiers. The tanks are mounted on withdrawable trucks on wheels, and are housed in steel cubicles. Underneath each tank, and forming part of the truck, is mounted a motor-driven fan to cool the tank. The rectifier cubicle also houses the ignition and excitation unit, grid control apparatus and other auxiliaries for the rectifier. The complete rectifier unit occupies a floor space of only 8 ft. x 5 ft. 6 ins., which has been possible due to the use of a most compact design of rectifier tank so far developed for Railway service.

The rectifier tanks are provided with grids, which are used for arc suppression in the event of a back-fire. Voltage control on the rectifiers is by means of off-load tap-changing switches on the rectifier transformers.

Adjacent to the rectifier cubicles, and forming a continuous panel with them, are the two cubicles which house the control and protective gear for the

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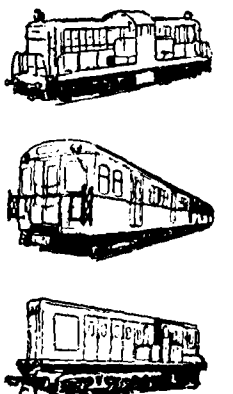
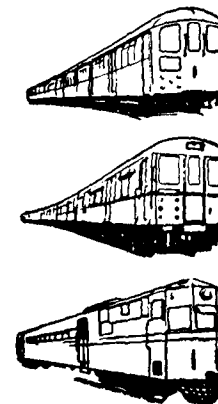


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rectifier and its associated oil circuit breaker. In these cubicles are contained various instruments to measure the voltage, current and power being supplied by the rectifier, switches to start and stop the rectifier, indicating lamps and protective relays.

All the 3000 volt D. C. circuit breakers are of the high speed type, working on the "rate of rise of current" principle, which enables discrimination between overloads and short-circuits. The breakers are mounted on trucks on wheels, which are housed in concrete cells. Shutter mechanisms, with padlocking arrangements, are provided with ensure perfect safety for personnel working inside the cells with the breakers racked out. The rectifier breakers are rated at 1600 amps. and are set to trip on a reverse current of 500 amps. The feeder breakers are rated at 1000 amps. and can be set to trip on forward currents in the range of 1500 to 2500 amps.

The operation of the entire equipment is automatic, and can be controlled either from the control board in the substation or from the supervisory remote control board in Howrah. Operation of one switch will in succession, close the 33000 volt A. C. oil circuit breaker, start the rectifier fans, put on the ignition and excitation circuits in the rectifiers and close the 3000 volt D. C. rectifier high speed circuit breaker. Protective devices ensure that the set is shut down and re-started (for a pre-determined number of time) in the event of any type of fault or incomplete sequence.

A noteworthy feature in the equipment is the comprehensive scheme of interlocking provided. Before access to the rectifier equipment could be obtained, a series of operations in a definite sequence have to be done; this is aimed at isolating the A. C. and D. C. sides of the equipment and earthing all live parts; conversely, these operations in the reverse sequence must be performed before the equipment could be energised.

Other items of equipment inside the substation are an L. T. A. C./D. C. board, which provides power at 400 volt 3-phase A. C., 110 volt single phase A. C. and 110 volt D. C. for the control circuits and auxiliary services, a negative recording cubicle to record the current drawn from the substation and to provide protection against an excessive rise in voltage of the rails above earth, a lead-acid station battery and a charging equipment.

The entire equipment, with the exception of the

batteries and charging equipments which have been supplied by two well-known battery makers, has been designed and manufactured by the British Thomson Houston Co. Ltd. of England, a member of the A. E. I. Group of Companies. A portion of the 3000 volt D. C. switchgear has also been manufactured in India by Associated Electrical Industries Manufacturing Co. Ltd., to BTH designs.

Associated Electrical Industries (India) Private Ltd. have also on order the complete traction equipments for 36 motor coaches and 68 trailer coaches to operate on the Howrah-Burdwan Main Line. These equipments, which will be installed on coaches built by Jessop & Co. Ltd., are being designed and manufactured by Metropolitan-Vickers Electrical Co. Ltd. of England, another member of the A. E. I. Group of Companies. The design of the equipment will be generally similar to the 450 sets of 3000 volt D. C. motor coach equipments successfully manufactured by Metropolitan-Vickers for railways in South Africa, Brazil and Poland.

Each 3-car train will comprise one motor coach and two driving trailer coaches, the motor coach being in the middle. The train will be powered by 4—210 H. P. traction motors, mounted in the motor coach. The motors will be of self-ventilated, axle-hung, nose-suspended type, driving the wheels through solid gear-wheels. Current at 3000 volts D. C. will be collected from the overhead line by either of two light-weight pantographs and fed to the motors through the standard form of resistance control. The motors will be connected permanently in series—pairs, and the control gear will be of the modern electro-pneumatic unit contactor type. A motor-generator set, mounted on the underframe and driven off the 3000 volt D. C. supply, will provide low tension power at 110 volt D. C. for train lighting and ventilation, operation of the control circuits and of the brakes.

The equipments are designed to permit a maximum speed of 65 m. p. h. on level track with a fully loaded train, and a starting acceleration of 1.2 m. p. h. per second upto 25 m. p. h. Upto three 3-car trains can be coupled together and operated by one driver in the leading cab, which facility will be required during peak hours. Provision is also made to cut out half the motor power and run the train at reduced speed, in the event of a fault in any one motor.

Worthy of particular note is the fact that

approximately 15% of the traction equipment is being manufactured in India. The manufacture is being carried out by Associated Electrical Industries Manufacturing Co. Ltd., to the designs of Metropolitan-Vickers. This is the first time when manufacture of traction equipment is being carried out in India, and represents a substantial and welcome saving in foreign exchange.

The electrification of the Howrah-Burdwan Main Line also involves provision of automatic signalling

between Howrah and Serampore, and manually controlled colour-light signalling beyond. Well over 350 colour-light signals of the multiunit type, 50 electric point machines, and considerable numbers of junction direction indicators, A. C. and D. C. relays, and other signalling equipment have been supplied by Associated Electrical Industries (India) Private Ltd. These equipments have been designed and manufactured by Metropolitan-Vickers-GRS. Ltd. of England, also a member of the A. E. I. Group of Companies.

SAMPLING OF FERRO ALLOYS

The Indian Standard Methods of Sampling Ferro Alloys (IS: 1472—1959) prepared recently by ISI lays down the procedure to be followed in collecting and preparing samples representing a lot of ferro alloys in order to determine the chemical composition of the alloy in the lot.

Ferro alloys covered by this standard have been divided into the following groups:

Group 1—Ferro Manganese, Spiegeleisen, Silico Manganese and Ferro Phosphorus

Group 2—Ferro Chromium and Ferro Silicon

Group 3—Ferro Vanadium, Ferro Titanium, Ferro Tungsten and Ferro Molybdenum

In sampling of bulk material, it had been the usual practice till recently to collect one representative sample from a lot and to evaluate the quality of the material in the lot from the test result(s) on the sample. This procedure did not provide any means for assessing the limits of variation associated with the estimated quality, knowledge of which is useful for proper quality evaluation of the material. The sampling procedure recommended in this standard would eliminate this drawback and would enable the determination of both the average level of quality and the magnitude of its variation.

* * * * *

A WORD ABOUT HYMEK DIESEL-HYDRAULIC LOCOMOTIVES

Hymek diesel hydro-mechanical locomotives are

ideally suited to those railways employing diesel traction. They have all the advantages associated therewith. Additionally, they are simple to handle and maintain and have an excellent power/weight ratio. They meet the exacting demands of modernisation.

The engines are manufactured in Britain by Bristol Siddeley Engines Ltd. and the transmission is produced also in Britain, by J. Stone & Co. (Deptford) Ltd.

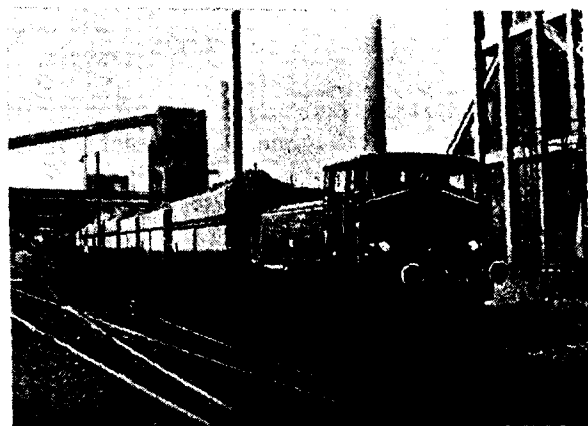
Hymek Diesel-hydraulic locomotives fitted with Bristol Siddeley Maybach engines and Stone-Maybach transmission have the advantages of simplicity design, excellent power-weight ratio, relatively low initial cost and low maintenance costs. They are noted for reliability, simple servicing and high starting torque. These engines possess automatic relation of torque to load demands. Their continuous maximum power at low speed, high efficiency at all speeds and no excessive wheel slip are salient features.

Locomotives equipped with Maybach engines and Mekydro transmission have successfully run millions of miles under exacting conditions. Forty-five Hymek locomotives have been ordered by the British Transport Commission for main line use in the western region of British Railways. These locomotives are built at Manchester by Beyer Peacock who have over a century of locomotive experience. The combination of these unrivalled facilities backed by components tested over millions of miles of arduous railway service results in modernity, reliability, and economy.

Austrian Shunting Locomotives

600 BHP three-axle diesel-hydraulic design

INVESTIGATIONS about the suitability of a change in traction to Diesel service have proved that the state railways will have many advantages when using Diesel locomotives for shunting duties. This will reduce costs for maintenance, fuel and the operating staff. With regard to this special requirements the Jenbacher Werke A. G. have developed a locomotive of 600 BHP for heavy shunting duty and open track work with light trains. The locomotive "Jenbach DH 600 C 48" comprises the rigid frame, superstructures and driving mechanism. The particularly rigid and shock-

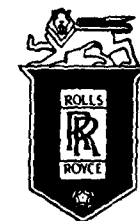


resistant frame is designed to take up a 300-ton impact force without any permanent deformation. Power transmission and drive are fitted to the frame which also carries the engine cowl with the cab and, at the head and tail, the buffers, couplings and adjustable fenders. The cab and control desk give the greatest possible safety in operation by extreme ease of control and optimum visibility of the line and signals. The locomotive can be driven with equal ease from each side of the control desk by one man who can be either standing or seated. Hot water heating, sound—and heat insulation, and efficient ventilation of the cab assist the driver to remain alert even over hours of duty. The engine compartment is cased-in with steel plates on all sides. The bonnet side panels can easily be removed, giving full access to all parts of the engine for servicing. The controls are installed in the cab, accessible from either

side and additional control instruments are provided to ensure that engine lubrication and cooling, and gears are functioning correctly. Automatic controls reliably prevent damage due to neglect of cooling water temperature and oil pressure. Safety switches are provided to prevent damage to the gears by careless gear changing or drag.

There are two pairs of lights at head and tail of the locomotive which can be dipped, and which can be adapted for use as parking lights by the insertion of a coloured pane. Glarefree lighting is of course provided for the cab. All instruments are illuminated even in the dark by indirect lighting. A compressed air whistle whose pitch is such as to penetrate the engine noise even in the closed cabs of other vehicles is provided for signalling. The locomotives are fitted with air brake equipment having two separate brake systems. Braking of the locomotive itself is effected by a direct-action non-automatic brake whose controls are combined with a hand screw-down brake. The trucks are usually fitted with automatic brake devices for indirect operation from the locomotive by means of a special brake valve. A piston compressor driven by V-belt drive from the engine controls the pressure of air to the brakes. Safety valves in the brake system prevent the maximum pressure in the compressed air receivers and the main brake cylinder from being exceeded. Pressure in this cylinders is so controlled that the contact pressure of all the brake shoes together does not exceed 80% of the weight of the locomotive. This means that the wheels cannot be locked unintentionally. Compressed air coolers and water separators ensure complete safety of operation of the whole brake system, which can be coupled to be brake system of the trucks by means of connecting tubes. In order to improve the braking action on wet or dirty rails a compressed air operated sanding device is provided which distributes sand evenly over the rails in front of the axles in the direction of movement. Sand concentration can be controlled by means of the operating valves in the cab.

Where a locomotive is driven by one man either in shunting or in open track work it is provided that



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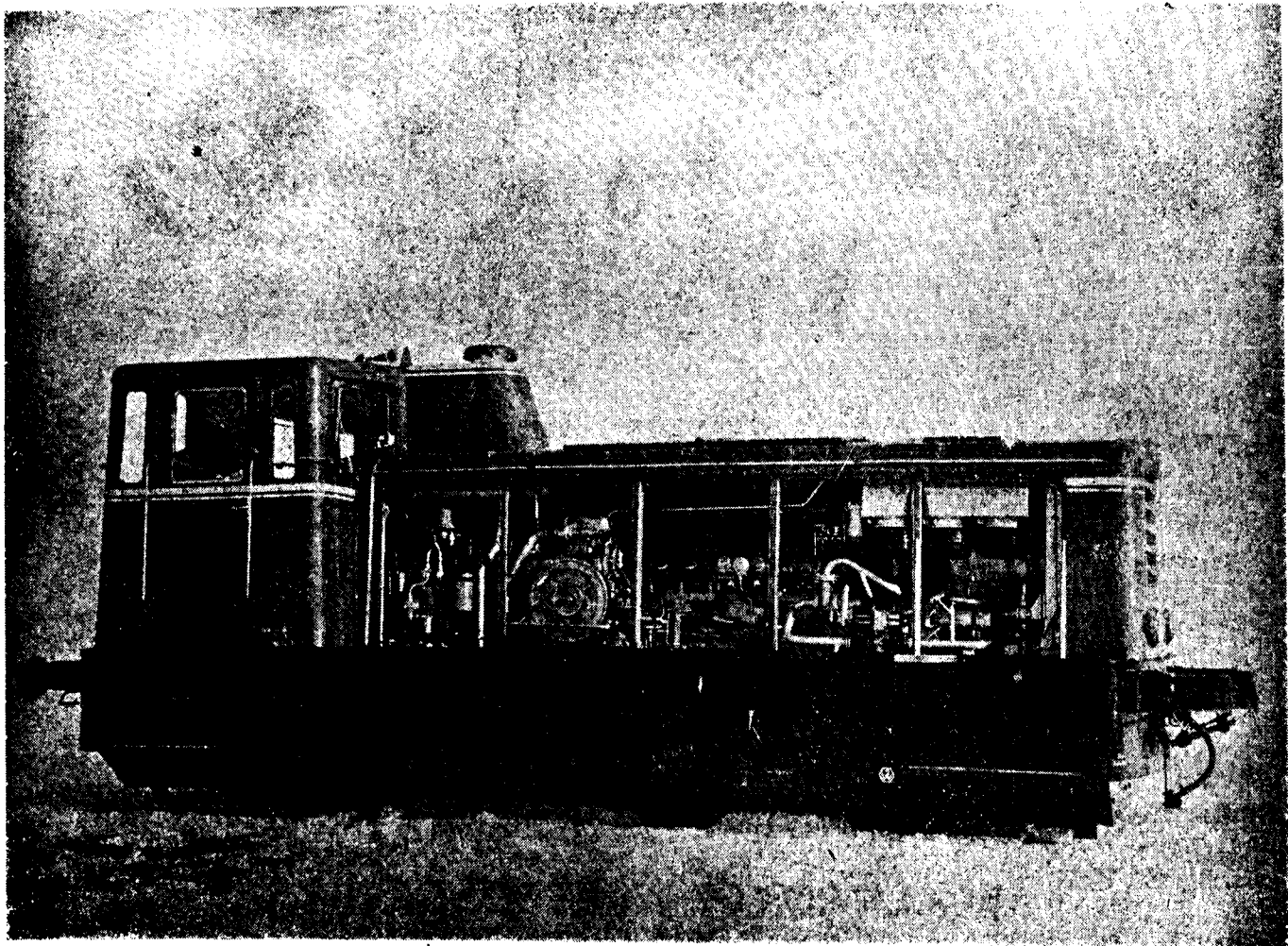
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safety devices are fitted to prevent accidents should the driver become incapacitated. The safety device can depend as well on the length of path as on the time interval. The safed device called dead man control consists of two buttons and steps. If this buttons are not pressed during the motion of the locomotive an audible signal is operated after a certain adjusted time or a distance of 75 metres. If the driver takes no action on this, the locomotive is stopped after a further 75 metres travel respectively after a further interval fixed before by interruption of the power transmission and by the application of the brakes both on the locomotive and the train. The engine continues to run idle.

In order to avoid cold starting of the engine as far as possible and to preclude freezing up during prolonged standing at freezing temperatures, the Jenbach-

locomotives are fitted with Diesel-oil fired heaters for the engine cooling water. These consist of an oil burner to which combustion air is supplied by an electrically driven fan and which heats the cooling water or maintains it at the right operating temperature even at partial load. The heater which also heats the cab can be switched on by manual-push-button or by semi-automatic controls from the cab.

Locomotive designed for operation in arctic temperatures are fitted, in addition, with a steam heating system for the engine which enables the locomotive to operate without special aids at temperatures down to -50° C. Such locomotives are moreover provided with a coke-fired heater in the cab. The locomotive is also suitable for operation in hot climates up to a mean air temperature of 45° C.



TECHNICAL DATA

Model	“Jenbach DH 600 C 48”	
Manufacturers	Jenbacher Werke AG	
Type	C	
Loaded weight, normal	in to	48
Axle load	in to	16
Nominal engine capacity in accordance with		
UIC-Codex 623	in BHP	600
Power consumption of auxiliary equipment	in BHP	50
Power available for hauling	in BHP	550 (with JW 220 Kv)
Track gauge	in mm (ft. in.)	1000-1676 (3.3 1/2"-5.6")
Fixed axle gauge	in mm (ft. in.)	4500 (14' 9 1/16")
Wheel diameter	in mm (ft. in.)	950 (3.1 1/2")
Minimum turning radius at 10 km/h (6.2min/h)		
driving speed	in m (ft.)	80 (262)
Fuel capacity		
Diesel oil	litre (Imp. gal.)	885 (195)
Engine lubricating oil	litre (Imp. gal.)	88 (9.4)
Lubricating oil in oil bath air filters	litre (Imp. gal.)	25,5 (5.6)
Hydraulic oil in the hydraulic gears	litre (Imp. gal.)	210 (46.3)
Lubricating oil in the mechanical gear box	litre (Imp. gal.)	33 (7.3)
Lubricating oil in the axle gear boxes	litre (Imp. gal.)	24 (5.3)
Lubricating oil in the air brake compressor	litre (Imp. gal.)	5,5 (1.2)
Cooling water	litre (Imp. gal.)	420 (92.6)
Sand	kg (lb.)	200 (441)
Compressed air container—volume	litre (Imp. gal.)	600 (132)
Maximum velocity in shunting	in km/h (miles/h)	30 (18.6)
open track work	in km/h (miles/h)	60 (37.2)
in hauling	in km/h (miles/h)	80 (49.7)
(delivery journeys)		
Model	“JW 600”	
Manufacturers	Jenbacher Werke AG	
Nominal rating	BHP	600
Nominal revs. p. m.	r. p. m	1500
Range of revolutions	r. p. m.	750-1500
Number of cylinders	12	
Arrangement	“V”-shape	
Bore	mm (ins)	150 (5.91)
Stroke	mm (ins)	170 (6.69)
Stroke volume	litre (cu. in.)	36 (2196)
Average piston velocity at rated speed	m./sec (ft./sec.)	8,5 (27.8)
Average effective pressure at nominal lead and		
rated speed	kg/cm ² (lb./sq. in)	5,0 (71)
Fuel consumption	g/BHP (lb./BHP)	165-175 (0.36-0.39)
Lubricating oil consumption	kg/h (lb./h)	0, 6 (1.33)
Battery voltage	Volt	24
Battery capacity	Ah	300
Starter load	BHP	15
Dynamo output	Watt	1000

The engine work on the two-stroke system with reverse scavenging. Together with direct fuel injection into the combustion chamber this brings with it considerable advantages in operation, such as the elimination of all moving control parts, simplified construction, easier maintenance, reduced fuel consumption, high capacity, and very uniform engine torque.

The scavenging air is aspirated by a centrifugal air pump through oil bath air filters and is pressed into the cylinders through scavenging slots in the cylinder liners. The amount injected is automatically adapted, by a speed regulator, to the load at any given moment. The pressure lubrication system which comprises an oil sump in the crank case, a geared pump with a pressure regulator, an oil filter, and a magnet separator, supplies clean lubricating oil, cooled in a heat exchanger, to all lubricating points in the engine.

The engines are started by a Bosch electrical starter motor. The power for this is supplied by a lead battery which is continuously re-charged from an automatically controlled dynamo. The fuel system includes fuel tanks with inspection windows and separators for water and gross impurities, two fuel filters, the fuel pump and the injection pump working in conjunction with the speed regulator, the injection nozzles and the overflow oil line.

The exhaust manifolds pass through two collectors into a resonance silencer to muffle exhaust noise, and are then exhausted into the air above the cab. The noises issuing from the engine and the gears are suppressed by special insulation.

The crank case, the cylinder liners, and the cylinder heads are completely equally cooled by the cooling water. A pump pumps the water through the lubricating oil heat exchanger (for engine and hydraulic transmission) to the engine, and through a tabular radiator whose sections can be removed and replaced individually, where it is re-cooled.

The use of infinitely variable power transmission within additional device to enable the whole set of gear ratios to be doubled renders the locomotives

described exceptionally versatile. The particular advantage of the hydraulic gears consists in the high starting torque and the high degree of efficiency in the upper speed ranges. They are moreover exceptionally reliable in operation and are highly resistant to wear because all parts are running at all times in pure and cool oil. The gears for the "Jenbach DH 600 C 48" locomotive are fitted with two automatically controlled torque converters arranged in series. Both gears require practically no maintenance.

Universal-joint shafts are fitted as flexible couplings between the mechanical gear box and the axle driven in order to compensate for the changes in length and direction resulting from the resilience of the axles. The shafts and universal joints were specially developed for heavy locomotives to withstand the stresses involved.

Since, with hydraulic gears, it is impossible to reverse the direction of revolution, a toothed-wheel gear system is provided which contains the gears for shunting and open track work and the mechanical gear wheels for change of direction. These gears, too are provided with a special lubrication system with oil bath and circulating pump. In order to preclude any damage to the jaw clutches resulting from inexpert operation, a safety device is provided that prevents the locomotive from moving off unless every control operation has been carried out correctly.

The axle drives C 22 V is a intermediate-gear axle drive where the pinion is driven through another pair of gear wheels—the intermediate gear.

The casing is a steel casting and therefore insensitive to outside influences. The bevel gears have curved teeth with the pinion being supported on both sides, thereby ensuring extreme quietness in operation and a perfect meshing of teeth. Mounting the axle drive on the driving axle is effected by anti-friction bearings, their size being determined by the axle diameter. A double-acting geared pump is used to lubricate the gears and bearings in either direction of running. The torque acting on the axle drives is absorbed by sturdy torque reaction supports. Maintenance-free rubber elements have been provided on the vehicle frame for the suspension of the torque reaction supports.

TWO LOCOMOTIVES START 3,500-MILE "PIGGYBACK" JOURNEY

Two brand new diesel-electric locomotives left recently on the first leg of a 3,500-mile long journey to Guatemala.

The trip, from the plant of the General Electric (U. S. A.) Locomotive & Car Equipment Department to the northern terminus of the International Railways of Central America in Tecun Uman, is unique not only for its great length but also because the locomotives are travelling "piggyback"—perched on flat cars.

This novel form of transport is necessary because the locomotives will be used on a railroad with 36-inch gauge tracks. All the tracks between Pennsylvania and Guatemala are of standard U. S. gauge, 56.5 inches wide.

It is believed by officials of General Electric, the company which built the 700 horsepower locomotives, that this is one of the longest piggyback rail journeys on record for a locomotive.

The locomotives are both of the universal-type, meaning that they can be used in passenger, freight and switching service when they are delivered to Central America. The International Railways of Central America is the largest railroad in Central America and operates in both Guatemala and El Salvador. It is expected that the locomotives will play an important role in the vital coffee, cotton and fruit industries in those two countries.

In making their unique journey, the two G-E locomotives will travel over the tracks of several railroads, including the Pennsylvania and Missouri Pacific in the U. S. and the National Railways of Mexico. The locomotives will pass through St. Louis, Missouri; Laredo, Texas; Mexico City, and Vera Cruz, Mexico.

Shipment of the locomotives by rail over the entire 3,500-mile distance is made possible by the fact that U. S. railroads and the National Railways of Mexico exchange rolling stock at several points along

the border between the U. S. and Mexico. Both countries, of course, use the same gauge tracks.

In Central America, the new locomotives will join a large number of G-E locomotives ordered previously by various Central American railways. There are, for instance, 19 such make locomotives already operating on the International Railways. Twelve of these are 1,200 horsepower diesel-electrics—the largest ever built for a 36-inch gauge railroad.

During shipment, the superstructures of the two locomotives will be carried on flat cars. The running gear for the two units will be carried on two additional flat cars. The four-car "special shipment" will be intermingled with regular freight trains throughout its journey in both the U. S. and in Mexico.

* * * * *

ANOTHER INDIAN RAILWAY CONTRACT FOR THE BICC GROUP

A further contract for the supply and installation of overhead equipment for 25 kV 50 cycles A.C. railway electrification has been awarded to the BICC Group by the Indian Railway Board. This job is valued at £ 1,200,000 and covers some 300 track miles of the Eastern Railway system. The route to be equipped is on the main line from Delhi to Calcutta and lies between Gaya and Moghalsarai. It forms part of the second phase of the Indian Railway Board's electrification programme and is to be ready for use by July 1961.

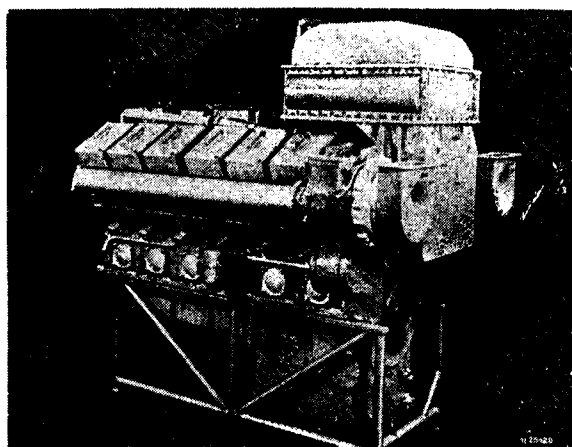
The equipment will be similar to that at present being installed by the BICC Group for the South Eastern Railway, the order for which was announced in December 1958. Such rapid progress was made on that scheme that it was possible for a section of the line to be energised only 12 months later so that an electric locomotive could make a demonstration run for delegates attending a meeting of the International Railway Congress Association.

Both contracts were secured in the face of keen international competition.

The M.A.N. Diesel Engines for Rail Vehicles

THE letters "M. A. N." stand for "Maschinen-fabrik Augsburg-Nürnberg A. G." Today M. A. N. comprises 5 works, in Augsburg, Hamburg, Nürnberg, München, and Gustavsborg with a total of 32,000 employees. A considerable part of the manufacturing programme of Werk Augsburg is dedicated to the manufacture of Diesel engines for rail vehicles. Until 1959 approximately 890 engines with more than 259,000 HP have been supplied for installation in railcars and more than 1,250 engines with a total of 412,000 HP for installation in locomotives. These figures do, however, not include the engines supplied for rail traction by Werk Nürnberg and the M. A. N. licensees.

The present programme of M. A. N. comprises a large power range both of high-speed engines up to 1,600 r. p. m. and of medium-speed engines up to 1,000 r. p. m. They are classified in three groups:

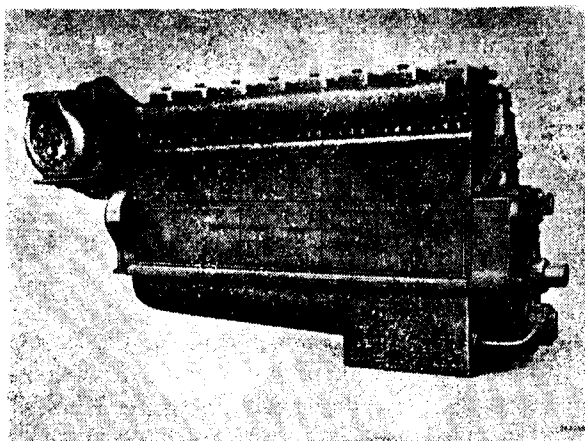


Nr. 36 251 20: L 12 V 18/21 engine with two turbochargers and air intercooler. Power output : 1,500 b.h.p. at 1,500 r.p.m.

the comparatively slow W6 and W8V 22/30 in-line engines and the V6 and V8V 22/30 Vee-type engines, the high-speed L12V 18/21 Vee-type engines and the RV and VV 16/18 engines which are built as in line and Vee-type engines. Between these two groups are the WV 17.5/22 A engines with 3, 4, 5, 6, and 8 cylinders in line and a maximum speed of 1,200 r. p. m.

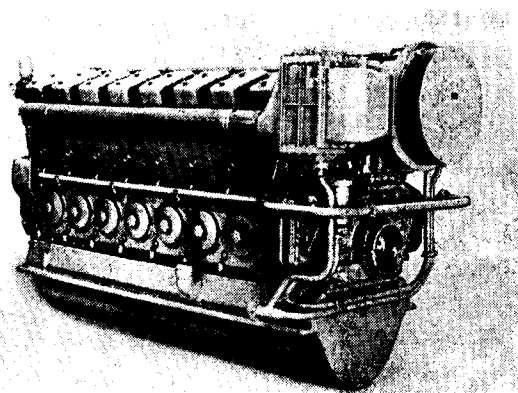
All of these engines have precombustion chambers and Bosch injection pumps and nozzles. The combustion process was considerably improved after the

war resulting in higher load capacity and lower fuel consumption. Another design feature these types have in common is the hardened crankshaft running in steel-backed lead-bronze bearings.



Nr. 36 205 92: Supercharged W 8 V 22/30 engine without intercooler. Power output : 930 b.h.p. at 1,000 r.p.m.

The pistons are of a light-metal alloy and either chill-cast or forged. The top piston ring is provided with hard chromium plating with the result that liner wear is considerably reduced. While formerly liner abrasion up to 1/10 mm in diameter after 1,000 service hours was considered standard, this figure corresponds nowadays to approximately 5,000 service hours and more.



Nr. 36 263 21: 4-stroke M.A.N. Diesel engine, type V8V22/30; 2,000 b.h.p. at 950 r.p.m.

An Important Announcement

We have great pleasure in announcing to all our readers and advertisers that we are incorporating a special supplement entitled "INTEGRAL COACH FACTORY SUPPLEMENT" along with our January 1961 edition. We need not very much stress the international importance of this gigantic coach-building unit of the Indian Railways in the whole of Asia. The Supplement will contain interesting articles specially contributed by eminent engineers about this largest coach-building factory in the public sector.

We take this opportunity of requesting such of those engineering firms who have had the privilege of contributing their mite to this great State undertaking to subscribe by way of technical articles on various aspects of coach-construction to our above Supplement.

The last date for receiving technical contributions is 28th January 1961. Advertisers desirous of buying advertising space in the above Supplement should intimate the fact to the Technical Editor on or before 28th January 1961 as there is very limited advertising space available.



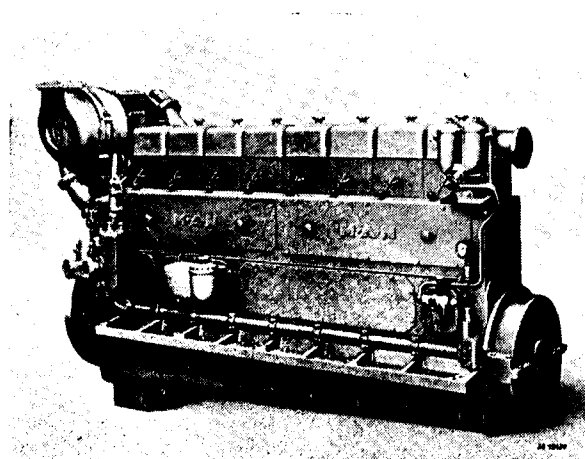
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Technical Editor

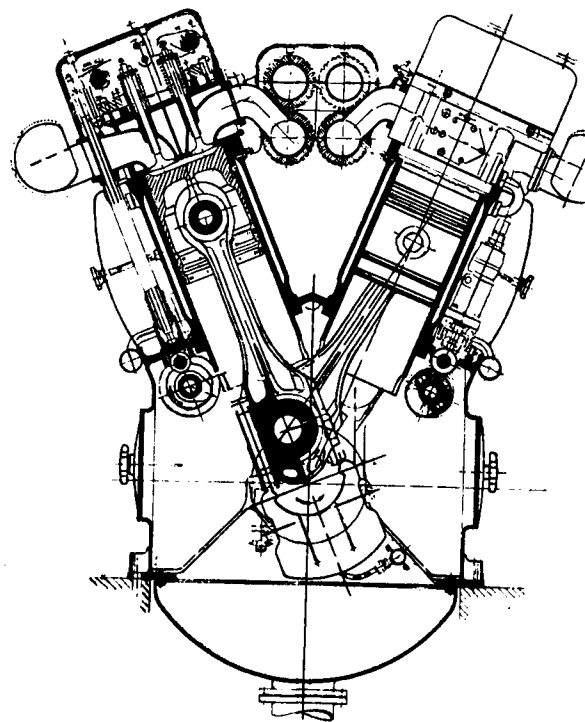
Engines having 6 and more cylinders can be boosted by exhaust turbo-chargers. If necessary, intercoolers can be provided with the result that an increase in power up to 80% or even 100% over the normally aspirated engine is obtained. All engine types afford the possibility to be optionally equipped with an electrical or compressed air starter.

(a) *W6 and W8V 22/30 engines*

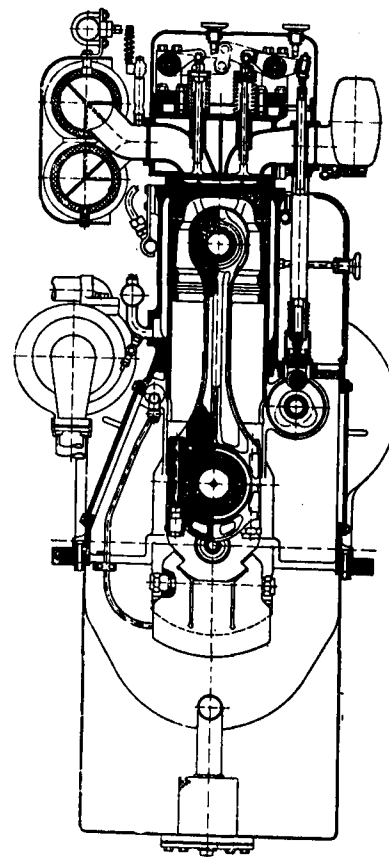
This type has a one-piece cast-iron casing. In view



36 194 30: *W 8 V 17.5/22 A engine, supercharged, without air intercooler; power output 440 b.h.p. at 1,000 r.p.m.*



Nr. 36 186 60: *Section through VV 22/30 engine.*



36 205 66: *Section through the WV 22/30 engine.*

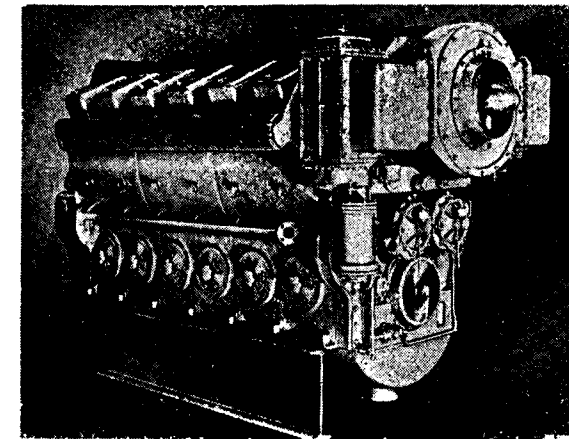
of the maximum speed of 1,000 r.p.m. and the resulting piston speed of 10 m/sec each cylinder head is equipped with 4 valves and a centrally located precombustion chamber. The turbo-charged version of the engine type has a power/weight ratio of only 6.3 kg/HP. On account of this low power/weight ratio the comparatively slow engines can be used for twin-engined 2,000 HP 4-axle bogie locomotives with hydraulic power transmission and axle loads of less than 18 tons.

(b) *VV22/30 Vee-type engines with 12 or 16 cylinders*

Approximately half of the components of this engine, especially all those subject to wear, are unmodified parts of the WV 22/30 in-line engine. The cylinder blocks are of cast iron and the crankcases of welded steel construction. The turbo-charged 16-cylinder version of this type has a power/weight ratio which is as low as 5.3 kg/HP.

(c) *WV 17.5/22 A engines with 3, 4, 5, 6, and 8 cylinders*

This engine has been developed for all applications and proved successful with a total of 4,000 units of 735,000 HP delivered to date. Engines used in rail



36 198 13: *V 6 V 22/30 engine, supercharged, with air intercooler; power output 1500 b.h.p. at 550 r.p.m.*

traction mostly have 6 or 8 cylinders with a power range from 200 to 440 HP. They are primarily intended for installation in small locomotives. Each

cylinder houses 2 valves as the mean piston speed remains below 9 m/sec.

(d) *L 12 V 5/21 engines*

This engine was originally designed as a source of propulsion in the 800 HP bracket for rail cars and locomotives of the German Federal Railways. The power was soon raised to 1,000 HP. Later, when 1,100 HP and more was required, an increase in bore with almost no other modification produced what became known as the L 12 V 18/21 type. The power/weight ratio being 3.8 kg/HP is considerably low for a 1,100 HP engine. The standard type of this engine has the turbo-charger located above the Vee. In case intercooling is provided, this place is occupied by the intercooler and each row of cylinders is equipped with a smaller exhaust turbo-charger of its own.

(e) *RV and VV engines*

The RV 16/18 and VV 16/18 engines are new types which were shown for the first time at the Hannover Fair 1960. They are designed as 6-and 8-cylinder in-line engines and 12-cylinder Vee-type engines. Turbo-charged engines develop 375, 500, and 750 BHP (metric) at 1500 r.p.m. The cylinder bore is 160 mm and the piston stroke 180 mm.

Equipment for Railways

The Ministry of Railways is anxious that self-sufficiency in regard to items of railway stores which are at present procured from abroad should be achieved as quickly as possible, by locating and developing manufacturing capacity for such items within the country, it is learnt.

The Railway Equipment Committee, appointed by the Government of India, had earlier reported that it was necessary that every opportunity should be taken to go ahead with schemes for achieving self-sufficiency.

Following these recommendations, the Railway Ministry were making arrangements for their personnel to visit industrial units to create a spirit of mutual help and understanding between the user and the manufacturer in order to develop the indigenous manufac-

ture of imported items. Railway experts claim that in this drive for self-sufficiency, however, there can be no compromise as regards the standards of articles used on the railways, as the consequences of a fall in standards could be disastrous. The Ministry of Railways have expressed their willingness to entertain new products as may be of particular use to the railways. If a new product offered promised to be of use to the railways, taking into consideration technical, economical, and other aspects, necessary trials will be arranged and, if as a result of the trials a product was found to be satisfactory, it might be standardised for use on all railways in consultation with them. The Ministry of Railways, therefore, hope that manufacturers interested in supplying railway equipment, which is at present imported, will develop the required capacity, so that purchase of these items from abroad may be eliminated as early as possible. This will at the same time help towards establishment of new industries and the expansion of existing ones.

2,100-H.P. Diesel-Electric Locomotives
for the Rumanian State Railways

IN 1936 the Rumanian State Railways placed an order with Sulzer Brothers Limited, Winterthur, as general contractors, for a 4,400-H. P. double locomotive of 2 Do1+1 Do2 axle arrangement.

This was at the time the most powerful Diesel-locomotive in the world. The electrical equipment was supplied by Brown Boveri & Co., Baden, and the mechanical part by Henschel & Sohn, Kassel. It was delivered in 1938 and was to have been the first of a large series of similar units.

In spite of the good results obtained with it, however, further orders had to be postponed on account of the outbreak of war. Twenty years later, in 1956, the Rumanian State Railways resumed this business and ordered a number of six-axled Co-Co locomotives of 2,100 H. P., mainly intended for freight traffic, from Swiss companies.

Six of these locomotives will be built entirely in Switzerland by a consortium formed for the purpose, consisting of Sulzer Brothers, Winterthur, Brown Boveri & Co., Baden and the Swiss Locomotive and Machine Works, Winterthur. The first of these companies will supply the power units, the second the electrical equipment and the third the mechanical part.

Ten further locomotives of the same type will be built in Rumania, the Diesel-electric equipment being supplied by the Swiss companies already mentioned.

PRINCIPAL DATA

Line	
Gauge	1,435 mm. (4' 8 1/2")
Minimum radius of curves :	
open track	275 m. (902')
points	160 m. (525')
sidings	100 m. (328')
Maximum permissible axle load	19,000 kg. (18.7 tons)
Maximum gradient on uncompensated curves of 275 m. (902') radius	
	25% (1 in 40)
Maximum height above sea level	1,054 m. (3,458')
Minimum height	0 m. (0')

Locomotive

Maximum speed	100 km./hr. (62 1/2 m.p.h.)
Dimensions :	
Length over buffers	17,000 mm. (55' 9")
Length of body	15,700 mm. (51' 6")
Maximum width	3,000 mm. (9' 10")
Maximum height above rail	4,272 mm. (14')
Distance between bogie pivot centres	9,000 mm. (29' 6")
Bogie wheelbase 1,950+2,150=	4,100 mm. (13' 5")
Wheel diameter (new)	1,100 mm. (43 1/4")
Weights :	
Mechanical part	54,760 kg. (53.9 tons)
Thermal part	24,620 kg. (24.2 tons)
Air-brake compressor	780 kg. (1,720 lb.)
Electrical equipment	27,100 kg. (26.7 tons)
Starting battery	2,100 kg (2.1 tons)
Fuel, lubricant, water, etc.	6,900 kg. (6.8 tons)
Weight with two thirds supplies	114,000 kg. (112.2 tons)
Axle load	19,000 kg. (18.7 tons)
Tractive efforts (for half-worn tires) :	
Starting tractive effort	32,000 kg. (31.5 tons)
One-hour tractive effort at V= 18.5 km./hr. (11.5 m. p. h.)	22,500 kg. (22.1 tons)
Continuous tractive effort at V= 21.5 km./hr. (13.4 m. p. h.)	20,000 kg. (19.7 tons)
Oil, water, etc. :	
Diesel fuel, total	5,030 lit. (1,110 gals.)
Cooling water	1,340 lit. (295 gals.)
Lubricating oil	720 kg. (1,590 lb.)
Sand	480 kg. (1,060 lb.)
total	6,900 kg. (6.8 tons)

VEHICULAR PART

Makers : Swiss Locomotive and Machine Works, Winterthur. As figures 1 and 2 show, the mechanical part consists of two six-wheel bogies, which are



Diesel-Electric Locomotives

Two 2,100-H. P. Co-Co Diesel-electric locomotives of Series 060-DA for Rumanian Railways

Diesel Engines	Sulzer Brothers Limited Winterthur, Switzerland	Represented by: Voltas Limited P.O. Box 900 Bombay 1
Electrical Equipment	Brown, Boveri & Co. Ltd. Baden, Switzerland	Represented by: Voltas Limited P.O. Box 900 Bombay 1
Mechanical Part	Swiss Locomotive and Machine Works Winterthur, Switzerland	Sole concessionaires for India: T. Maneklal Mfg. Co. Ltd. P.O. Box 111-A Bombay

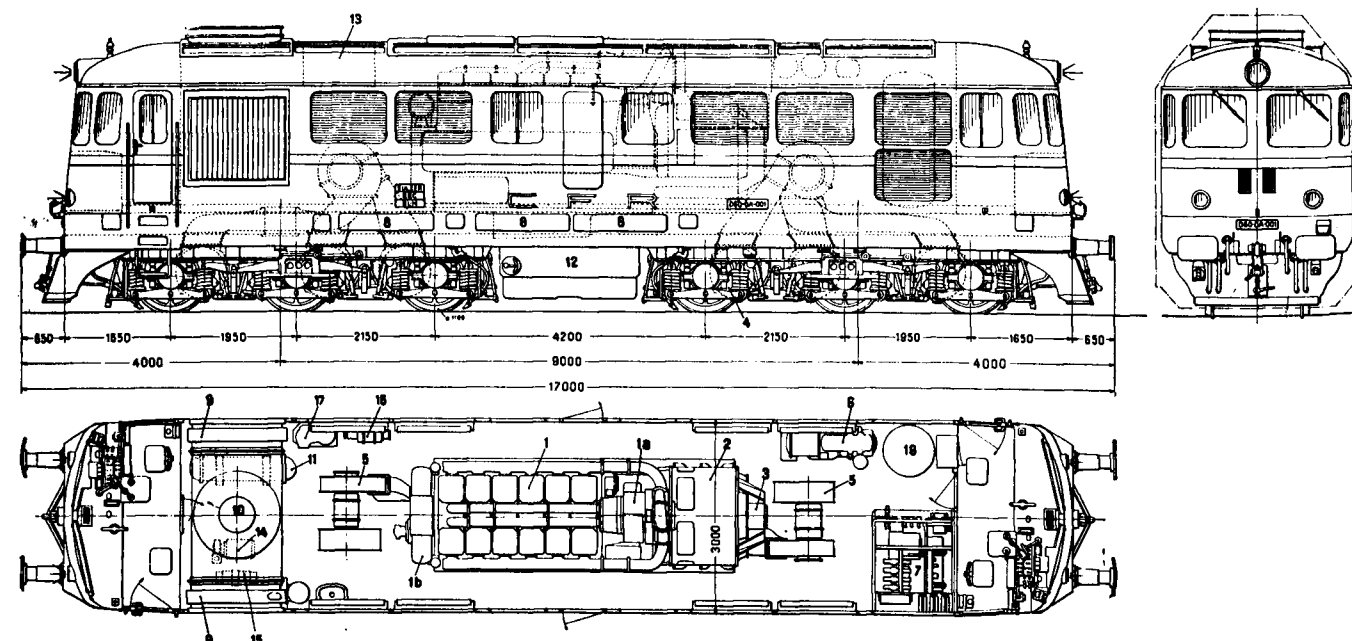


Fig. 1. 2,100-H.P. Diesel-electric locomotive for the Rumanian State Railways (CFR)

- | | | |
|---|---------------------------|---|
| 1. Diesel engine | 6. Braking-air compressor | 14. Cooling-water pump |
| 1. (a) Supercharger | 7. Electrical control box | 15. Transformer unit |
| 1. (b) Lubricating-oil filter | 8. Battery | 16. Auxiliary lubricating-oil pump and fuel transfer pump |
| 2. Main generator | 9. Water cooler | 17. Cooling water and lubricating-oil heater. |
| 3. Auxiliary generator | 10. Cooler fan | 18. Main air reservoir |
| 4. Traction motor | 11. Oil cooler | |
| 5. Ventilation unit for traction motors | 12. Main fuel tank | |
| | 13. Water tank | |

connected by an S. L. M. transverse coupling, and the locomotive body, which is of integral design. The tractive and propulsive efforts are transmitted by the locomotive body, as the draw-bars and buffers are fitted on the body head-stocks.

The locomotive body rests on face bearings supported by bolster springs placed longitudinally on both sides of the bogies (fig. 3). These springs are connected by two swing bolsters suspended from the bogie frame. The bolster springs are held in position by links in the longitudinal direction. The draw-bar and buffer efforts are transmitted to the locomotive body in each case through a pivot with a transversally movable bearing.

The bogie frame is of welded design consisting of I-section sole bars and box-type transoms. It rests on the axle boxes by means of helical springs which contain frictional shock-absorbers. The axle boxes are guided by cylindrical guide pins on the S.L.M. system. The axles run in SKF self-aligning roller bearings. Equalisers for the axle loads are provided between the two outer axles.

The brake equipment consists of an automatic Knorr KSS-brake, a direct Oerlikon brake for the locomotive alone, and a Brown Boveri-Charmilles wheel-slip brake. Two brake cylinders are housed in each bogie. Each wheel is braked by two double-faced brake blocks.

POWER UNIT

Suppliers: Sulzer Brothers Limited, Winterthur. The power unit is a twelve-cylinder twin-bank four-stroke Diesel engine (figs. 4 and 5) incorporating airless injection and fitted with Sulzer exhaust-gas turbochargers.

Engine data :

Bore	280 mm. (11")
Stroke	360 mm. (14.2")
Weight (without water and oil)	21,000 kg. (20.7 tons)
U. I. C. Continuous rating	2,300 H. P. at 750 r. p. m.
Running data :	
Mean effective pressure	10.4 kg./cm. 2 (148 p. s. i.)

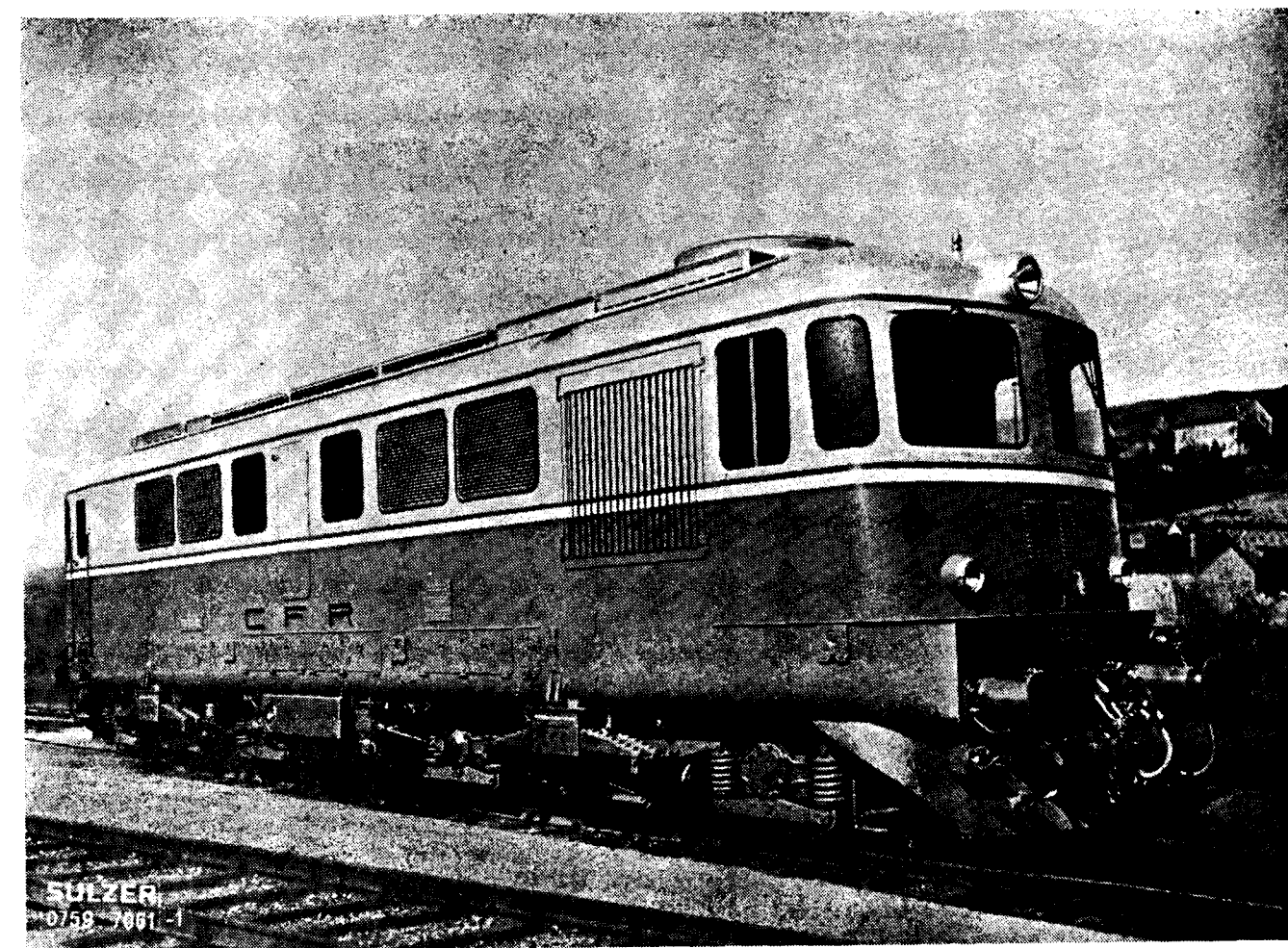


Fig. 2. 2,100-H.P. C. C. Diesel-electric locomotive for the Rumanian State Railways (CFR)

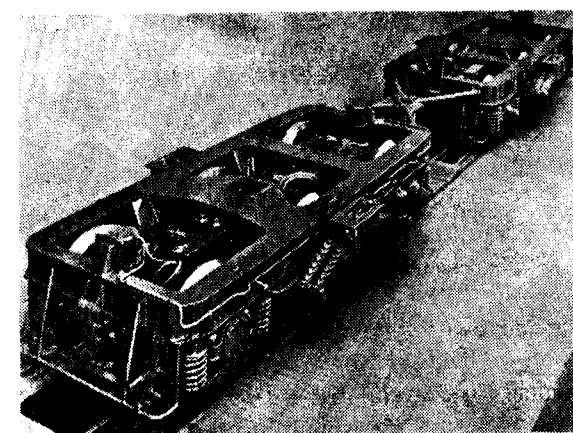


Fig. 3. Bogies fitted with traction motors, connected by transverse coupling.

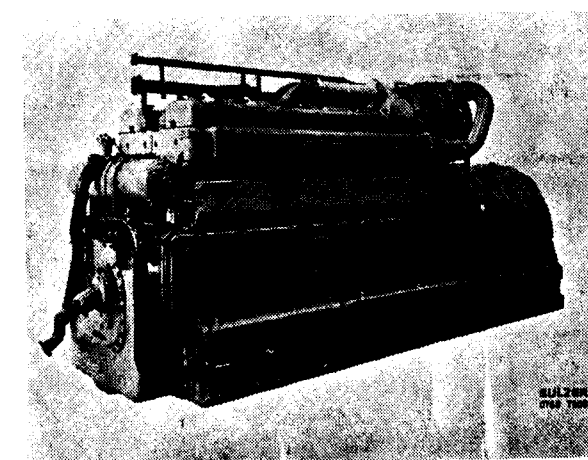


Fig. 4. 2,100-H.P. Diesel generator unit.

Piston speed 9 m./sec. (29.5 ft./Sec.)
 Supercharging pressure 1.75 kg./cm. 2 (25 p. s. i.)
 Output in Rumania (barometric pressure 720 mm. = 28.35" Hg. air temperature 35 °C = 95 °F, relative humidity 80%) 2,100 H. P. at 750 r. p. m.

An engine of this type has already been run continuously on the test-bed at 2,500 H. P. and 750 revs. per min.

The two banks of six cylinders are parallel, each bank having its own crankshaft. The shafts are synchronised by means of an intermediate gear which is coupled directly to the generator. The gearing between crankshafts and intermediate gear is such that the generator runs, 1.44 times faster than the engine. The Diesel engine, gear and flanged generator form a com-

pact unit which is flexibly mounted on four rubber pads resting on the locomotive frame.

The Diesel-electric set can be controlled from either of the driver's cabs at the two ends of the locomotive. A number of speeds can be set with the control lever by means of a speed setting unit which also adjusts the fuel regulator. The load regulator, which is influenced both by the fuel regulator and by the speed setting unit, automatically varies the excitation of the generator so as to keep the load on the Diesel engine constant at a given speed. Overloading of the power units is consequently impossible. Safety devices are provided to prevent unduly high cooling-water temperatures, insufficient oil, cooling-water or charging air pressures, slipping of individual axles and over speeds of the Diesel engine.

The air for the cooler set is drawn through louvres in the side walls. The fan is driven hydrostatically from the Diesel engine with thermostat control.

A heater fitted in the cooling-water circuit preheats the engine or keeps it warm in cold weather.

ELECTRICAL EQUIPMENT

Makers: Brown Boveri & Co. Ltd., Baden

Power is transmitted to the six axles of the locomotive by way of the main generator, which is rigidly coupled to the engine, and six nose suspended traction motors.

The data of the main generator are:

Design rating	2,460 KVA at 1,080 r. p. m.
Maximum current	3,700 A
One-hour current	2,700 A
Continuous current	2,460 A
Maximum voltage	890 V

The generator operates as a series-wound motor for starting purposes.

The auxiliary generator, which forms a single assembly with the main generator, is used for exciting the latter, for charging the battery and for feeding the driving motors of the cooling-water, fuel and lubricating-oil pumps, the air-brake compressor and the transformer for the lighting system. The data of the auxiliary generator are as follows:

Continuous rating	75 kW
Over a speed range of	530—1,080 r. p. m.
Voltage	175 V

The particulars of the starting battery, from which some of the auxiliary services can also be fed for short periods, are:

Number of cells	72 (lead)
Capacity at ten-hour discharge	320 Ah

The traction motors are d.—c. series units with forced ventilation, the data being:

One-hour rating	194 kW at 900 A
Continuous rating	200 kW at 820 A
Max. running speed	2,300 r. p. m.

The gear has a transmission ratio of 1:4.6. The gearwheel which is pressed against the axle is of the sprung rim type.

The motors are connected to the bus bars of the main generator in three parallel series-connected pairs. One fan set is provided for cooling three traction motors in each bogie.

All switchgear is of modern design and is housed in a control box (fig. 6).

The locomotive is equipped with multiple control permitting two or more locomotives to be driven from one cab. There is a safety device which automatically initiates rapid braking if the driver's attention should be relaxed for any reason, so that one-man operation is possible.

The locomotives are able to haul trailing loads of about 600 tons in freight service at a constant speed

of approximately 22 km. per hr. (14 m. p. h.) on gradients of 25 per mille (1 in 40) with the engine at full load, and express trains of about 480 tons at a

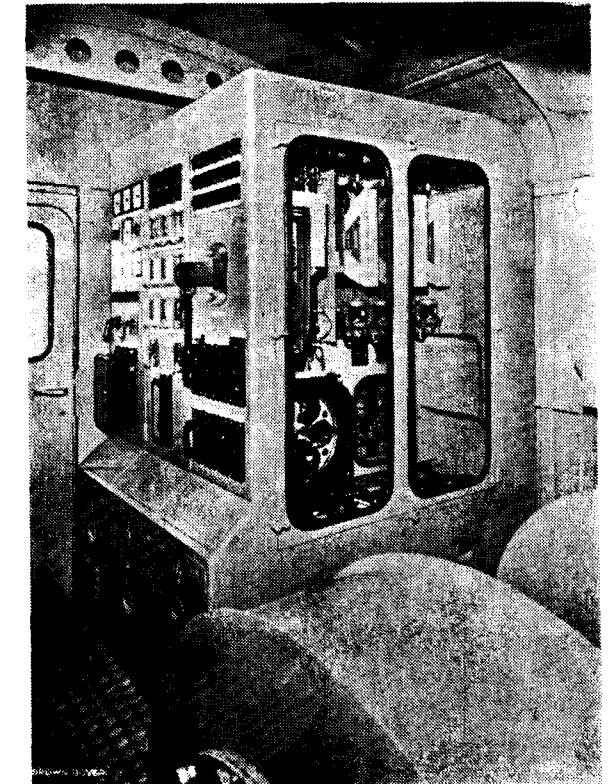


Fig. 6. Electrical control box.

maximum speed of 100 km. per hr. (62 m.p.h.) on the level. In the course of tests on the Gotthard line in Switzerland the first locomotive accelerated a 550-ton train from a standstill to 14 m. p. h. in about three minutes up a gradient of 1 in 38 with continuous curvature.

On all trips the locomotives demonstrated their excellent running characteristics over the entire speed range.

SILVERED MICA CAPACITORS

The Indian Standards Institution has recently drafted a Specification for Silvered Mica Capacitors [Doc: ETDC 8 (80)]. The draft lays down test and requirements for fixed mica dielectric capacitors with silver electrodes, which are used in radio and communication equipment. The draft standard covers two grades depending on degrees of climatic durability

and includes an appendix on colour code for such capacitors. Manufacture of this important component has been started in India now.

The draft standard is shortly being circulated for eliciting technical comments to producers, consumers, technologists and other interests concerned.

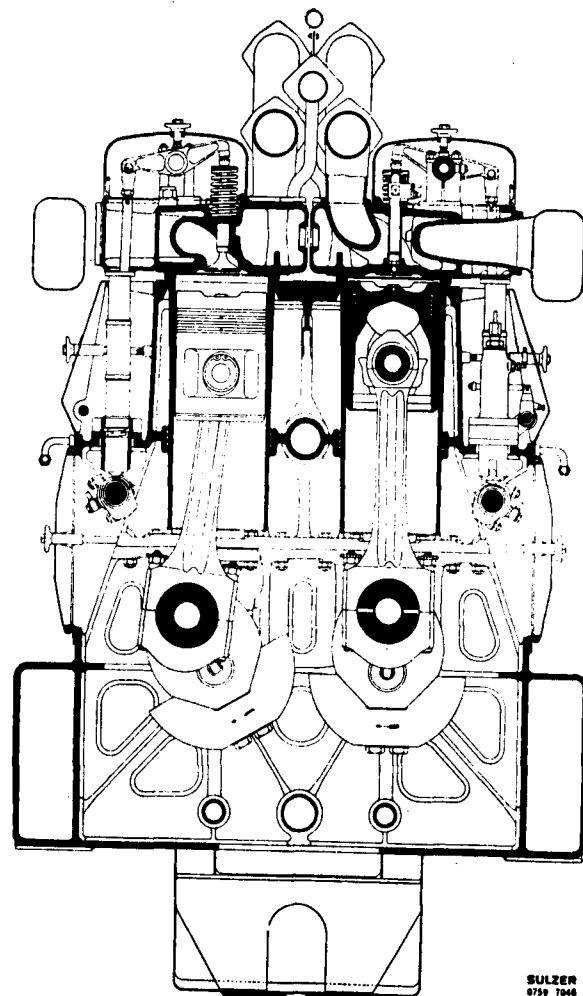


Fig. 5. 2,100-H.P. Sulzer 4-stroke 12 cylinder twin-bank Diesel engine type 12 LDA 28.

EVALUATION OF RAILWAY DRAFT GEARS

By *W. D. Wallace*

Member A S M E
Vice President — Engineering & Research
W. H. Miner, Incorporated Chicago, Illinois.

Draft gear is a most important factor in economics of the railway freight car. By careful selection, one original investment can provide high efficiency for minimization of impact shock and full control of long trains at all speeds.

IN presenting this article the author's object is to provide an explanatory outline of the essential mechanical characteristics of railway freight draft gears.

In the early days there was a great preponderance of cars equipped with coil spring draft gears or ineffective early designs of friction draft gears. Tests of such cars, one loaded to capacity striking a similarly constructed, equipped, and loaded car, showed complete exhaustion of cushioning at the extremely low impact speed of 2 miles per hour and lower.

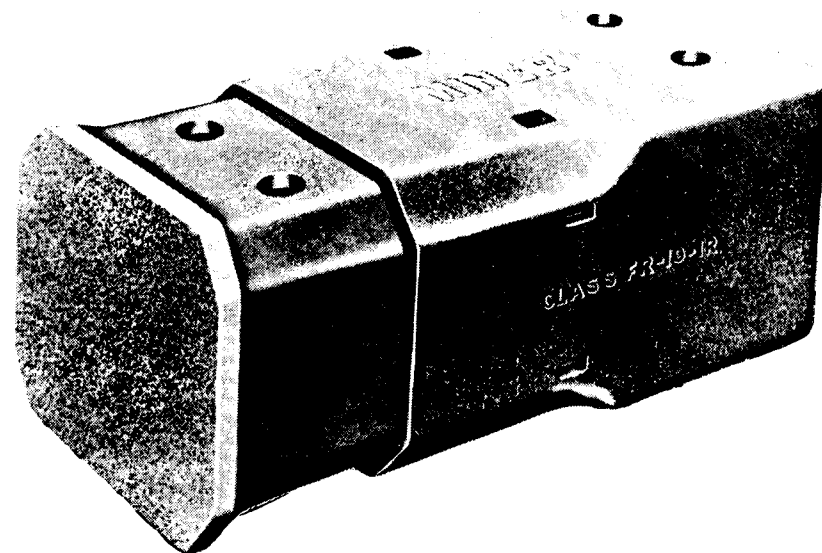
Graphic charts, such as the ones reproduced herewith as Figures 1 and 2, were valuable in those days as they are now, for a basically simple explanation of why draft gears of greater capacity were needed.

OPERATION OF DRAFT GEARS

The draft gear operates in a pocket formed between the center sills by the front and rear lug structures as shown by Figure 3. Since it is a cushion the

draft gear develops a cycle of work during its closure and release under the various intensities of draft or buff impact, either when operating in the moving train or when they are being collided singly or in groups of cars during train make-up. The mechanics of this work cycle is not complicated and is expressed graphically as in Figure 4 by plotting pounds of pressure vertically against inches of movement horizontally. The area under the compression curve O-A equals the total input of cushioning work in foot pounds. The area included between the compression line O-A and the release line A-B-O is that part of the total input absorbed by friction. Area O-B-A-C-O is the work causing gear release or recoil.

The draft gear cushioning cycle is evaluated exactly like the steam or gas-engine work cycle, such as that shown in Figure 5. Engine action is considered positive on the basis of heat being changed to work to cause acceleration while the draft cycle is negative work being changed to heat, causing deceleration. The draft gear work during compression is commonly called capacity, and the ability of the draft gear to keep this capacity at a high level of quality and



MINER.[®]

CLASS FR-19-IR RUBBER DRAFT GEAR

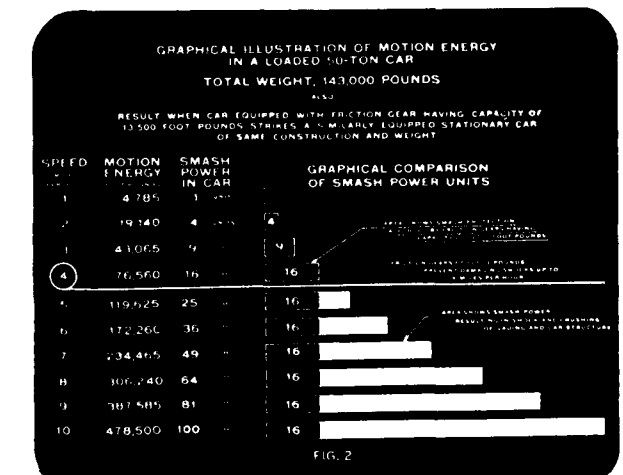
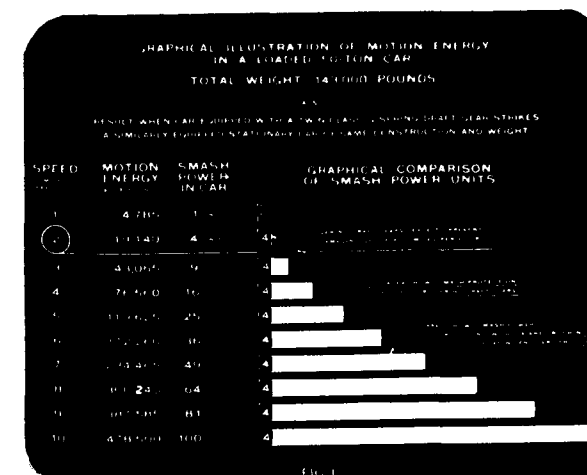
ENGINEERED FOR FULL-TIME PROTECTION of lading and cars. The entire 24-5/8" pocket is utilized for the superior protective action of this gear. Proper initial compression will provide slack-free operation of cars.

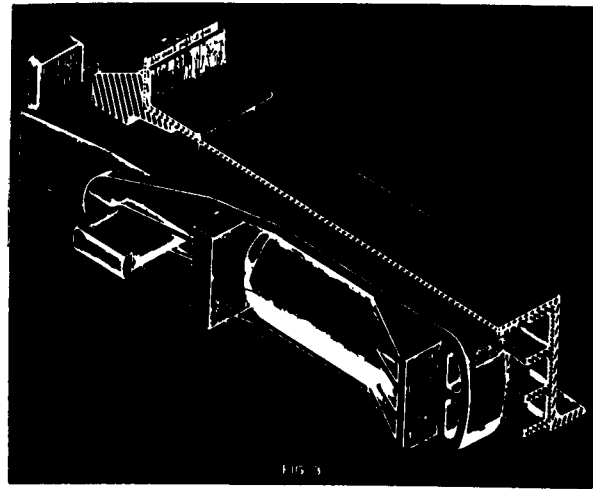
The FR-19-IR Gear, like all Miner gears, is fully enclosed and self-contained, giving the rubber pads protection against foreign material, and aiding in an easy application within the yoke and to the car at any shop or rip track.

W. H. MINER, INC.

OFFICE OF FOREIGN OPERATIONS

1212 Pennsylvania Building, 425 Thirteenth Street N. W. Washington 4, D. C., U. S. A.





quantity during many years of service is called endurance. The higher the capacity of the draft gear, the greater the degree of impact which can be accommodated with full cushioning. Granted that the draft gear has the desired capacity with adequate endurance, the quality of the cushioning depends upon how the total foot pounds of capacity are developed during the cycle of compression and release.

DRAFT GEAR WORK CYCLE DETERMINATION

By means of electronic instrumentation the compression and release curve of a draft gear is readily determined. The action of Figure 4 is typical of what experience shows to be the best presently attainable for freight car service with many years of endurance and minimum first cost. The quantity of new gear cushioning or capacity represented is 23,000 foot pounds, which is a fair average of the better standard pocket friction draft gears.

A travel of 2.60 inches is shown in Figure 4 because this is close to the average of the better friction gears. When the car is coupled at a switching speed beyond the capacity of the draft gear, the overload must be assumed by the coupler shank as well as the draft gear column, the rear stop lug construction, and finally the center sills of the car. The elastic limit of the present Type E coupler shank is about 525,000 pounds. The column of the draft gear, the rear lugs, and the center sills have progressively higher elastic limits. Thus the coupler shank, being the weakest, cheapest, and most readily replaced of the four elements under compression, acts as a safety valve. Heavy overload may cause a permanent set in the shank, but this set performs the important function of reducing maximum pressure and the damaging

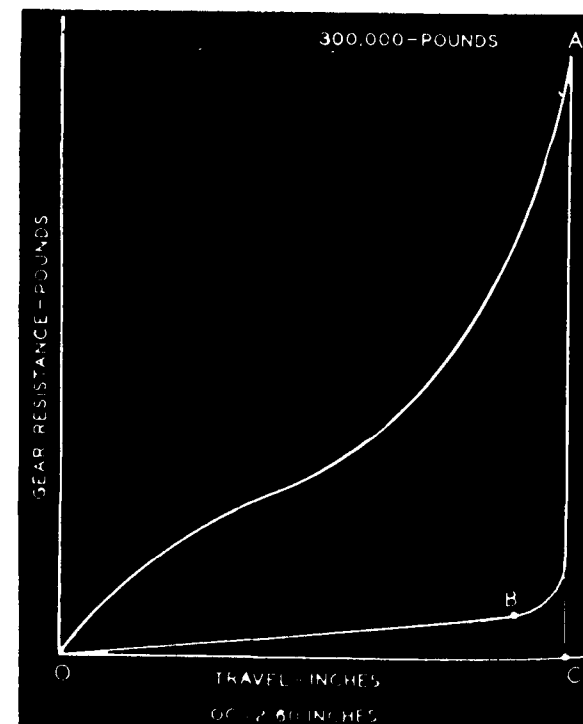


Fig. 4

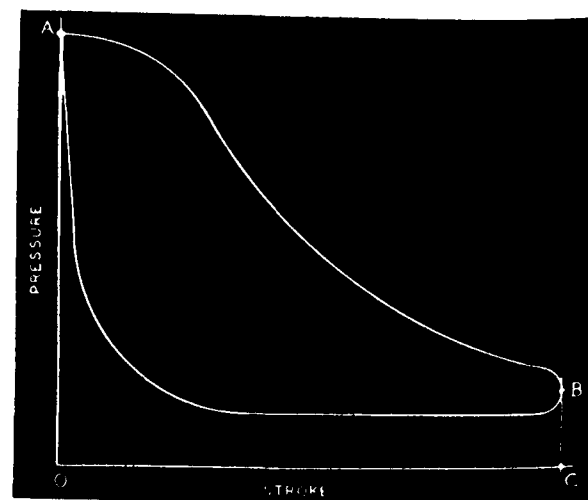


Fig. 5

effect upon structure and lading. The better designs of approved friction gear use surprisingly little of this safety value action over long periods of time.

RUBBER SPRINGS BEING USED

Rubber gears should be carefully evaluated for design to insure that quality of action is satisfactory for the purpose intended. Not only can the action within the rated total capacity of a given device greatly exceed the proper safe loading for rubber, but

the resulting compression line can be far from an ideal action for reducing the pressure effect of a given shock.

Where provisions for the oversolid protection of the material beyond rated capacity is omitted in the design, the rubber is subjected to extremely destructive overload. Most friction gears provide overload protection in terms of a steel column which is considerably stronger than the coupler, and will assume overload after the capacity-producing system has developed its total travel.

EXAMINATION OF RECOIL CHARACTERISTICS

Unquestionably the high absorption cycle is extremely desirable in draft gears, important not only in the car impacts involved in train make-up, but indispensable as the desirable action in the moving train.

The better friction gears have an average recoil of about 10 per cent of capacity, which means 90 per cent absorption. Most all-rubber gears run about 50 per cent plus. The unit pressures required to develop total draft gear capacity in a limited quantity of rubber are very high, and the consequent molecular friction peculiar to the overloading tends to disintegrate the material and adversely affect endurance.

COMPRESSION

Early in the travel the efficient draft gear cycle, such as that of Figure 4, shows a substantial amount of work by virtue of exerting positive resistance at a level well above ordinary tractive forces. Otherwise, the gear is in a constant state of compression and release during train operation and it is a well-known fact that this whip produces unnecessary fatigue in the gear and wear in the attachments. The present Association of American Railroads' specifications for draft gears set 4,500 foot pounds for the minimum amount of initial work at 1-5/16 inches travel. The better friction gears develop about 35 per cent of their total capacity at half travel even after many years of service. The positivity of this initial action will be noted by reference to Figure 4. Figure 6 is the same action plotted to a different scale.

CAPACITY AT HALF TRAVEL

Early designs of all-rubber gears had difficulty in getting initial compression. This is evident from the characteristic action of these earlier gears shown in

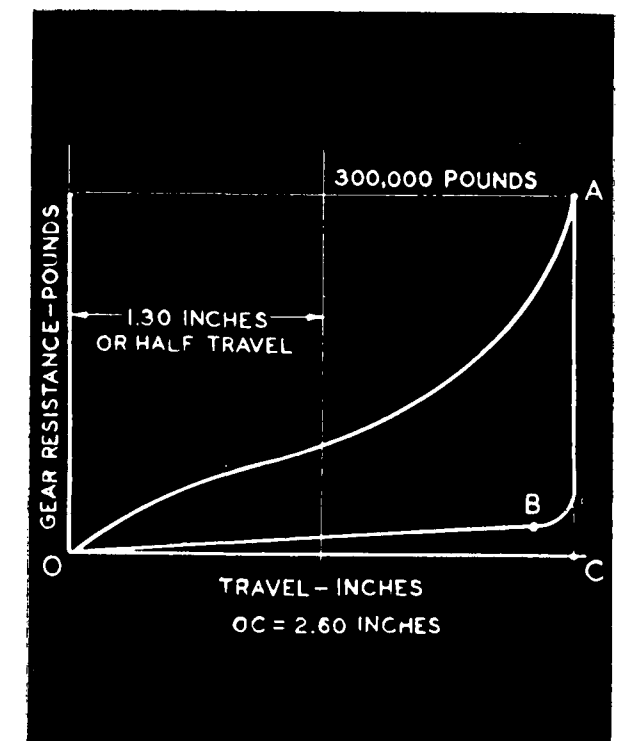


Fig. 6

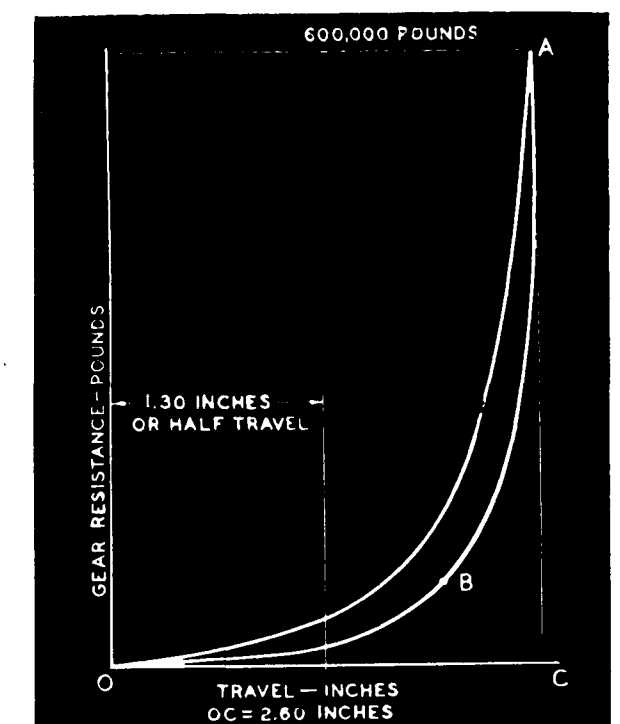


Fig. 7

Figure 7. The same total capacity of 23,000 foot pounds and 2.60 inches travel of Figure 6 is plotted to the same scale. Figure 8 is a superimposed plotting of

the two capacity actions. The engineer responsible for selecting a design of rubber gear which will give the best performance for train operation should therefore determine the exact figure for capacity at half travel and give favourable consideration to the device having at least 20 per cent minimum.

The best possible cushioning action, as well as efficient action for train operation, is insured by preference for capacity at half travel greater than 25 per cent. A draft gear is a machine for accommodating the largest possible quantity of impact work with the least amount of maximum pressure. Figure 8 superimposes the capacity lines of Figures 6 and 7. It is obvious that serious deficiency in the amount of work done at half travel means an excess in the maximum pressure as the gear goes solid.

Again referring to Figure 8, note that the friction gear having adequate capacity at half travel has double the cushioning efficiency of the rubber gear of the same capacity. The typical efficient friction gear develops 23,000 foot pounds with 300,000 pounds of maximum pressure. Assuming the same capacity and poor initial action, the rubber does it with 600,000

pounds. The friction gear required only 13 pounds of pressure per foot pound of capacity, but the rubber gear required 26 pounds and therefore has twice the stiffness.

HIGH CAPACITY FRICTION GEARS

Some of today's higher capacity friction gears are dedicated to efficient service for cars in special services warranting a higher protection standard. A typical gear is illustrated by Figure 9. They advantageously employ rubber springs to activate the friction clutch and obtain more capacity by virtue of higher working pressures well within the elastic limit of the coupler and the same cushioning efficiency of about 13 pounds or less per foot pound of capacity. It should be emphasized that the use of rubber in a

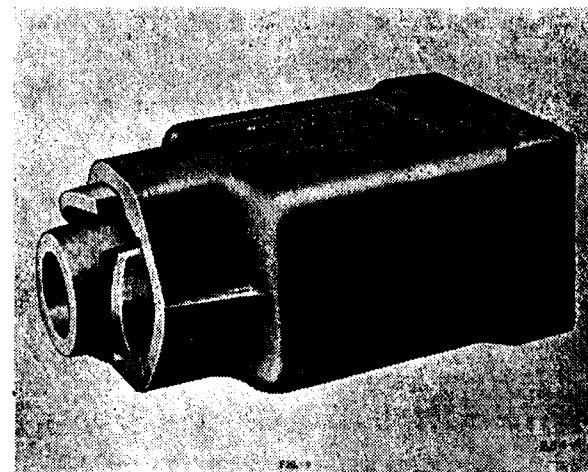


Fig. 9

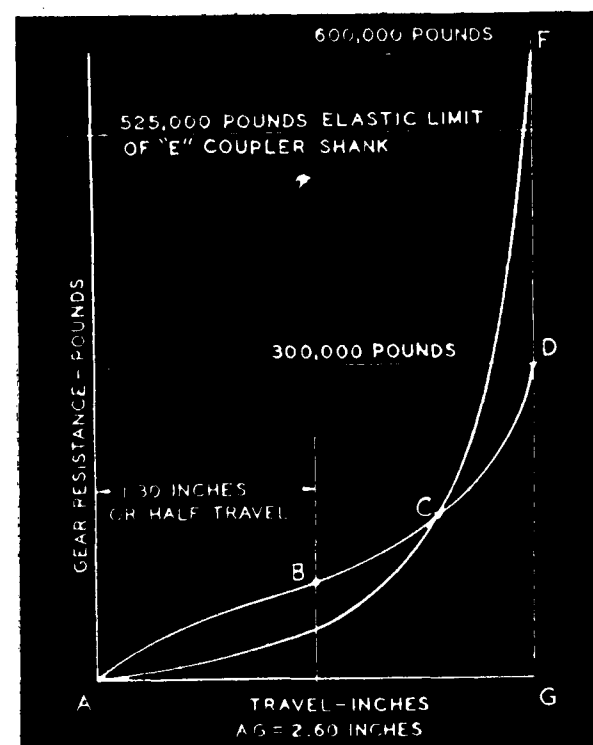


Fig. 8

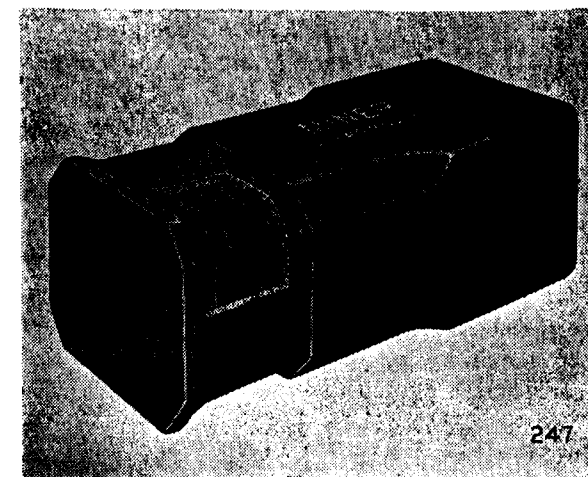


Fig. 10

(Continued on page D.E.31)

Vulcan-Sinclair Dual Fluidrive SSS Transmission

THE Vulcan-Sinclair Dual Fluidrive SSS transmission has been designed for use with the Paxman 'Hi-Dyne' engine, which was originally introduced towards the end of 1954. Since then, there has been considerable works development of this transmission, coupled with experience gained by Hudswell Clarke and Co. Ltd. in the operation of the locomotive 'Enterprise', in which was installed the prototype engine and transmission.

The Dual Fluidrive is now available for engine powers up to 600 b. h. p., with two, three or four speeds. For main line working, two engine/transmission units may be installed in the locomotive, which can therefore have as much as 1,000 h. p. available at the drawbar.

When the Sierra Leone Government Railways decided to introduce diesel units, some difficult technical problems had to be met, owing to the fact that the gauge is 2 ft. 6 ins., the track is light and that there is a severe restriction on axle load, namely five tons. Their considerations led to the ordering from Messrs. Hudswell Clarke of Leeds, of twenty-two diesel-mechanical locomotives incorporating 225 h. p. Paxman 'Hi-Dyne' engines and Dual Fluidrive SSS two-speed transmissions. As the Paxman engine develops constant horsepower over its working speed range and as the changes between the two ratios in the transmission are effected without interruption of tractive effort, the combination gives a smooth and stepless speed/tractive effort curve, with the simplest possible handling and the minimum weight or complication.

(Continued from page D.E.30)

friction gear means protection from overstress and oversolidity of the material by the gear column, and the limitation of maximum stress in the rubber. This protection, plus the complete prevention of unnecessary activity provided by friction, is most conducive to the provision of permanence of high level capacity of best quality during the total life of the car.

It requires outstanding design to produce mechanically acceptable rubber gears. In view of the higher

GENERAL FEATURES

These Dual Fluidrives have the following important features of interest:—

1. Ratio changes up and down take place automatically at pre-determined speeds of the locomotive and do not depend upon the driver's judgment. Handling of the locomotive is thus very simple; it responds immediately to the controls and may be entrusted to relatively unskilled labour. A single air pressure control line connects the transmission with the engine fuel control in the driver's cab.
2. Due to the unique torque/speed characteristics of the 'Hi-Dyne' engine in combination with the Dual Fluidrive, the ratio changes up to a higher speed gear are made smoothly without the marked drop in tractive effort that would be otherwise present with a conventional engine and stepped ratio transmission.
3. With the 'Hi-Dyne' engine, a uniformly high horse-power is obtainable on the track over the entire speed range; thus nearly the full power capacity of the engine is continually available with a

first costs involved, it is most important for the engineer to check any proposed investment in this type of cushioning against its ability to meet fully the minimum requirements. An acceptable design is illustrated by Figure 10. If railroad management desires to use rubber gears, the possibly higher first cost of the better designs should not act as a deterrent to their use because some devices will maintain a degree of permanent positive initial action, prevent the damaging effects of slack action, prolong the capacity, and lengthen the term of effective service.

proved low specific fuel consumption. The drawbar horsepower developed by the locomotive is over 80% of the gross b. h. p. output of the engine, which is considerably higher than that with other systems.

The typical tractive effort/speed curve for a two-speed Dual Fluidrive and a Paxman 'Hi-Dyne' engine, shown in Fig. 1, illustrates these points. It will be seen from the shape of the curve that tractive resistance curves will cut the tractive effort curve sharply, giving a well-defined balancing speed, and this leads to reliable and predictable train schedules.

Due to the constant horsepower characteristic of the engine, it is evident that the two speed ratios are equivalent in coverage to a three speed transmission with a conventional engine. Similarly, Dual Fluidrives with three or four speeds, with the 'Hi-Dyne' engine, are equivalent to conventional four-speed and five-speed transmissions respectively, without the disadvantage of "steps" between the ratios.

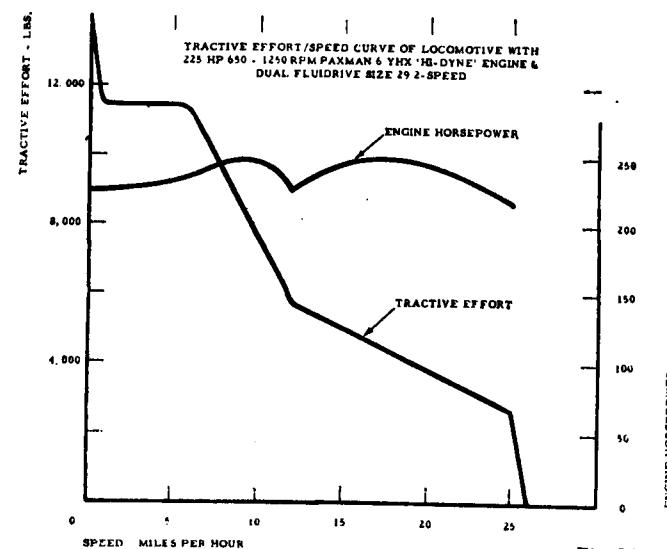


Fig. 1

CONSTRUCTION

The Dual Fluidrive SSS transmission incorporates two Vulcan-Sinclair fluid couplings and a change-speed gearbox built into a self-contained unit. For the sake of simplicity in description, the two-speed version will be taken. The basic layout is shown in Fig. 2, from which it will be seen that the two fluid couplings are connected to the low gear and high gear trains respectively. Changes between the two gear ratios are made simply by filling one of the fluid couplings with oil while the other is emptied.

Thus gear changes are made without interruption in the drive and the built-in control system determines automatically the point at which the changes take place.

FLUID COUPLINGS

The fluid couplings incorporated in this transmission are of the well-known Vulcan-Sinclair type. The main elements of each fluid coupling are an impeller, connected to the engine, and the runner which forms the output member, containing between them the "working circuit".

When the working circuit is filled with oil, power is transmitted from the impeller to the runner, through a rotating vortex of oil.

As will be seen from Fig. 2, the two impellers are both driven from the input shaft of the transmission. The runner in the left hand circuit is carried on a solid shaft which drives the low gear pinion, while the other runner is mounted on the hollow shaft which carries the high gear pinion. The two shafts are concentric.

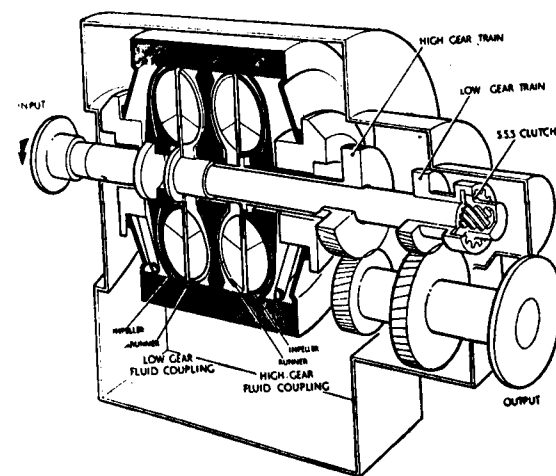


Fig. 2

It will be readily seen, therefore, that if the left hand circuit is filled with oil, the right hand one remaining empty, as shown in Fig. 3, the drive from the engine will be taken through the left hand circuit to the low gear train and the locomotive will be driven in low gear.

During acceleration of the locomotive, at a pre-determined speed, the oil is automatically transferred from the left hand working circuit into the right hand one. This results in the drive being transmitted to the high gear train and that in the low gear being discontinued. As this change in gear ratio is

effected by transfer of oil from one fluid coupling to the other, the drive is maintained throughout the gear change.

Likewise, the transition from high to low ratio is made by transferring the oil from the right hand circuit to the left hand one.

The fully automatic control effects the gear change at the appropriate locomotive speed and the point at which it takes place does not depend upon the driver's judgment.

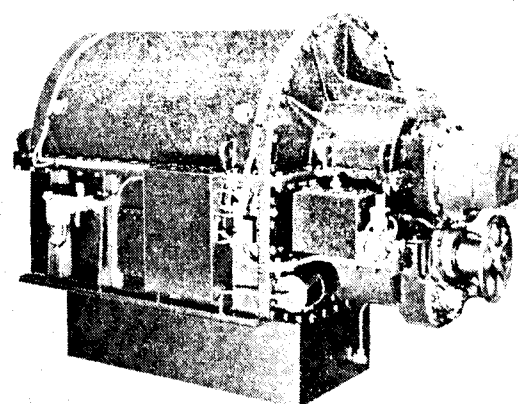


Fig. 3

Dual Fluidrive SSS locomotive transmission, size 29, with two speed gear, as installed in 22 Hudswell Clarke diesel/mechanical locomotives for Sierra Leone Government Railways.

When the oil is emptied from both circuits, the transmission will be in NEUTRAL (as shown in Fig. 2). In this condition, changes between forward and reverse can be made, when the locomotive is stationary, on the final drive gear which is interposed between the Dual Fluidrive transmission and the locomotive jack shaft.

BASIC OIL SYSTEM

Associated with each working circuit is a scoop tube which can slide in the stationary casing.

Also, each working circuit has a rotating oil reservoir and, in communication with the latter, a scoop chamber alongside the working circuit.

It will be seen that when the unit is running, the oil will form a rotating ring in each reservoir by the action

of centrifugal force, and the depth of oil in this ring can be governed by the position of the sliding scoop. To maintain circulation of oil through the circuits, an oil pump, driven from the input shaft, is provided. This pump feeds cool oil to the working circuits, displacing the warmer oil which is continually leaving the circuits through ports in the inner casing, and which passes into the rotating reservoirs and the scoop chambers, whence it returns to the sump.

The two scoop tubes, one in each scoop chamber, are connected by a cross-over pipe. The scoop tubes are operated by air cylinders, acting through a rack-and-pinion mechanism.

When the gear is in neutral, the two scoop tubes are positioned so that their tips are in line with the outside diameter of the working circuits, and excess oil entering the reservoirs from the oil circulation pump is trimmed off by the scoops and returned to the sump tank.

To establish the drive in first gear, the scoop operating in the left hand circuit is retracted towards the centre, while that for the right hand circuit is moved into the rotating ring of oil in the right hand reservoir. This oil is thereby transferred through the cross-over pipe, to the left hand working circuit and the drive is taken up in low gear.

For the transition from low to high gear, the left hand scoop is moved radially outwards and the right hand one retracted, to transfer the oil from the left hand working circuit into the right hand working circuit, whereupon the low gear drive will be disengaged and power will be transmitted in high gear without interruption of tractive effort.

TWO-SPEED GEAR

The two-speed gear is of simple construction, comprising two pairs of single helical, hardened and ground gears.

The high gear pinion is mounted on a hollow shaft carrying the runner and the high gear working circuit and this hollow shaft surrounds the solid shaft upon which is mounted the low gear runner.

The low gear pinion is not secured to its shaft, but can run freely about it.

When driving in low gear, power is transmitted from the shaft to the pinion through an SSS (synchro-

(Continued on page D.E.35)

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 over-haul 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.



"G1-O1" 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 Alapáyevsk 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

(Continued from page D.E.33)

self-shifting) clutch. When in high gear, this clutch automatically disengages so that the low gear runner is not driven at an excessive speed.

CONTROL SYSTEM

The driver's control is of the simplest description, as a single regulator controls the engine speed and, at the same time, the engagement of the Dual Fluidrive transmission. With the regulator set in its idling position, the Dual Fluidrive is in neutral and the engine is idling. The act of moving the control from this position causes the low gear circuit in the transmission to fill and then accelerates the engine. The locomotive will then move off in low gear.

As the locomotive accelerates the train, at a suitable speed the automatic control will effect the transition from low gear to high gear. Likewise, with falling speed, the change from high to low will be made automatically.

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.

The control system is operated by compressed air from the locomotive air system.

THREE AND FOUR-SPEED TRANSMISSIONS

For the sake of simplicity in explanation of the basic principles, the two-speed transmission only has been described above. As mentioned before, the Dual Fluidrive is available with three and four speeds. Selection between gear ratios is effected by means of SSS clutches, although the actual change of ratio, when required, is made by the transfer of oil from one fluid coupling to the other, as in the case of the two-speed version. The shape of the speed/tractive effort curve obtained with the combination of Dual Fluidrive and Paxman 'Hi-Dyne' engine makes this transmission as suitable for high power main line locomotives as for shunting locomotives.

The Dual Fluidrive SSS locomotive transmission is manufactured by Fluidrive Engineering Co., Ltd. of Isleworth, Middlesex, England, whose interests in India are handled by Greaves Cotton & Co., Ltd.

An Australian Design of Diesel-Hydraulic Locomotive

PERHAPS Australia does not come readily to mind as a country building diesel locomotives, but in fact some 490 have already been built there and their number is increasing each year.

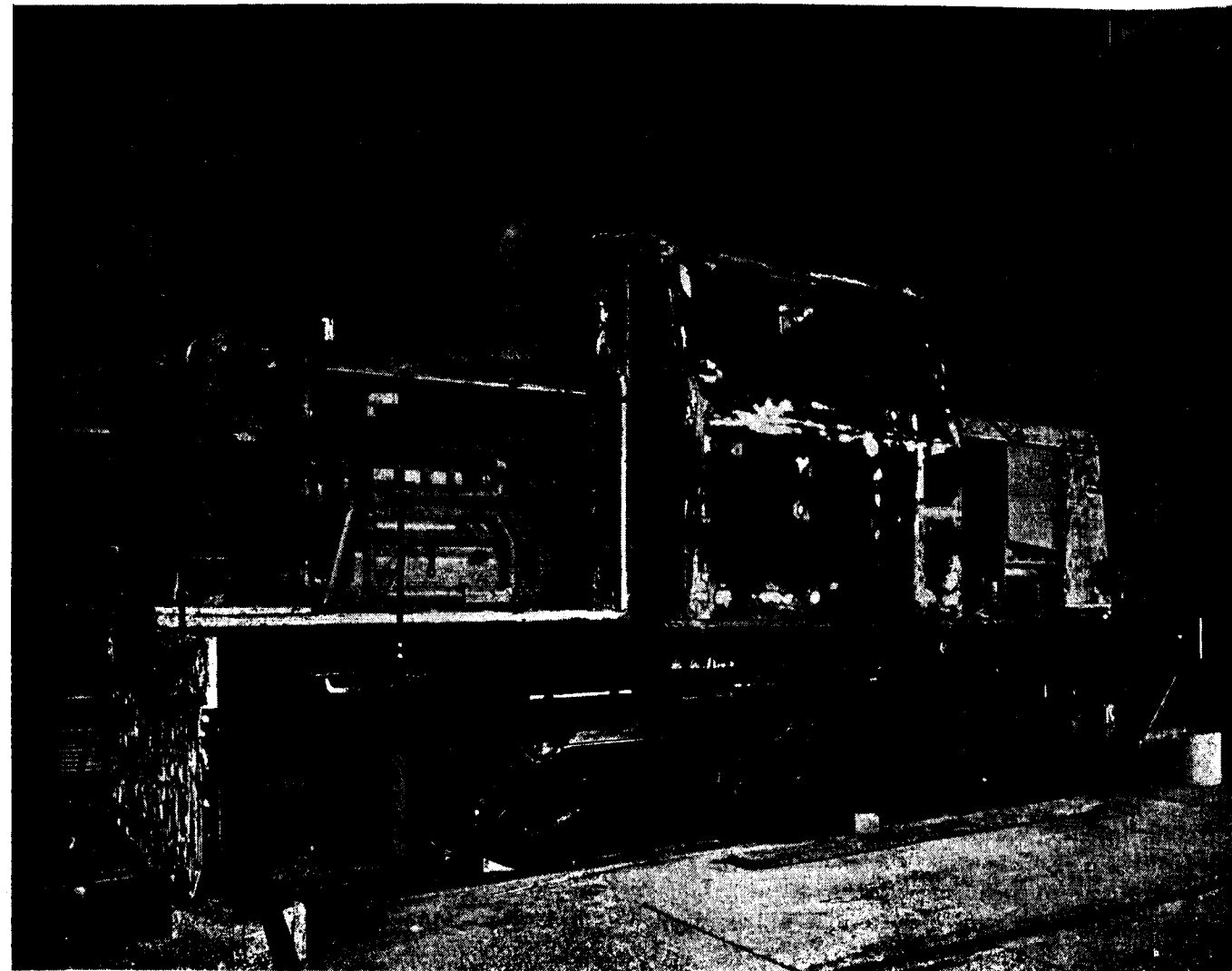
Because of climatic conditions ranging from tropical to sub-freezing, vast arid areas with their dustbowl conditions and the sparsely populated areas from whence come huge tonnages of her primary products, the diesel locomotive designed and built in Australia to meet the local conditions compares more than favourably with its counterpart built elsewhere in cost, service and demands for maintenance.

The railway Authorities in all the Commonwealth

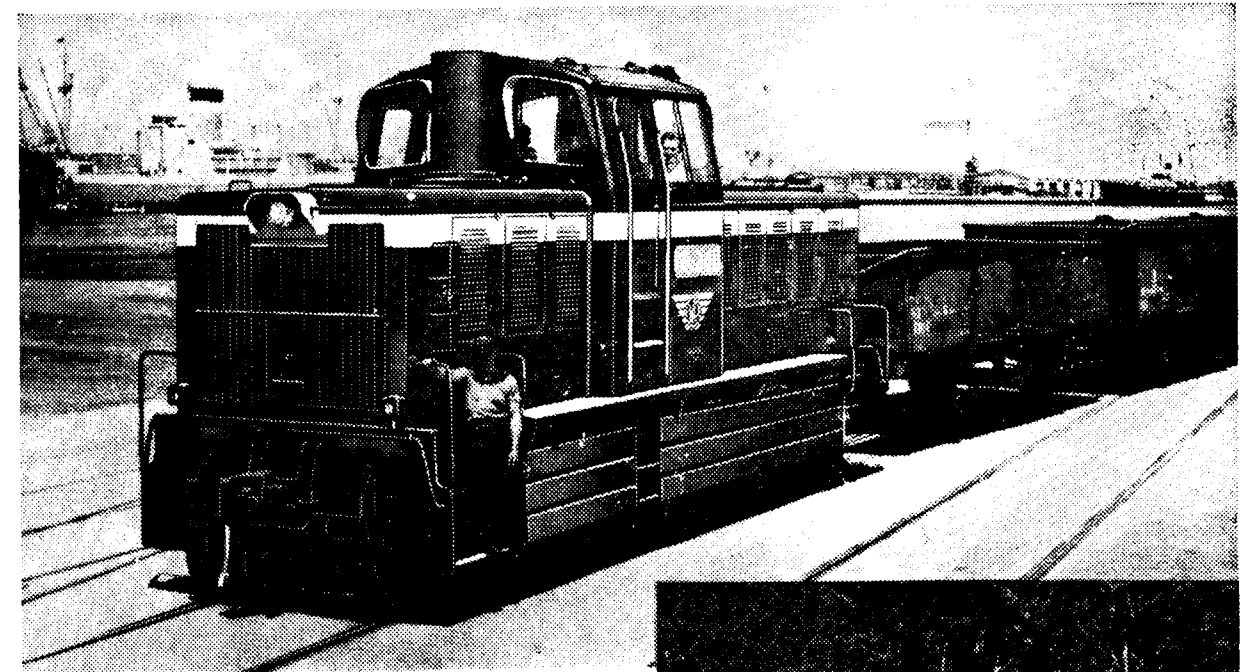
States are constantly showing their confidence in the Australian product as they replace their obsolescent equipment.

In general, the Australian built diesel locomotive, apart from the smallest units, is equipped with imported components for its power source and transmission system. The frame is designed and fabricated by the builder who often procures sub-assemblies such as wheel-sets, coupling rods and draft gear, made to his designs, from local works especially tooled for their manufacture.

Building of the locomotive takes place on assembly lines, provided with pit facilities and overhead crane service, and machine tools and workbenches located



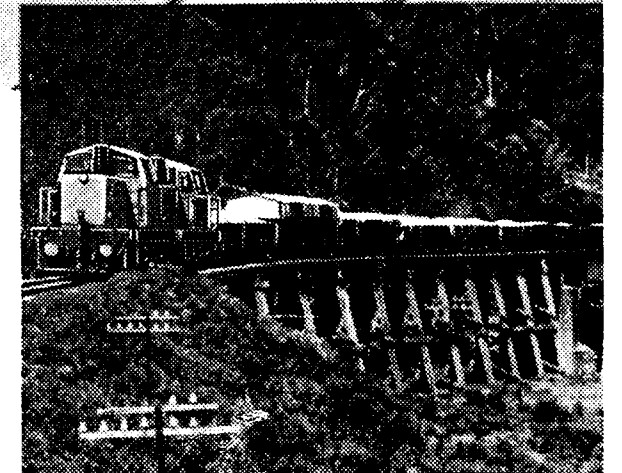
TULLOCH DIESEL-HYDRAULIC LOCOMOTIVES



Above: 700 H.P., 0-6-0 Tulloch-designed, Tulloch-built Diesel Hydraulic Locomotive for shunting and transfer work, one of an order of twenty-five for the Victorian Government Railways, Australia. The design incorporates 12 cylinder Mercedes-Benz diesel engine, Krupp hydraulic transmission and axle gear and Behr hydrostatic cooling plant.

At right: 350 H.P., 0-6-0 Tulloch-designed, Tulloch-built Diesel Hydraulic Locomotive for shunting and secondary line operations on the Tasmanian Government Railways, Australia. Power is supplied by a Rolls-Royce 8 cylinder turbo-charged diesel coupled to Krupp hydraulic transmission.

A feature of Tulloch design is roomy cab layout with extreme simplicity of controls.



TULLOCH
LOCOMOTIVE DIVISION *Limited*

CONCORD ROAD, RHODES
SYDNEY, AUSTRALIA

DESIGNERS AND BUILDERS OF DIESEL LOCOMOTIVES



alongside. Full use of portable power tools is made at all times.

In Australian railway working a particularly important role is played by locomotives in shunting duties at yards and sea terminals and in service on secondary lines operating through the back country. In both cases, dependability and economy together with easy handling and maintenance are pre-requisites for satisfactory performance. Well worthy of note in their successful satisfaction of all these sought after features are the diesel-hydraulic locomotives designed and built by Tulloch Ltd. at Rhodes, NSW.

By their well considered choice of components, Tulloch Ltd. has developed a class of diesel locomotive that, without shock, provides for both constant and stepless variations in power being available at the wheels from a single manual control.

These units are available in the 200—1,000 h. p. range (20—60 tons) with optional wheel arrangements of 0—4—0, 0—6—0 or B—B. The Tasmanian and the Victorian State Railways, between them, have already ordered 27 locomotives of the 0—6—0 type. The individual requirements of these two railway systems differ both in rail gauge and power output, but the basic design is unchanged on their account and has proved itself to be very satisfactory on both railways by the units already in service on each.

Tulloch Ltd.'s 0—6—0 locomotive takes the power from the diesel engine through a flexible coupling and cardan shaft to a Krupp Hydraulic two-speed transmission which delivers its output through a second cardan shaft to a combined "Bevel-Spur" gear on one axle shaft and the drive taken to the other wheels through side coupling rods.

Normally, Daimler-Benz engines are fitted. Their fine service records throughout the world are well-known, and being available in either six or twelve cylinder units, with or without superchargers, permit coverage of a wide range of output power with a substantial interchangeability of working parts between the differently rated engines.

The transmission comprises a variable blade torque converter, at all times filled with fluid, driven through a built-in step up gear from which the power flows through either of two constant mesh gear trains of different ratios to two final gear wheels turning freely and concentrically over the output shaft on independent roller bearings set in the transmission case. The final gear wheels include dogs on their inner hubs which can be engaged by a correspondingly dogged sliding sleeve splined to the output shaft of the transmission, to provide either forward or reverse movement. The change in direction is compressed-air

operated and protected against the shift being made unless the locomotive is at a standstill. A manual lock to the 'neutral' position allows haulage of a dead locomotive with security.

Noteworthy too, is the economy in fuel realized on light duties, because much of such work can be carried out with the engine idling and meeting the tractive demand by merely varying the torque converter blades.

In operation the choice of gear ratio will be decided automatically as a functional combination of roadspeed-load-engine output, so that effective control for working the locomotive is reduced to one lever.

The change in gear ratio is accomplished through two multiple plate clutches, hydraulically controlled both as to their engagement and application pressure, which without breaking the flow of power to the



driving wheels bring into use one or other of the gear trains, as required by the load. Usually the gear change is adjusted to occur at about one-half of the maximum road speed. No fluttering between the two ratios can occur, because the automatic change up to the higher gear ratio is made at a road speed greater than that bringing about the downward change.

By variation of the design and its internal lay-out, power may be transmitted to several final points of output, as in bogie arrangements, from a single source of power. For bogie drives, by the use of twin torque converters and individual gear trains within a single housing, power is taken to each bogie without any possibility of the transmission becoming 'wound up' by road curves or even by the wheelsets of one bogie differing appreciably in diameter from those of the other.

The axle gear is constituted by bevel and spur gears carried in a substantial housing from which extends a reaction arm anchored to the locomotive bogie frame through flexible bushings. Optional over-all gear ratios enable the designer to combine any load requirement with efficient utilization of power.

Radiator cooling for the engine and the heat exchanger for the transmission's fluid is set at one end of the locomotive. In the higher power range, the equipment includes a variable-speed fan operated by a thermostatically controlled hydraulic motor. The power absorbed by the fan is at all times only that necessary for the actual cooling needs, leaving additional power available for traction and the realisation of substantial economies in fuel.

All axles of the locomotive turn on roller bearings whose housings carry the weight of the unit through a compensated system of laminated springs. Axle box guides are fitted with replaceable manganese wearing plates on rigid frame cases. Coupling rods can either be plain or roller bearing.

Westinghouse air-brake equipment is fitted. Power to the compressor is taken from the engine either through "Vee" belts or a direct coupled reduction gear. Vacuum brake equipment is optionally fitted.

Other mechanical parts are of simple and robust design, and in accordance with well established locomotive practice.

The locomotive superstructure provides for a centrally located cab with steel housings fore and aft

protecting the engine and ancillary equipment against the elements. Large doors in the housings give easy access for servicing all equipment from surrounding walkways.

The cab, insulated against heat and noise, is fully glazed for clear vision all round, the side windows may be opened. Inside, a central panel groups the tell-tale instruments (Gauges, Thermometers, Tachometer and Warning Lights Etc.) at eye-level and a central desk carries the controls for accessory equipment (Electric starter, lighting etc.).

All driving controls are duplicated to either side of the cab for right or left hand working from comfortable seated positions.

For multiple operation one driver controls from one unit, without need for anybody to be aboard the other units. Each locomotive will, of itself, take its fair share of the load at all times.

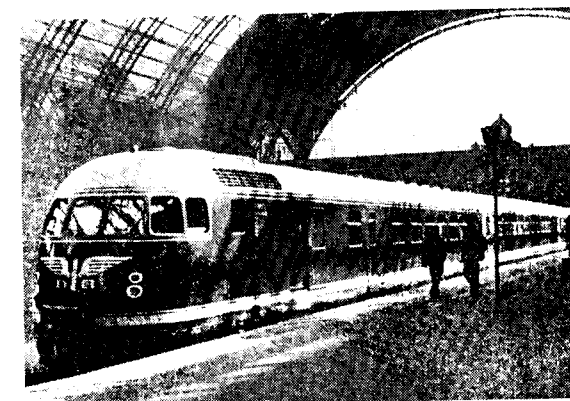
The principal characteristics are tabulated:—

	Tasmanian Rlys.	Victorian Rlys.
Locomotive weight	29 Tons	48 Tons
Wheel arrangement	0-6-0	0-6-0
Track gauge	3 ft. 6 ins.	5 ft. 3 ins.
Nominal power	330 HP.	650 HP.
Maximum speed	30 m. p. h.	40 m. p. h.
Minimum track curve, radius	150 ft.	200 ft.
Maximum Starting T. E. @ 30% adhesion	18,500 lbs.	32,250 lbs.
Continuous T. E. @ 5 m. p. h.	15,000 lbs.	29,200 lbs.
Engine Data :		
Maker	Rolls-Royce	Daimler-Benz
Model	C. 8. T. F. L.	MB 820 B
No. Cylinders & Arrangement	8 in line	12—60° V
Maximum Governed Speed	1800 rpm	1500 rpm
Transmission & Axle Gear Data :		
Maker	Krupp	Krupp
Transmission Type	2 W 1 L 1 15	2 W 1 D 46
Axle gear Type	KS-320	KS-620

MERCEDES-BENZ RAILWAY ENGINES

THE Mercedes-Benz Diesel engine model MB 820 Bb, of which more than 100 are in service in German Federal Railways TEE-trains, V 200 main line locomotives and the VY 08 long-distance railcars, has now been in operation for 8 years. It belongs to the power unit of those vehicles which, according to the yearly survey for 1959 published by the management of the German Railways have covered as long distance vehicles an average of 723 km = 450 miles per working day (diesel locomotive) or 973 km = 604 miles per day (diesel railcar).

At the beginning of 1960 an engine from a V 200 locomotive which had covered without a break and without any overhauling 609,481 km = 378,000 miles from the Summer of 1956 to December 1959, was used for thorough examination. The engine was checked for output and operating values on the Federal Railways test stand in Nurnberg. The results corresponded fairly accurately with those ascertained on the factory test stand at the time of delivery. When the engine had been stripped the wear on the most important parts (crankshaft, bearings, pistons) was so insignificant, that they could almost all be used again. The checking of the crankshaft as well as the main and connecting rod



Express coach of the German Federal Railroads with Mercedes-Benz Diesel engine type MB 820 with supercharger.

bearings showed only insignificant wear, and the breaking-in lead layer was still completely intact on all shells. The protective layer of aluminium plating on the cylinder linings was in perfect order. The inside of the liners at the zone of the upper ring in dead centre was clean and worn evenly 0.03 mm in

the driving direction and 0.042 mm in the transverse direction. In the middle the figures were 0.015 to 0.022 mm and underneath 0.008 to 0.013 mm.

The fuel consumption can be considerably lessened by building in an intercooler, and in this way the economy of the diesel drive can be increased. In Mozambique in Portuguese Africa, 5 Krauss-Maffei locomotives with Daimler-Benz engines of this model have been running for several years with the greatest success. In spite of the greater room needed for the cooling system the normal outer shape of the locomotive is in no way influenced and the most important requirement for rail service—a clear view ahead—is satisfactorily fulfilled.

Hitherto the fast-running Diesel engine was—in the minds of many people—still considered as a source of noise. It was for that reason that when it was re-introduced on the railways after the least war great importance was paid to silencing.

A strict request for further silencing was made with the mounting of the unblown Mercedes-Benz engine MA 820 B (600 HP, 1,500 rpm.) in the V 60 locomotive. For the silencer good use was made of the available room under the engine hood.

Measured under operating conditions :

full load 550 rpm = 69 DIN-phon
full load 1450 rpm = 87 DIN-phon
idling 550 rpm = 68 DIN-phon
idling 1550 rpm = 82 DIN-phon

Particularly worth mentioning are the rail vehicles which run for years day in day out as iron foundry locomotives with their heavy loads through fog and smoke, in very limited spaces. Every year they have to work even longer hours than the Diesel engines running in locomotives throughout the land or in the shunting yards, although these locomotive engines, the M 836 Bb (500 HP at 1,500 rpm) attain already operating times of over 20,000 hours before being completely overhauled for the first time.

In distant and tropical countries where the engines often only receive the most rudimentary maintenance service, the 6000 hour limit is always being reached or exceeded by 234 vehicles with Mercedes-Benz engines in service without overhauling for more than two years.

DAIMLER-BENZ ENGINE NOVELTIES 1960

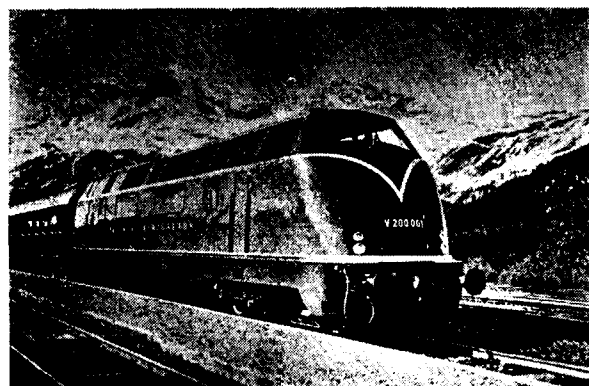
One big engine, as well as a water-cooled and an air-cooled series of middle-sized engines.

The Diesel engine program of the Daimler-Benz AG is indeed a broad one. In addition to a selection of models proved for many years and manufactured in large numbers, Daimler-Benz presents this year nine remarkable new designs, which again broaden its extensive range. A newcomer is the type MB 835, a big 12-cylinder Diesel engine; also new is the series of four water-cooled and four air-cooled engines MB 851 to 854, and MB 861 to 864, respectively, of the Berlin Marienfelde division, which embody for engines between 20 and 80 HP to the largest degree possible the system of interchangeable parts. With the new line Mercedes-Benz now offers an engine for practically any purpose.

One of the new engines is the
MB 835 Ab,

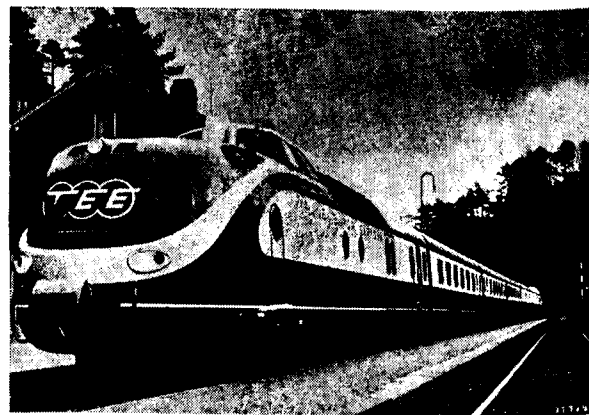
a 12-cylinder Diesel engine V-type, supercharged with 1450 HP at 1500 r. p. m. This new engine with normal charging is similar in bore (190 mm=7.48 ins.) and stroke (230 mm=9.055 ins.) to the MB 839. Here also the system of interchangeable parts is in the making.

In fact the engines MB 835 and MB 839 are similar in design. A large number of engine parts, such as pistons, connecting rods, cylinder liners, cylinder heads, valves, etc. are identical in the two engine



Diesel-powered locomotive of the German Federal Railways equipped with Mercedes-Benz engines, model MB 820, fitted with supercharger.

types. The crankcase of the new MB 835 engine consists of grey cast iron (upon request, light metal); to increase rigidity, the case goes up to the cylinder heads. The crankshaft bearing caps are each held by four clamping screws in the crankcase, with two of these screws serving as anchor bolts and extending up to crankcase top. The design of the new MB 835 engine incorporates all the experience gained



Mercedes-Benz Dieselmotor in V-Form.

throughout the many years of operation of the versatile and very successful MB 820 engine. The MB 839 Bb engine is provided with high pressure supercharger and intercooler, while the new MB 835 engine is equipped with a normal exhaust gas turbo charger, a type of engine mainly used in rail vehicles.

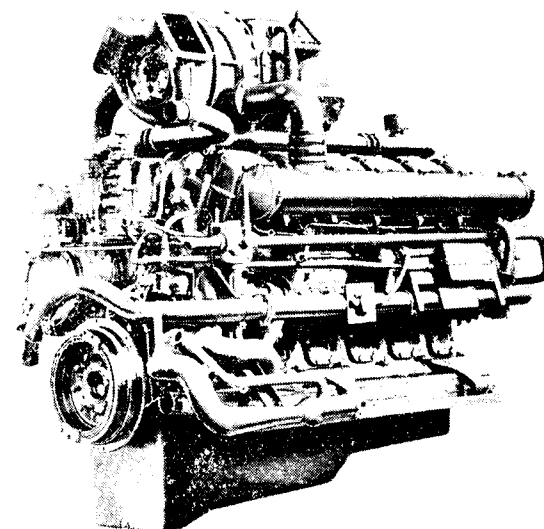
The continuous output B of the MB 835 engine is 1450 HP at 1500 r. p. m. In another version, this engine is designed as a straight aspirating engine, while still another version is equipped with high pressure supercharger and water-cooled charging air. In the latter type the continuous output B is 1800 HP at 1500 r. p. m.

Equipped with supercharger and water-cooled charging air the last named engine is mainly used to drive ships and fast boats. It is also used as a driving engine for emergency power units.

The other new engines manufactured by the Berlin-Marienfelde division of the Daimler-Benz AG are in the medium and low output field:

- MB 851—1-cylinder 20 HP at 2000 r. p. m. water-cooled
- MB 861—1-cylinder 20 HP at 2000 r. p. m. air-cooled
- MB 852—2-cylinder 40 HP at 2000 r. p. m. water-cooled
- MB 862—2-cylinder 40 HP at 2000 r. p. m. air-cooled
- MB 853—3-cylinder 60 HP at 2000 r. p. m. water-cooled
- MB 863—3-cylinder 60 HP at 2000 r. p. m. air-cooled
- MB 854—4-cylinder 80 HP at 2000 r. p. m. water-cooled
- MB 864—4-cylinder 80 HP at 2000 r. p. m. air-cooled

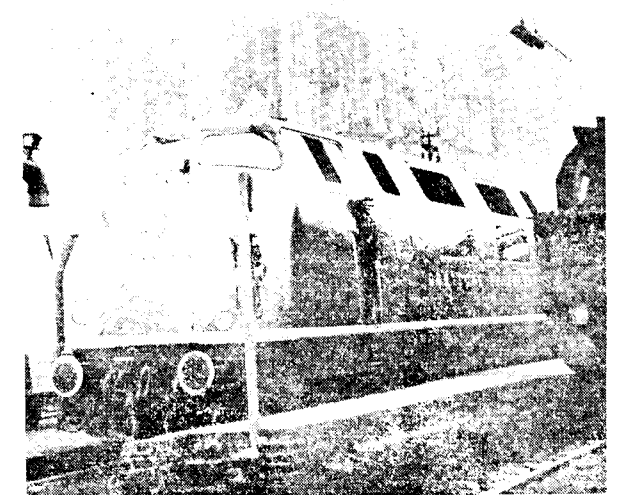
This new series embodies to the largest possible extent the interchangeable parts system. As a matter of fact in the water-cooled and in the air-cooled models, all parts of identical design are



Mercedes-Benz Diesel Type MB 835 Ab.

interchangeable. The Mercedes-Benz Diesel engine line built up to now is significantly supplemented by the new series. Used as stationary or as built-in types for a versatile number of purposes, these engines excel by their simplified and robust design which is easy to operate.

By the rigid tunnel casings, the good access and the practical arrangement of all operating elements and accessories, as well as by alternative power take-off at front or rear shaft end, these Diesel engines can be used for the most varied purposes.



F 404: Krauss-Maffei-Lokomotive V 200 001.

The relatively high revolutions give the new engines a wide range of applicability. For example the 2-cylinder Diesel engine of the new series, either water or air-cooled, provides at 1000 r. p. m. already 22 HP and at 1500 r. p. m. even 32 HP. The engine delivers its maximum torque already at 1000 r. p. m.

Air-cooling which in special cases is very efficient for built-in engines, has been developed thoroughly, and the engine designed in such a manner that thermal over-strain is impossible.

The multiple jet injection, which is particularly effective in combination with air-cooling, permits simplified and robust construction, completely in line with the often primitive operating conditions of these engines. Of particular interest is the fact that with the exception of the cylinders and the cylinder

Czechoslovak Electric Locomotives

THE lively development of railway electrification all over the world has influenced also the activity of the Czechoslovak Skoda Locomotive Works. This well-known locomotive works, which has built nearly 4000 locomotives since its foundation in 1920 stopped completely building steam locomotives a year ago and now devotes its attention exclusively to electric traction. The works has a long tradition also in this branch. The first electric locomotive left the works in 1928 and since that time, especially during the last ten years, several hundred locomotives of different types and sizes have been built at Plzen.

At present the production programme of this locomotive works includes almost exclusively heavy d. c. line-service locomotives and open cast mine locomotives. The Skoda series E 499.0 main line locomotives of 2344 kW one-hour rating weighing 80 tons are a particularly successful type. In the group of 3000 V d. c. locomotives they represent an example of the highest technique due to their specific weight, which is only 34.1 kg /kW. There are about 100 of these locomotives in service on the Czechoslovak State Railways. They have become the backbone of the electrification of the Czechoslovak State Railways, which is proceeding very quickly.

For further electrified sections of the Czechoslovak State Railways the Skoda Locomotive Works have started building an improved series E 499.1 locomotive. Its electrical part is identical to the electrical part of the E 499.0 series, but the mechanical part includes substantial changes resulting from the progress achieved in production technology and certain requirements of the railways, of which an increase of the axle pressure by one ton and an increase in resistance to the pressure of the frame are worth mentioning. Besides home deliveries a great number of these locomotives will be exported to the USSR, where two

experimental E 499.0 locomotives delivered in 1957 have proved their worth. At present tests of several prototypes of a six-axle locomotive derived from the four-axle locomotive are being carried out in Czechoslovakia and abroad.

Among open cast mine locomotives the 150 ton 1560 kW locomotive consisting of three sections, whose details are continuously being improved, is already a classical construction. Hundreds of these locomotives are already operating in Czechoslovakia, China and in different regions of the Soviet Union. Since 1957 there have been added to these locomotives smaller narrow gauge four-axle open cast mine bogie locomotives of 17 E type. Their weight is 64 tons, their one-hour rating being 520 kW. They have proved very well in difficult service in mines, which is best confirmed by a whole series of further orders.

Besides these main products the Skoda Locomotive Works supplies also different special electric locomotives, such as two-and four-axle storage battery shunting locomotives, small standard gauge 600 V trolley shunting locomotives, locomotives for coke works and line-service locomotives for electrified second class railways with low axle pressure.

The Research Department of the Skoda Locomotive Works is at present studying a number of other problems, especially those concerning the design of an a.c. locomotive, of an open cast mine locomotive of higher capacity and of the electrical part of an electrical multi-car set.

The Skoda Locomotive Works will continue to contribute its share to improvement of the operational economy of public and industrial railways.

FUEL ABSTRACTS AND CURRENT TITLES

The Institute of Fuel has recently launched a new publication entitled 'Fuel Abstract and Current Titles.' It provides a monthly summary of world literature on all technical and scientific aspects of fuel and power and is intended to aid all those who are engaged in research in Fuel Technology and to those who are concerned with the many technical application of fuel. The annual subscription for this monthly publication is £ 1/12s including index and postage. It can be obtained from the Institute of Fuel, 18, Devonshire Street, Portland Place, London W.1. A specimen copy of 'Fuel Abstracts and Current Titles' is available for perusal in the British Information Services Reading Room at Mercantile Bank Building, Mahatma Gandhi Road, Bombay-1.

heads both the water-cooled and the air-cooled engines have identical parts. This simplifies very much spare parts storage for these new series.

With these new engines the Mercedes-Benz Diesel engine program has now an even more extended field of application. The engines are designed for any operation requiring reliable, mobile or stationary



Mercedes-Benz-Diesel type M 204 B.

power plants, such as engines for small locomotives, street rollers, cranes, dredgers, boats, pumps and supercharged Diesel generator units.

Besides the before-mentioned new models, at this year's German Technical Fair at Hanover also the following already known Daimler-Benz engines are shown:

MB 839 Bb 16-cylinder Diesel engine, V-type, super-charged, with compressor inter-cooling, ZF reduction and reversing gear BW 1400 2400 HP at 1500 r. p. m.

MB 820 Db 12-cylinder Diesel engine, V-type, super-charged, with compressor inter-cooling, Renk reduction and reversing gear 1350 HP at 1500 r. p. m.

MB 837 Aa 8-cylinder Diesel engine, V-type, charged 530 HP at 2000 r. p. m.

MB 846 Ab 6-cylinder, water-cooled, for fishing boat equipment 290 HP at 1200 r. p. m.

M 204 B 4-cylinder, water-cooled boat Diesel engine, for fishing vessels 120 HP at 1200 r. p. m.

OM 326 6-cylinder, water-cooled marine Diesel engine, with ZF reduction and reversing gear 155 HP at 1800 r.p.m.

OM 636 4-cylinder, water cooled built-in engine 35 HP at 3000 r. p. m.

Performance characteristics of all engines named above refer to continuous output B, according to DIN 6270 (German Industrial Standard).

The MB 837 engine, an already well-known model, will also be shown this year at Hanover, because of its unique position in engine design. Extremely compact, it offers at minimum size and extremely low weight a most outstanding max. output. Its space requirements of only 1.45 cubic meter (1270 × 1050 × 1105 mm) or approx. 51 cu. ft. are so low that the engine is ideal for application wherever vehicles or vessels are expected to deliver a high output, with only little space available to install the engine.

Much care was taken to keep engine weight as low as possible. At the special performance of type MB 837 Aa of 600 HP at 2200 r. p. m. (exclusive fan input), when used in vehicles, the engine weighs 2860 lbs. or a power to weight ratio of only 2.11 kg/HP (4.56 lbs./HP).

Because of their high speeds, in part up to 2200 r. p. m., all large Mercedes-Benz engines have a both wide and universal field of application.

THE DELTIC STORY

By An Engineering Correspondent

THE railways of Great Britain have always prided themselves that their type rolling stock is considered the finest in the World from a general efficiency point of view, and constant research has always been the aim of the Commission to maintain the high standard in travel that is demanded by the public.

Modernisation is a hard task master to serve and in order to achieve the ultimate object in view drastic steps may have to be taken.

As we well know the diesel engine has now been a keen competitor of the steam engine and its efficiency has been proved to be so very much greater than even the modern steam turbine taking weight for weight. It is, therefore, not surprising to find that the railway engineers have looked to the makers of diesel engines to supply the answer to the modern need for high power and efficiency and lower weight.

From a survey of diesel engines available the British Railways Commission selected the Napier Deltic diesel locomotive engine as one of the types most suitable for long distance and speedy travel for general use on the various regions.

The English Electric Co. Ltd., were asked to tender for rolling stock requirements for British Railways and they received the contract to build 22 locomotives powered with the Napier deltic engine.

D. Napier & Son Limited is a member of the English Electric Group and are the manufacturers of the famous Deltic engine. English Electric Co., D. Napier & Son and the Vulcan Foundry who is also a member of the Group got down to designing a locomotive that has won itself the highest praise in railway history.

Some interesting facts emerge from the private venture of the English Electric Co. Ltd., in the designing and building of the Deltic prototype for British Railways; due to high rate of utilization of diesel/electric locomotives, these can be operated 24 hours every day and one particular type is at present operating over 22 hours out of 24. Another point is that these Deltics will perform the same duties that formally required the use of 50 steam locomotives.

Another advantage of the diesel/electric locomotive is the greater rate of acceleration, a fact that is

always in the engineers mind, since it makes for better time keeping, and this is possible only because the diesel/electric gives full horse-power throughout its speed range, whereas the steam locomotive does not.

The tractive efficiency of the steam locomotive is low—somewhere between six and eight per cent, except under skillful firing conditions when the average is slightly increased. These figures when compared with the efficiency of the Deltic, which has been defined as 27.5 per cent shows without doubt the great advantage gained on the use of diesel/electric traction.

Further the working conditions are much cleaner and the strain on the driver is far less than working under steam.

The Deltic locomotive with its two 18 cylinder engines develops a total of 3,300 h. p. making it the most powerful single unit of its class in the world, designed for a maximum service speed of 105 m. p. h. which has won for itself the enviable reputation of regularity and time keeping.

Coming on to the smaller type of diesel/electric locomotive ordered from English Electric Co. Ltd., by British Railways, these have the same fine characteristics of their big sister. These are the T9-29 type Napier Deltic 9 cylinder, rated at 1,100 b. h. p. at 1,600 r. p. m. designed for short distance passenger train working and is the first traction application of the nine cylinder, two-stroke opposed piston, pressure charged unit.

There is no doubt that the use of the diesel engine with its various applications to railway traction has come to stay and throughout the World the progress has been clearly marked by the various types, each suitable to the varying conditions of the country, now in operation on the railway systems of the World.

Many people, both young and old everywhere are keenly interested in railway engines, will feel a little sad at the thought that the steam locomotive, with its graceful lines and spectacular sense of power is passing and that a new era is quietly taking its place, will soon acknowledge the new line and graceful statistics of the diesel/electric successor.

Well done burra-mem-sahib for your long and wonderful service and success and good fortune to the new mem-sahib and what a mem-sahib!!

Supercharged power
at 90 miles per hour

Napier MS 200 exhaust-driven turbo-blowers are fitted to the two N.B.L./M.A.N. L12V 18/21 S 1,000 b.h.p. at 1,500 r.p.m. power units of the British Railways D600 diesel-hydraulic locomotives. Napier Turbo-blowers are found in marine, industrial and rail-traction applications throughout the world—and every Turbo-blower is backed by a world-wide service organisation. Napier Turbo-blowers improve diesel power, performance, efficiency and fuel consumption.

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The Diesel Locomotive with Electric and Hydraulic Power Transmission

ALMOST without exception, present day rail traction is dominated by the electric and the diesel locomotive. While the electric and the diesel locomotive made its appearance as early as the beginning of this century to an ever increasing extent, the diesel locomotive has advanced rapidly to the foreground especially during the last two decades. The advantages offered by the diesel locomotive in respect of operational and economical application led to the fact, that the change-over to diesel traction is taking place in almost every country of the world with great rapidity.

With the diesel locomotive, the main interest is, first of all, directed naturally enough to the characteristic part of the vehicle, namely the diesel engine. The development of the diesel engine with its various types of design for use as a prime mover in diesel locomotives has meanwhile reached such a high standard that the question of the suitability of the respective type of design is scarcely of basic importance.

Greater importance should be attached to the transmission of power from the diesel engine to the drive wheels of the locomotive as it must adapt itself to the traction requirements. The main interest is chiefly centered upon electric and hydraulic power transmission both of which conform to the requirements of railway operations. When selecting, the respective requirements of operation are decisive. It then becomes apparent, that either one or the other type of power transmission may be the more suitable for certain operational requirements. To fulfill the many-sided requirements of railway operation which differ in every country of the world, a selection concerning the type of power transmission is desirable and necessary.

Henschel supplies diesel locomotives with electric as well as hydraulic power transmission for all power ranges and normal track gauges. Naturally, diesel locomotives equipped with mechanical power transmission can also be supplied where smaller outputs are concerned which can be handled by this type of power transmission without excessive expense and complications.

With its modern type designs, Henschel takes an important part in the development and the building of

diesel locomotives. The following illustrated and briefly described locomotives show a small section of the Henschel supply range.

1. DIESEL ELECTRIC LOCOMOTIVES

Fig. 1 shows the most powerful diesel electric locomotive of its period in the world which Henschel built for the Rumanian State Railways in 1938. This

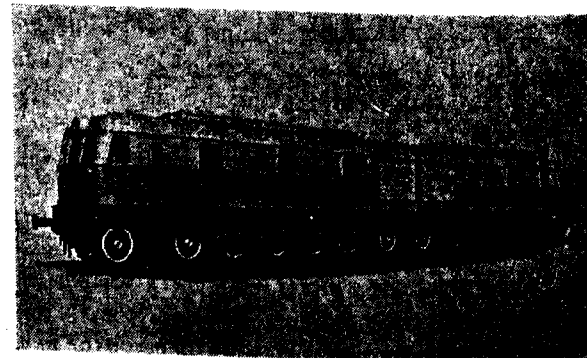


Fig. 1.

4,400 h. p. double-unit locomotive with a service weight of 115 tons with 2'D₀ 1'—1'D₀ 2' axle arrangement is a rigid frame locomotive of welded design and was built in co-operation with Gebr. Sulzer A. G., Winterthur, and BBC, Baden/Switzerland. Even today, this locomotive is in operation on mountainous railway service hauling heavy express trains.

By virtue of a license agreement concluded in 1954 with General Motors (GM), a diesel engine and a electric power transmission is available to Henschel for the building of diesel electric locomotives which are known all over the world and have excellently proved themselves to a total of more than 17,000 units.

Basically, the GM diesel engines of various output are similar and differ only in the number of cylinders. Except for the number of cylinders associated with each crankshaft, all parts subject to wear are interchangeable.

With the electrical equipment, only two different types of generators and one traction motor are provided for the entire power range of from 600 to 2,000 h. p.

HENSCHEL



10 HENSCHEL DIESEL SHUNTERS

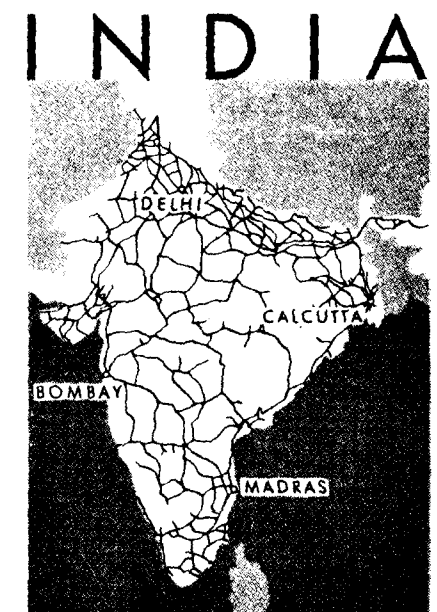
440 HP · 6-wheeler · 5'6" gauge ·

45 ts · 33000 lbs starting tractive effort,

arriving in India, destined for BOMBAY PORT TRUST

Wherever Railways, Port Authorities and Industry rationalize their transport systems, replacing steam by modern Diesel power, the Henschel Diesel Shunting Locomotives pay for the investment through high availability and easy, low-cost maintenance and operation.

HENSCHEL standardized Diesel Hydraulic Shunters range from 120 HP to 1000 HP, narrow to broad gauge, and suit all service requirements



HENSCHEL-WERKE GMBH KASSEL GERMANY

For track gauges under 1,435 mm the traction motor varies. Thus, standardization has been accomplished to a great extent. The resulting advantages are of great importance when considering spare parts.

For the mechanical part of the locomotive, Henschel-Werke have developed their own design in order to comply, as far as possible, with the special requests of their customers.

Henschel GM general-purpose design locomotives with an output of 1,425 h. p. have been in service for many years with the Staatsmijnen Limburg/Netherlands (State Mines) on a continuous 24-hour around-the-clock operation (Fig. 2). Noteworthy on this loco-

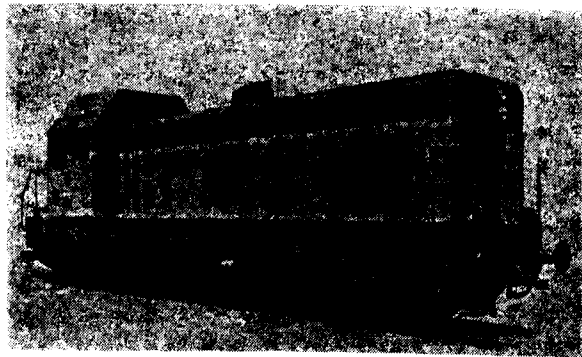


Fig. 2. Diesel electric Bo'Bo' locomotive model Henschel-General Motors, type G 12, for the Staatsmijnen Limburg/Holland, to pull heavy coal trains from colliery to harbour.

Gauge	1 435 mm
Service weight	74 000 kg
Output	1 425 HP
Max. speed	100 km/h

motive is the driver's cab with large windows offering a good view of the track, being adapted to the special operating conditions.

Since 1957, 13 heavy diesel-electric Henschel-GM locomotives type KK 16 have been in service with the Egyptian Railways (ER). On this stream-line locomotive with a driver's cab at either end and with an output of 1,900 h.p., the engine unit was sub-divided on special request into two separate and independent units of 950 h.p. each. With a permissible axleload of 22 tons, sufficient weight was available, so that the additional weight resulting from the sub-division was acceptable.

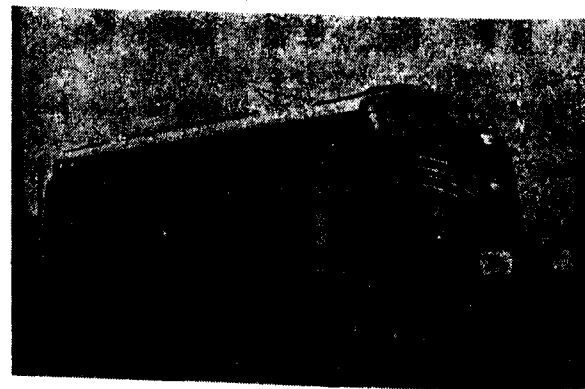


Fig. 3. Diesel electric A1A-A1A locomotive, model Henschel-General Motors, type KK, for the Egyptian Railways, to pull heavy ore trains in the Nile valley.

Gauge	1 435 mm
Service weight	132 000 kg
Output	1 900 HP
Max. speed	105 km/h

At the present time, Henschel-Werke have a repeat order from the Egyptian Railways for a further 108 diesel-electric locomotives. Out of this number, 70 locomotives are of type AA 12 with 1,425 h. p. and Bo'Bo' axle arrangement, and 38 are of type AA 16 with 1,950 h. p. and A1A-A1A axle arrangement (Fig. 4). These locomotives are now being delivered. They differ from the type KK 16 in that they are equipped with only one engine unit.

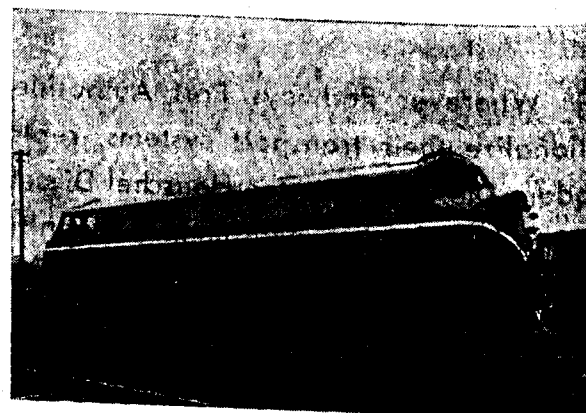


Fig. 4. Diesel electric A1A-A1A locomotive, model Henschel-General Motors, type AA 16, for the Egyptian Railways.

Gauge	1 435 mm
Service weight	115 000 kg
Output	1 950 h.p.
Max. speed	120 km/h

The 18 diesel-electric Henschel-GM locomotives of type TT 12 with 1,425 h. p. and Co' Co' axle arrangement for the Ghana Railways are of a new design for tropical service, which is a combination of the stream-line and general purpose design. A spacious driver's cab is located at either end of the locomotive with a hood extending over the entire profile width. The central engine compartment is narrow and kept to the minimum dimensions required by the engine unit. Thus, the maintenance walkways are external and covered by the roof which extends over the entire width of the locomotive. Inspection of the power unit as well as maintenance and repair work can, as it were, be carried out in the open air. The personnel are protected against sun and rain by the roof overhang so that all work can be properly carried out. Numerous doors in the side walls of the engine compartment enable easy access to all parts of the engine unit and facilitate the dismantling and mounting of components requiring repair. The roof overhang at the same time offers protection against rain for the air-intake slits located in the side walls. With inside walkways, sun radiation as well as heat dissipation of the driving engine not yet cooled-off would complicate work in the engine compartment. As for the rest, this tropical design, which has already proved itself and gained recognition can also be applied with equal success to streamline locomotives of other operational methods (Fig. 5).

A further diesel-electric Henschel-GM locomotive of special design is the 1,425 h.p. Bo'Bo' locomotive

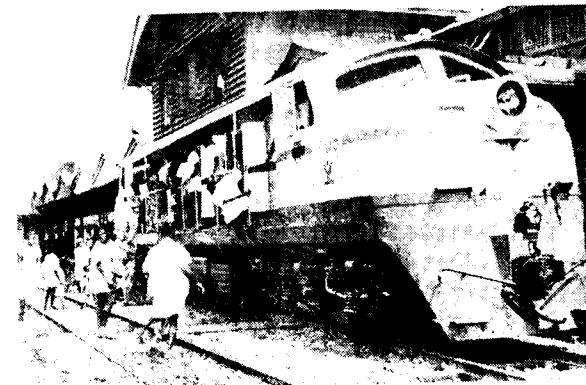


Fig. 5. Diesel electric Co'Co' locomotive, model Henschel-General Motors, type TT 12 as tropic-design of the most modern type for the Ghana Railways.

Gauge	1 067 mm
Service weight	83 000 kg
Output	1 425 HP
Max. speed	100 km/h

of type J 12 for the Österreichische Bundesbahnen (Austrian Federal Railways) (Fig. 6). At request of the Austrian Federal Railways, the outer shape of the locomotive was adapted to their latest electric locomotives.

All diesel-electric Henschel-GM locomotives are equipped with GM engines of type 567 C with 8, 12 or 16 cylinders, the output of which corresponds to 950, 1,425 and 1,950 h. p. respectively. The main generators designed as direct-current engines are rigidly coupled to the diesel engines. Starting of the diesel

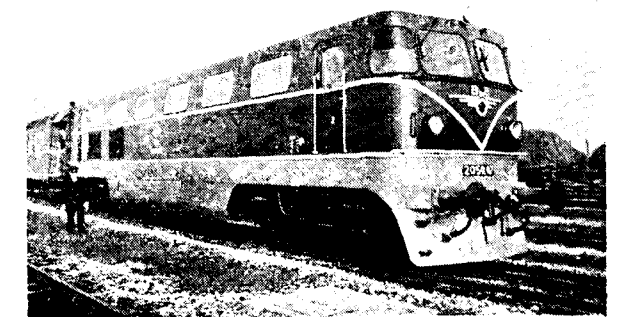


Fig. 6. Diesel-electric Bo'Bo' Locomotive, Henschel-General Motors design, Type J 12 for the Austrian Federal Railway.

Gauge	1435 mm
Weight in running order	72 000 kg
Output	1425 HP
Max. speed	100 km/h

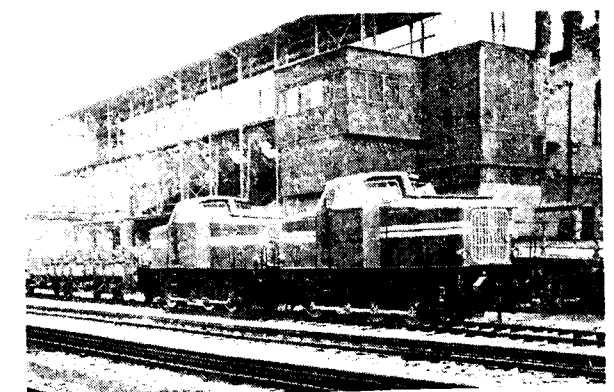


Fig. 7. DH 360 with double control

Gauge	1435 mm
Weight in running order	42 000 kg
Output	360/390 HP
Max. speed in shunting	30 km/h
„ in line service	60 km/h

engines is by the main generators which have been provided for this purpose with a special current winding. Underframe and superstructure are of welded steel construction. On the streamline locomotives as shown on Figs. 3, 4 and 6, underframe and superstructure have been welded together to a common supporting structure.

The bogies are of welded steel design of the well-proved box-type and flexicoil design. Diesel-electric Henschel-GM locomotives can be supplied with outputs up to 4,000 h. p. All locomotives may, without difficulty, be operated by multiple-unit control. Provision is made for the installation of an electric train resistance brake on all locomotives.

II. DIESEL-HYDRAULIC LOCOMOTIVES

For many years, Henschel has been active with the development of the design and the building of diesel-

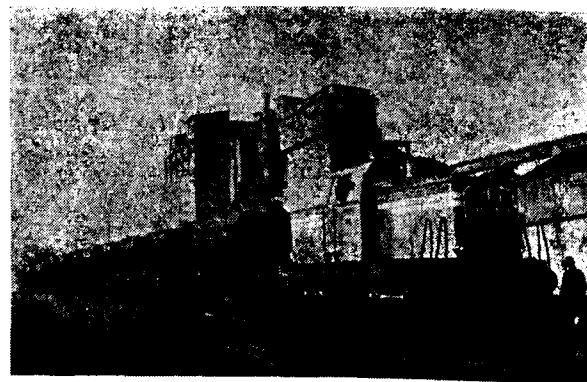


Fig. 8. Diesel hydraulic 0—8—0 locomotive with Beugnot type levers, type 650, for the Marburger Kreisbahn

Gauge	1 435 mm
Service weight	60 000 kg
Output	650 HP
Max. speed in shunting	30 km/h
„ in line service	60 km/h

hydraulic locomotives. During the course of time — and especially during recent decades — based upon the experience gained on practical operation, certain power classes of diesel-hydraulic locomotives have taken shape which range between approx. 100 and 2,200 h.p. Arising from this development, Henschel instituted a standard program for diesel-hydraulic locomotives by utilizing the building-block system. The power range can thus be met with two engine types and three

transmission types. The locomotive frame, driver's cab and superstructure, control equipment, wheel sets, axle bearings and their guides, suspension springs, brake equipment and rigging, rods and cardan shaft

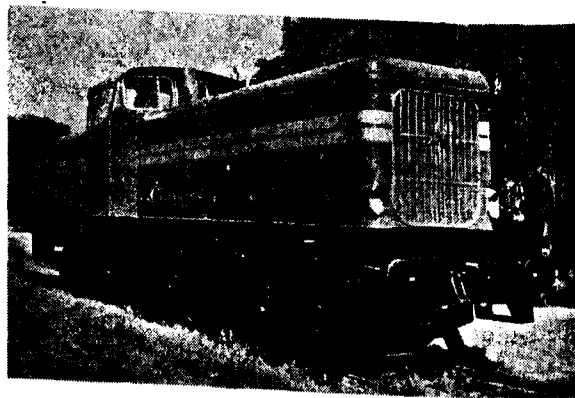


Fig. 9. Diesel-hydraulic BB bogie locomotive type DH 630 for "Hadir"

Differdingen -Luxemburg	
Gauge	1435 mm
Service weight	64 000 kg
Output	630 HP
Max. speed	35 km/h



Fig. 10. Diesel hydraulic BB bogie locomotive for the South African Railways (SAR)

Gauge	1 067 mm
Service weight	75 000 kg
Output	1 420 HP
Max. speed	90 km/h

drives as well as radiators and fan drives are widely interchangeable. Generally, the building-block system is usually only applicable within the power groups up to approx. 850 h.p.

On locomotives with more power, special Railway Administration conditions have in most cases to be taken into consideration, so that in these cases this

system can only be applied to a limited extent. Most large Railway Association such as the Deutsche Bundesbahn (German Federal Railways) have on the whole developed their own design program within the above mentioned output limits.

For example, Fig. 7 shows two locomotives with double-unit control of the three-axle type DH 360, which is utilized in large numbers at home and abroad as a light shunting locomotive.

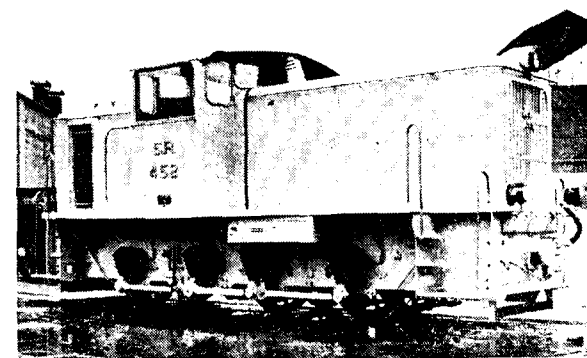


Fig. 11. Diesel-hydraulic 0—6—0 locomotive for the Sudan Railways.

Gauge	1 067 mm
Service weight	47 000 kg
Max. speed in shunting	32 km/h
in travelling	68 km/h

The same design, however with an output of 440 h. p. has been supplied in large numbers to the Railways of the Bombay Port Trust and the Steel Works Bhilai-Steel, India, to the Iranian State Railways, and to the Danish State Railways. The same design, however, with outputs of 500 and 700 h. p. has already found wider acceptance than the types DH 500 and DH 700. Fig. 8 shows the four-axle type DH 650/850 with an output of 650 h. p. and 850 h. p. respectively, with Beugnot type bogies.

The four-axle type DH 650/850 with an output of 650 and 850 h. p. respectively, however, of bogie type design and with cardan shaft drive, is shown on Fig. 9.

Fig. 10 shows the 1,420 h. p. diesel-hydraulic bogie-type locomotive for the South African Railways (SAR).

It has two independent engine units with GM diesel engines of 710 h. p. each.

Further special designs are shown on Fig. 11, one three-axle diesel-hydraulic locomotive with an output of 365 h. p. for the Sudan Railways, and on Fig. 12, one ICI diesel-hydraulic locomotive with an output of 400 h.p. for the Thailand State Railways.

This rather brief review, due to the limited space, concerning the participation of Henschel in the development of locomotives for modern rail traction may be concluded with the mention of a diesel-hydraulic

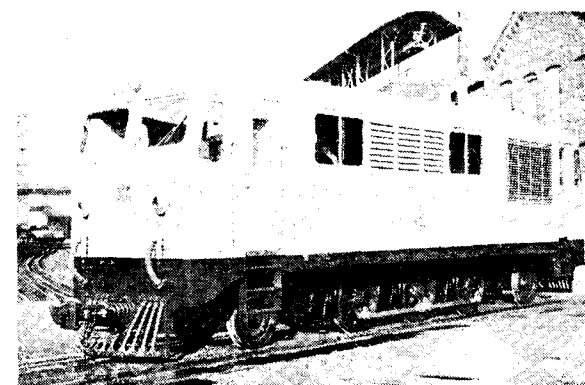


Fig. 12. Diesel hydraulic 2—6—2 locomotive in steel light-construction for the Thailand State Railways (Meklong line)

Gauge	1 000 mm
Service weight	33 400 kg
Output	400 HP
Max. speed	55 km/h

locomotive which is under construction, having an output of approx. 4,000 h.p. Up-to-date, this output is the highest being installed per unit in diesel-hydraulic locomotives. This locomotive will be equipped with two three-axle bogies onto which the output of 4,000 h.p. is transmitted by two independent engine units. The service weight of the locomotive is approximately 120 tons, the operating speed is 160 km/h, and the permissible top speed 175 km/h. Development of this locomotive is in close co-operation with the Deutsche Bundesbahn (German Federal Railways) utilising all scientific knowledge available and Henschel's decades of experience in the building of locomotives.

The Building of Diesel Locomotives in Czechoslovakia

By A Correspondent

THE revolution in railway traction actually taking place at present has resulted practically in complete stopping of the building of steam locomotives throughout the world. Though five years ago, except in the USA and Canada, steam locomotives were built almost exclusively, it seems to-day that steam traction will disappear in about twenty-five to thirty years' time, i.e. when the service life of the last steam locomotives built expires.

All steam locomotives in operation will have to be replaced by diesel locomotives—except on electrified lines—and the diesel locomotives will have to cope also with the increase in transport requirements.

The building of locomotives in Czechoslovakia proceeds in harmony with this world-wide development. The oldest Czechoslovak locomotive works has been occupied with diesel traction for thirty years already. Originally it built different types of railcars and small diesel locomotives. After the last war it started to build also heavy shunters and lately also main line diesel locomotives. In 1958 nearly 200 diesel locomotives of different types left the works.

The rich tradition in diesel traction enables the ČKD Works to fulfil the complicated tasks with which it is confronted by its customers. In serial production they have built and are building diesel electric 750 h. p. shunting locomotives, narrow gauge line-service 350 h. p. locomotives and 150 h. p. mechanical-transmission industrial locomotives.

The 750 h. p. locomotive of the T 435.0 series is supplied with a weight of 60 or 65 tons for a standard or broad gauge. It has proved successful at home and in the Soviet Union and its production will be gradually increased. The ČKD heavy low revolutions railway diesel engine is particularly suited for heavy shunting.

The T 47.0 narrow-gauge diesel-electric line locomotive is designed for service on lines of 750 or 762 mm

gauge with low axle pressures, heavy grades and frequent curves of small radii. To eliminate the necessity of guard's van it has a guard's compartment with a space for luggage. Large deliveries of these locomotives have been effected to climatically widely differing parts of the USSR, a small number being in operation in Czechoslovakia.

The type BN 150 is being built in large series. The firm of Strojexport has exported a large number of these locomotives to Germany, China, Poland, Soviet Union, Albania, UAR and Bulgaria.

In March of 1959 long duration trials of series T 698.0 diesel-electric locomotive were begun. This main line locomotive of modern design attains speeds 120 km/h as an express train locomotive and 80 km/h as a goods train locomotive. Though it was put into service only a short time ago, a more powerful variant of 2000 h.p. is already being prepared.

The BN 150 H type of 150 h.p. and the T 306.0 type of 400 h.p. locomotives with hydraulic transmission are undergoing long duration trials. The trials of both types have given quite satisfactory results. A prototype of the T 324.0 diesel locomotive is being completed. This is a locomotive with a driving set identical to that of the T 306.0 locomotive, but with a higher speed and cardan shaft drive instead of coupling rod drive, so that it can be used not only for shunting, but also for local railway service. In 1959 prototypes of the T 444.0 diesel-hydraulic locomotives of 700 h.p. for express trains on secondary lines and the T 499.0 of 1300 h.p. for heavy shunting will be completed.

By systematic development the ČKD locomotive works are securing for the near future a wide production programme which will correspond not only with their wide assortment, but also with the quality of their products to the contemporary technical development of railway transport throughout the world.

Water Coolers for Internal Combustion Engines

By An Engineering Correspondent

A water cooler for an internal combustion engine should efficiently dissipate the heat from the cylinder jacket, whilst at the same time its weight should be as small as is consistent with good design, it should occupy the minimum space, and the power necessary for the fan and water circulating pump should be low. Finned tubing is eminently satisfactory for this type of equipment for it is reliable, possesses the requisite strength, and the heat transfer properties are good. It is particularly suitable for large scale installations, and where a robust design is required to withstand rough usage or vibration.

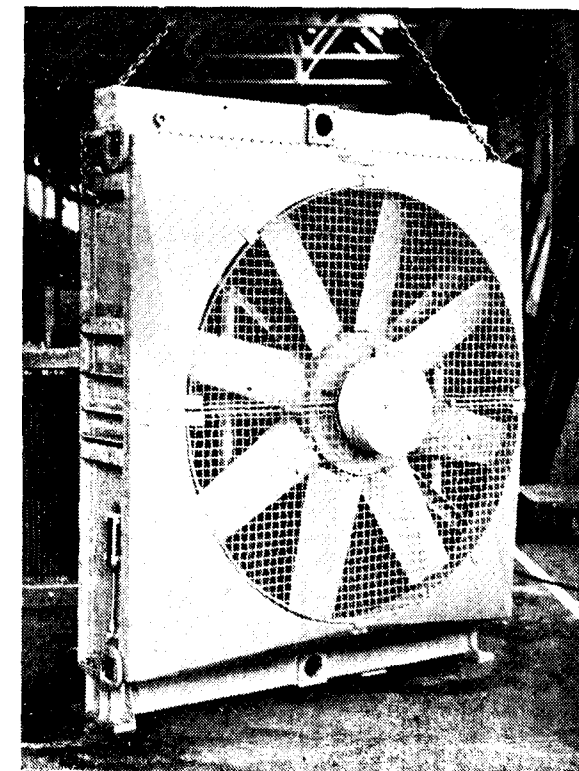
The purpose of the cooler is to lower the temperature of the water to a point which is considered to be a maximum temperature for the engine. The cooler is therefore designed to limit the engine outlet water temperature to this desired level under the warmest ambient air conditions which may be experienced on site. Cold weather, or conditions of light load, might result in over-cooling but this is countered by restricting the air quantity by means of shutters, or by providing thermostatic control of the water circulation.

Whereas the units previously discussed have air heating as their major function, in the cases of engine coolers the hot air is a by-product (although in many instances the hot air from stationary engines is used for space heating). As the air is primarily responsible for the removal of the heat, the installation should be so arranged that there is an unobstructed passage for the cooling air and free dissipation of the hot air leaving the cooler.

It is convenient to express the heat to be dissipated in terms of B. t. u. / (BHP) (hr) and this value depends on the type of engine and the conditions of the load, which may be continuous or intermittent. If the engine is not developing its maximum brake horse power continuously an estimate of the average power developed must be made and the size of the cooler may then be based on this estimate. Thus, for main line traction 85% to 90% of the continuous full load may be taken whilst for cranes, excavators or shunting locomotives 50% of the continuous full load may be ample.

When an engine is started from cold only a small proportion of the heat given off will be dissipated by the cooler, which, it will be appreciated, is due to the very small mean temperature difference at this time. The remainder of the heat is absorbed by the circulating water and metal of the pipe work and engine. A higher water temperature then results, the mean temperature difference becomes greater, and a larger proportion of heat is dissipated by the cooler. This process proceeds until the mean temperature difference becomes high enough to enable the cooler to dissipate the required amount of heat from the cooling water and, unless some change in the conditions occurs, the temperature of the cooling water from the engines will remain substantially constant. When these steady conditions exist the following equation is satisfied:—

$$Q = W_a C_p (t_2 - t_1) = W_w C (T_1 - T_2) = UA (\Delta t) \dots (48)$$



Where Q = quantity of heat dissipated
B. t. u/hr.

W_a = lbs. of air/hr.

C_p = specific heat of air at constant pressure.

W_w = lbs. of water circulated/hr.

U = overall transfer co-efficient B. t. u/
(sq. ft.) (°F) (hr) based on the
air side surface.

A = air side surface sq. ft.

t_1 = initial air temperature.

t_2 = final air temperature.

T_1 = temperature of water entering the cooler.

T_2 = temperature of water leaving the cooler.

(Δt) = the true mean temperature difference.

The equation shows the relationship between the variables which enter into the computation. It has been shown that the overall transfer co-efficient is dependent upon the type of finned tube, the air velocity and the velocity and temperature of the cooling water. The type of tube and the air velocity will be chosen to give the most economical ratio of heat dissipation to fan power and will for normal conditions remain a constant. It is possible for the designer to control the water velocity to some extent by arranging suitable passes for a given design of cooler, but the quantity of cooling water circulated and its temperature will decide the overall heat transfer co-efficient. It will be seen from an inspection of the equation that for a given heat dissipation and air quantity an alteration in one variable will influence all the remainder.

Consider the effect of an increase in the water quantity through a given size of cooler and a given entering air temperature. In the first place the overall co-efficient will be increased due to the increased velocity. For equation (48) to be satisfied the mean temperature difference will be reduced so that the value of $UA (\Delta t)$ remains constant. This will reduce the values of T_1 and T_2 and the drop in the mean water temperature will have an adverse effect on U . At the velocities normally encountered this is very small however. At the same time the temperature drop in the water will be decreased so that value of $W_w C (T_1 - T_2)$ remains constant. This will have the effect of lowering the value of T_1 and increasing the value of T_2 until the mean temperature difference again satisfies the equation. In order to bring the

value of T_1 to the original level A must be reduced, so that an increase in the water quantity has the effect of reducing the surface area required. In practice a smaller cooler would be used. This would have a smaller air quantity and the value of $(t_2 - t_1)$ would be increased, thus reducing the mean temperature difference (Δt) , but the cooler can be reduced in size until the equation is again satisfied.

Now consider the effect of a rise in the value of T_1 . In the first place the transfer co-efficient U increases due to the rise in the mean temperature, but the mean temperature difference also increases and the value of A would again have to be reduced to satisfy the equation. It will be seen therefore that the water quantity and the temperature allowable have a big influence on the size of the cooler.

The effect of an increase in the heat to be dissipated should be noted, as this can occur in practice due to a temporary overload. The conditions become unstable and the water temperature begins to rise until, eventually, the mean temperature difference reaches a level which will again satisfy the equation and stable conditions are restored. The extent of the rise in the water temperature depends on the increase in the load and the mean temperature difference. An increase of 10% in the heat to be dissipated would require an increase of approximately 10% in the temperature difference, or for a temperature difference of 30°F. this would be a little over 3°F. The temperature difference is usually about 50° for normal temperature conditions and may be as low as 25° for tropical conditions, and in the latter case the increase in the water temperature due to a temporary overload will therefore be negligible.

Conversely the effect of a comparatively small increase in the water temperature will have a marked effect on the size of the cooler required, particularly when operating in a high ambient air temperature. The following example will illustrate this point. A certain engine is to operate with a given water quantity in an ambient temperature of 115°F. with a maximum water temperature of 160°F. Assume this requires a cooler with a frontal area of 38½ square feet. If the water temperature is increased to 180°F. a cooler with a frontal area of 22 square feet would be adequate, a reduction of 43%. If the water quantity is doubled a cooler with an area of 27 square feet would limit the temperature to 160°F., whilst one with 18 square feet would maintain a temperature of 180°F.

The importance of an accurate knowledge of the heat emitted by the engine must be emphasised, particularly when working in tropical conditions. If, for example, the heat emitted by the engine in the above example has been over-estimated by 10% a cooler of 32½ square feet would limit the temperature to 160°F. with the low water quantity, whilst a cooler with only 14 square feet would limit the temperature to 180°F. with the higher water quantity.

Provided the engine will run efficiently with the increased water temperature the size of the cooler may be reduced by pressurising the system thus taking advantage of the increased water temperature, with its consequent effect on the mean temperature difference and increased film co-efficient on the water side. Such

coolers can be run at temperatures above 212°F. and may be desirable in certain circumstances.

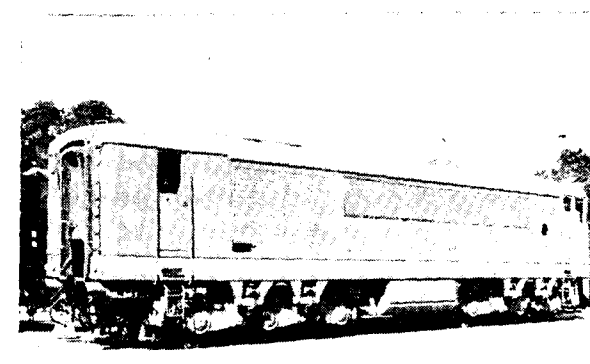
For small engines thermo-syphon water circulation may be adopted but it is inefficient and necessitates a relatively large cooler. For traction work on diesel rail cars the fan may be dispensed with, for the cooler is mounted on the roof of the car and thus the movement of the car through the air gives the necessary air velocity. With a good water circulation this type of cooler is very efficient.

It will be appreciated that the design of a cooler to meet a certain set of conditions is a complex matter and calls for the closest co-operation between the designers of the engine and cooler if the most compact and efficient cooling equipment is to be provided.

CKD T 698.0 TYPE DIESEL-ELECTRIC LOCOMOTIVE

This is an example of a high quality locomotive made by the CKD.

The CKD T 698.0 Type diesel-electric locomotive is used for fast passenger trains with a maximum



speed of 120 km/h (75 miles/h) or for freight trains with a maximum speed of 80 km/h (50 miles/h). The passenger and freight train locomotives of this type are identical, the only difference being the power

transmission ratio between the traction motor and the driving axle.

The engine is the robust CKD slow speed engine of the same cylinder bore and stroke as that used in the CKD T 435.0 Type diesel-electric locomotives, this means that the stock of spare parts at the railway workshops is considerably reduced. The engine is provided with a turbo-charger. The output of the exhibited type is 1,650 HP, however, the new series, planned for 1960 will have a higher output of 2,000 HP, the compression ratio being increased by applying a medium pressure turbo-charger. The locomotive can be delivered either with driver's cabin at one end only, or with cabins at both locomotive ends. The multiple unit control equipment enables the driver to control several locomotives from one post. During trials at a speed of 135 km/h (84 miles/h) the locomotive travelled perfectly smoothly.

Main technical data are: wheel arrangement Co' Co', rail gauge 1435 mm (4'—8 1/2"), weight 105 tons (100.7 long tons).

Transmission Gear for Diesel Locomotives

By P. Zens

President, General Manager, Compagnie des Chemins de fer departementaux

OPERATION OF THE "ASYNCHRO" GEAR BOX

THE combination of a brake and clutch, operated through a single air piston, located at the entry to the gear box provides two positions :

	Clutch	Brake
(1)	Engaged	Released
(2)	Disengaged	Applied

(It should be noted that the piston does not require a ball joint and that the stop is called into use only for the short time during which the piston is moving).

The gear box is brought to rest when changing gears, and it is then that the sliding clutch is brought into operation. Consequently, no expedient is employed in this gear box, where the "synchros" are

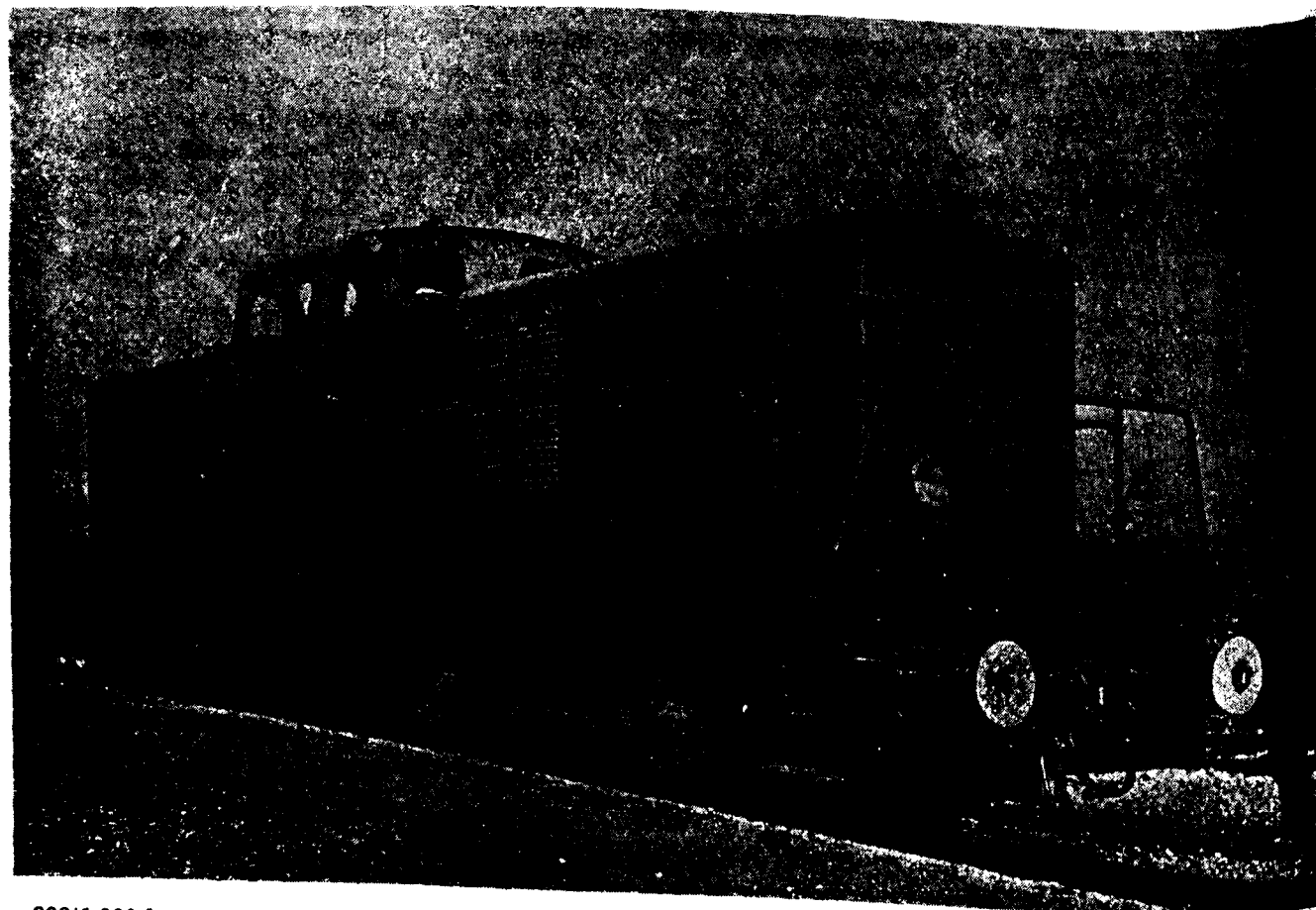
substituted by a single outside brake, which may be of any suitable dimensions, and is as reliable as that ensuring the safety of millions of car drivers.

The brake used is of the multi-disc type, operating either dry or in oil, which offers the best guarantee of long service life. The possibility of mistakes is totally eliminated by a simple device bringing the gear drive to a complete standstill.

Actual practical experience has shown that when the brake is prevented from acting, passive resistance brings the gearing to a slow stop, and that the gearchange operates, without difficulty, after a few seconds when the gearing has come to rest.

GEAR-CHANGING

We shall describe the operation of a gear box intended for engines of 500 to 600 hp.



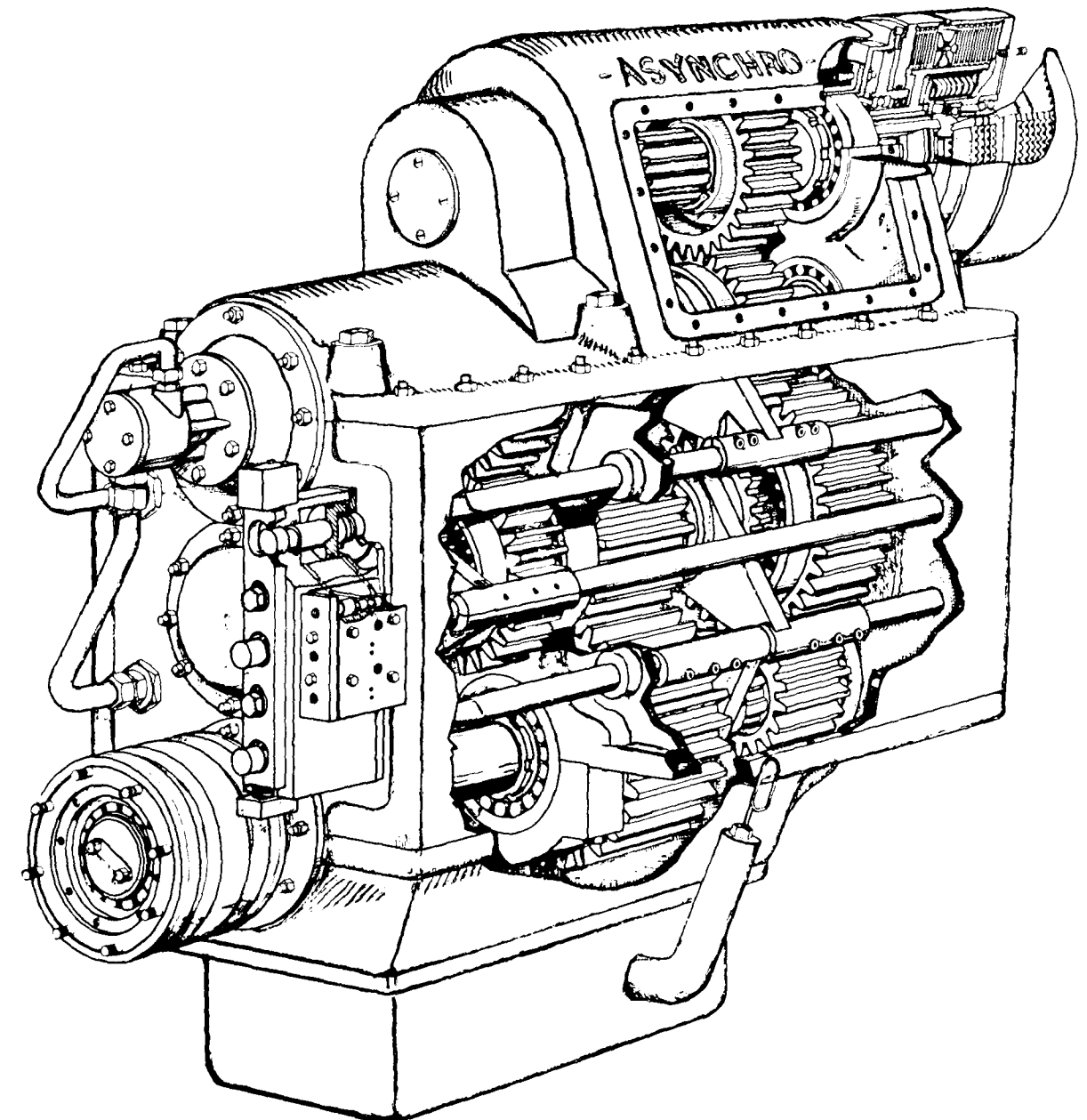
800/1,200 h.p.—68 Ton Diesel Locomotive Hydro-mechanical transmission system—"Asynchro" patented gear box.

ATELIERS C.F.D.

MONTMIRAIL (Marne)

Direction : 10, Avenue de Friedland — PARIS (8^e) — Tel. CAR. 14-30

GEAR BOX « ASYNCHRO »



**AUTORAILS - LOCOTRACTORS - LOCOMOTIVES
ALL POWERS**

The gear box is provided with a pre-selective servomechanism.

The driver operates :

- (1) the speed pre-selection handle (S),
- (2) the impulse button (I).

He positions the pre-selector for the required gear, and, when he depresses the button, the gear-change is effected automatically, with full reliability no matter how many gear boxes there may be, in the

case of either a twin-engine locomotive, or of locomotives working in multiple.

OPERATION OF THE CONTROL

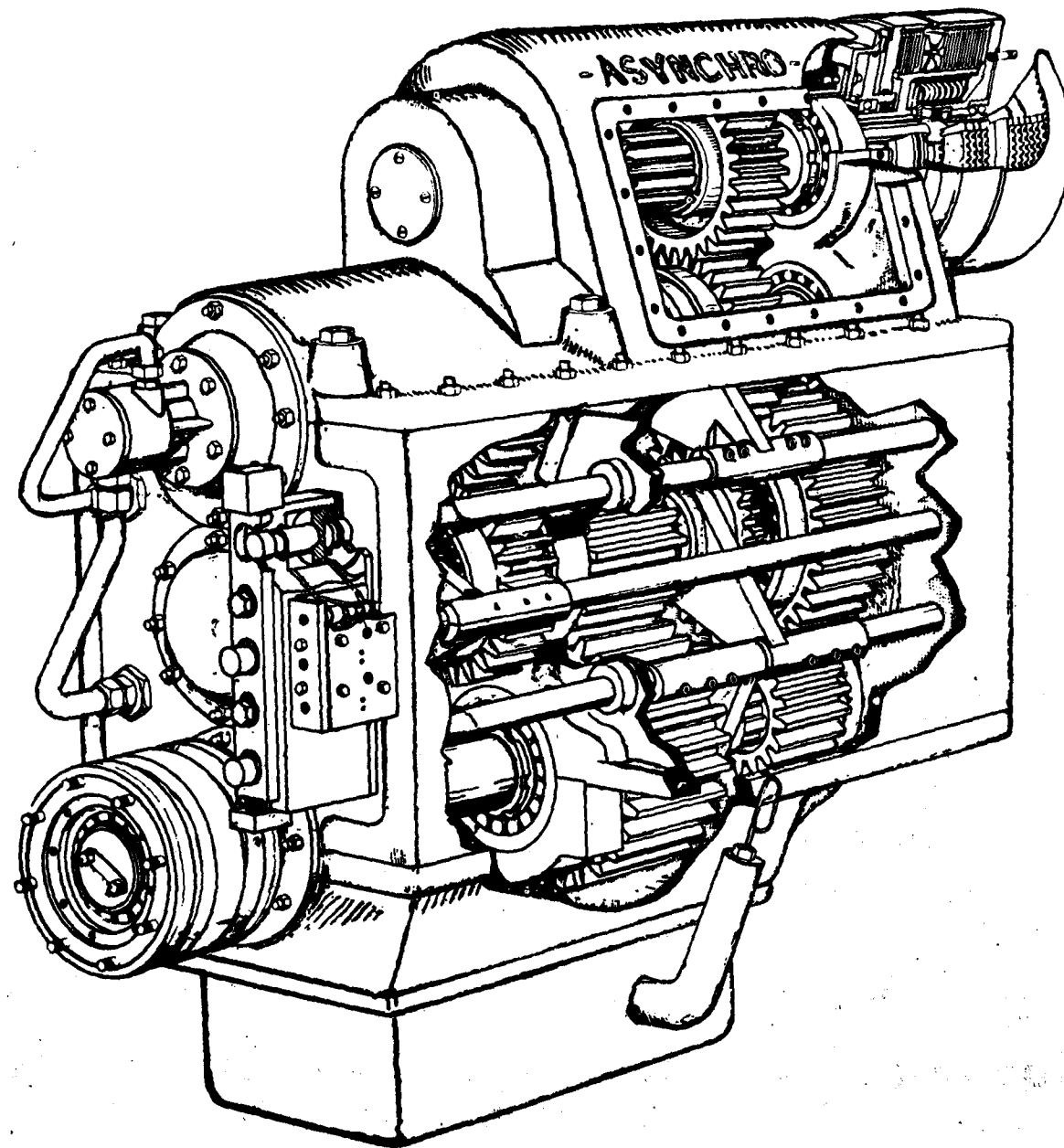
The gear box is provided with a valve D, directing the flow of air to the speed cylinders C_v.

The valve, being remote-controlled from the cab, through a 3-way valve A, B, C (A_p B_p C_p, with compressed air supply or A_o B_o C_o, with exhaust supply), thus providing the following combinations, each corresponding to a speed :

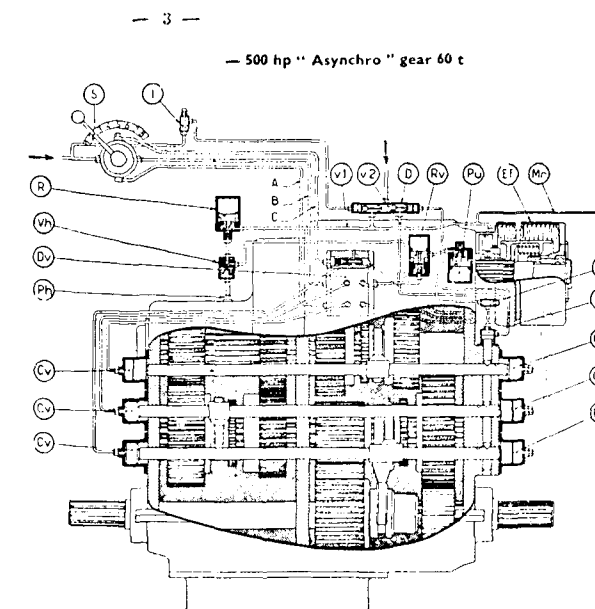
- | | |
|---|---|
| 1) A _p B _p C _p | 5) A _o B _o C _o |
| 2) A _p B _p C _o | 6) A _o B _p C _o |
| 3) A _p B _o C _p | 7) A _o B _o C _p |
| 4) A _p B _o C _o | 8) A _o B _o C _o |

A combination having been pre-selected, depressing the button causes the 2-way valve slide (D) to move to the right. Through its piping 1 this valve supplies air to the clutch-brake (E), the engine idling control (M_r) and the direct electro-pneumatic valve (E_v) on the supply side.

Through its piping 2 it puts the exhaust through to the rod locking mechanism (V) which, under the action of its spring, moves upwards thus unlocking the 3 rods.



Asynchro Gear - 8 Speeds 600 h.p.



C_v : Speed cylinder — D : C.P.O.A.C. valve — D_v : Gear valve — E_t Clutch/brake — I : Impulse valve — M_r : Idling-control — P_n : Oil-pressure take-off — P_u : Interlock bleed — R : Delayed action mechanism, gear-change — R_v : Delayed action mechanism, gear-interlock — S : Pre-selector valve — V : Gear-interlock — VV : Dual valve — V₁ : C.P.O.A.C. piping No. 1 — V₂ : C.P.O.A.C. piping No. 2 — V_n : Hydraulic-control valve.

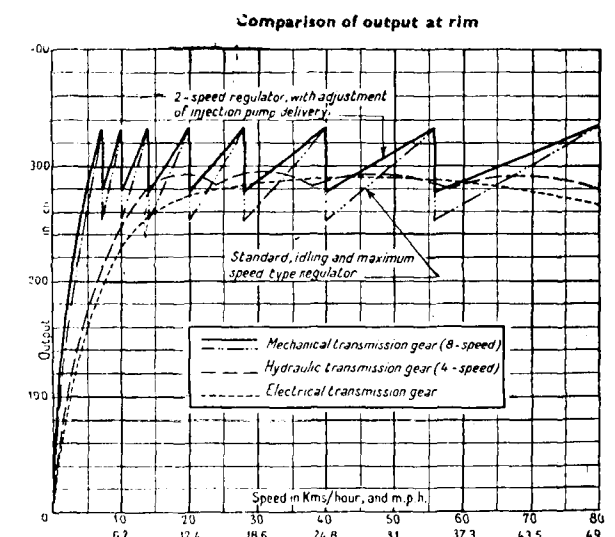
As soon as the gear box comes to rest, about 1 to 1 1/2 seconds after the button has been depressed, the pressure of oil in the gear box pump (P_b) falls to zero, the mancontact (M) energises the electro-pneumatic valve (E_v), which then admits air to the speed valve (D_v). This latter supplies the cylinders giving the pre-selected combination, whilst, due to the action of the slowing device (R), a fraction of a second after the

opening of the electro-valve, air arrives through the double-valve (V_v) bringing the rod locking mechanism (V) under pressure; when the rods are all positioned, this latter moves downward, operating valve (Z) at the end of its travel. This brings slide (D) back to the left and piping (1) is opened, to the exhaust, thus releasing the brake, engaging the clutch, and restarting the engine injection. Piping (2), through the double-valve V_v, takes over in order to maintain (V) locked. Several gear boxes may be controlled in the same way, a single depression of the button initiating the operation. It is then only necessary, in order to maintain the tractive effort, to put the pre-set braking device to the piping (I) of the valves (D) when the operating of each gear box will be initiated at the required instant.

It should be noted that, owing to the free-wheel, any combination of the gear box may be engaged, whatever the speed of the machine, and that this control enables changing over from any one combination to any other.

COMPARISON OF EFFICIENCY

It is often emphasized that the hydraulic and electrical transmission systems make available, at any required moment, the maximum torque and speed of the engine, hence its full power output. However,

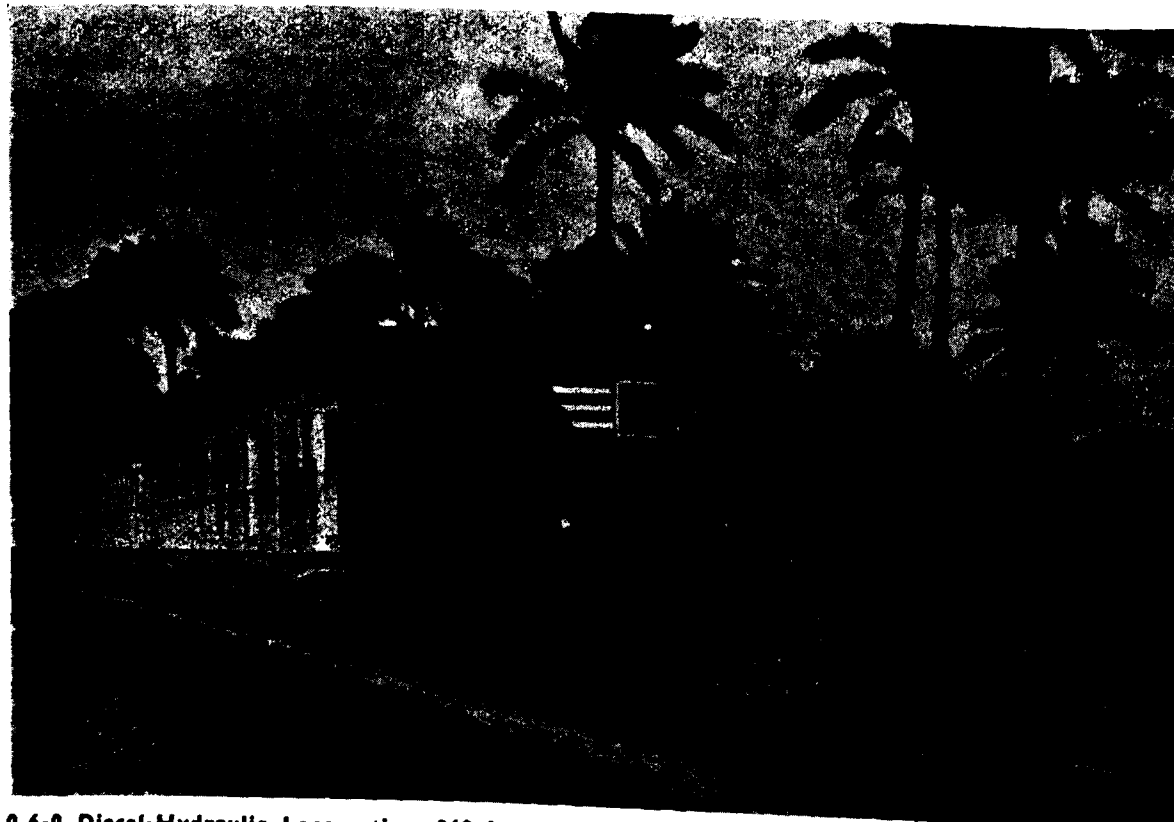


this does not apply to the mechanical type except under rare circumstances, the engine output which mechanical transmission makes available being, at the maximum, this full power and, at the minimum, the quotient of the full output by gear box ratio.

But this advantage offered by the hydraulic or electrical transmission system is only apparent, for

JUNG JUNGENTHAL

Manufacturing Locomotives since 1885



0-6-0 Diesel-Hydraulic Locomotive—360 h.p. gauge 1435 mm., for service in tropical climate on desert railways, driver's cab at the end, remote control, equipped with MWM diesel engine Type RH 335 S and Voith hydraulic transmission L37. Supplied: among others, 42 units to Egyptian Republic Railways

Our manufacturing range includes:

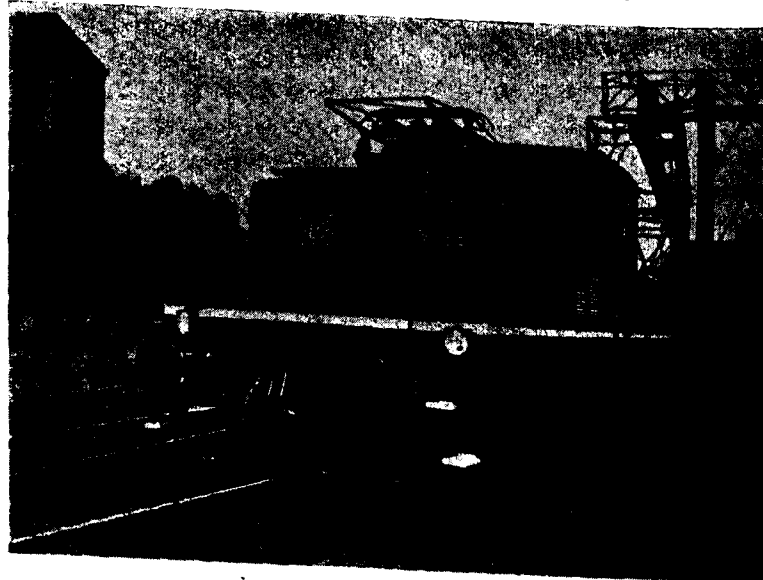
Diesel and Electric Locomotives
Steam and Fireless-Locomotives
Compressed air and storage battery
Mine Locomotives
Containers and Apparatus · General Engineering

Dept.: Machine Tools:

Vertical Turning and Boring Mills

BoBo Two-Power Electric-Diesel Locomotive gauge 1435 mm.

Weight in service order 80 tons, rated output of the traction motors 4 X 148 kW. = 592 kW., trolley wire voltage 600 V. Supplied: up to now 13 units to Western German metallurgical works and mining enterprises.



JUNG JUNGENTHAL

ARN. JUNG LOKOMOTIVFABRIK G.M.B.H., JUNGENTHAL bei KIRCHEN-SIEG (GERMANY)

July 1960

THE INDIAN RAILWAY ENGINEER

D.E.63

though these do actually enable the transmission to get the full output, the transmission does not make full use of it.

The rim finally gets nothing of this, and the result of the additional power supplied and not used is solely engine consumption and wear.

We shall make a comparison with the hydraulic transmission system, calling attention to the fact that when this has to handle high output, several changes of the combination are provided for; beyond a somewhat restricted range of operation, the efficiency is no longer satisfactory.

Let us consider a 400 hp, 8 cylinder, 1,500 r. p. m. engine, with a maximum 1-hour rating of 400 hp.

We shall assume that the gear box and mechanical transmission are provided with a ratio of 1/40; though this requirement is readily realised with the

mechanical type of transmission, it does not yet appear to have been achieved with the hydraulic type.

We shall, likewise, assume that the engine auxiliaries take 35 hp for the mechanical type transmission, and 40 hp for the hydraulic, i. e. an additional 5 to 8 hp for cooling the transmission gear.

This results in a loss, with the mechanical type transmission, of:

Loss in hydraulic coupler

—3 ground spur gear trains	2.5%
—1 bevel gearing	3%
—2 spur gears on drive axle	2%
	2%
	9.5%
efficiency:	90.5%

USSR RANKS FIRST IN LENGTH OF ELECTRIC RAILWAYS

Pravda carries an article by the Minister of Railways Boris Beshchev devoted to the All-Union Railway-men's Day, a traditional national holiday.

The Minister writes that the Soviet Union now ranks first in the world for the length of electrified railways and the rate of railroad electrification. Forty-four per cent of the freight carriage on Soviet railways is done by electric and diesel traction. The volume of rail freight carriage done by electric and diesel traction in the Soviet Union this year is over three times greater than the entire rail freight carriage of Britain, France, the FRG, Italy, Austria and Spain taken together.

Boris Beshchev writes that the USSR is now accomplishing the task of developing large electrified trunk lines with a high throughput capacity. Already this year, work will be completed on the electrification of the important Moscow-Kuibyshev-Cheliabinsk-Irkutsk section of the Soviet railway system with a total length of over five thousand kilometres. It will be the world's biggest line with the world's biggest throughput, the Minister observes. It will link the central regions of the European part of the USSR with the Urals and Siberia.

The Minister stresses that the programme for the introduction of new progressive forms of traction, envisaged in the Seven-Year Plan (1959—1965) can be accomplished ahead of schedule.

OVERHEAD RAILWAY

Muscovites are justly proud of their Metro or the underground railway, which in less than a quarter of a century has grown to over 50 miles of lines with 56 stations. It carries on an average 2,700,000 passengers daily—almost four times as many as Berlin, and half as many again as the London tube.

Within the next few years it will stretch out in all directions to the farthest residential suburbs.

Along with their Underground, Muscovites are going to have an overhead railway connecting Moscow's main international airport, Vnukovo, with the city's underground rail system.

The line will be a double one, carrying streamlined cars 60 to 70 feet long, each seating 75 passengers. These electrically propelled cars will be suspended by pneumatic-tyred wheels from a double-rail track, laid on trestles supported by reinforced concrete props up to 40 feet high and at intervals of about 100 feet. The bottom of the car will be about 20 feet above the ground, allowing plenty of room for surface transport.

The trains will be able to develop speeds of up to 100 m. p. h., and—including the stops—will take only 11 to 12 minutes from the airport to Moscow.

Standardized Power Equipment by Rolls-Royce

AS railway dieselization progresses, the need for a wide variety of rolling stock is likely to lead individual concerns into a danger of having too many different types of engines and transmissions. In such a situation, maintenance is bound to be inconvenient; worse still is the cost and difficulty of holding a diversity of spares.

FLEET STANDARDISATION

Recognizing this problem, Rolls-Royce are extending the scope of their familiar diesel-hydraulic installations, so that railway operators may standardize on their high-speed, medium-power diesels for virtually all powered rolling stock.

The installations on offer are suitable for shunting, freight and mixed-traffic locomotives of up to 1400 h.p. On the passenger side, single-engine or twin-engine installations can be supplied for suburban railcars; for high speed passenger trains, it is proposed that every coach should be powered.

BASIC POWER PLANT

In all these arrangements, the basic power plant is a Rolls-Royce diesel engine and torque converter. Generally speaking, locomotives call for vertical engines, whereas in railcars it is usually more convenient to use horizontal engines mounted below the floor level, where they do not occupy useful carriage space. Rolls-Royce engines are fully rationalized; that is to

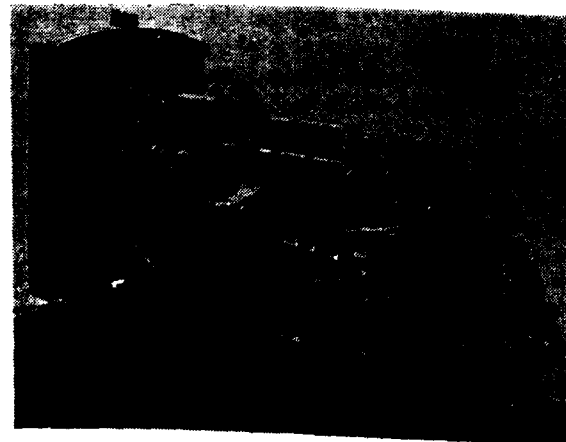


Fig. 1. Typical diesel-hydraulic unit for 200 h.p. shunting locomotive. These units can be shipped from England for local installation.

say, all models, whether of four, six or eight cylinders, normally aspirated, supercharged or turbo-charged, vertical or horizontal, use common working parts. This is obviously a benefit when spares holding is considered.

CHANGE-SPEED TRANSMISSION

A brief description of the hydrokinetic change-speed transmission may not be out of place. The torque converter automatically and continuously matches the

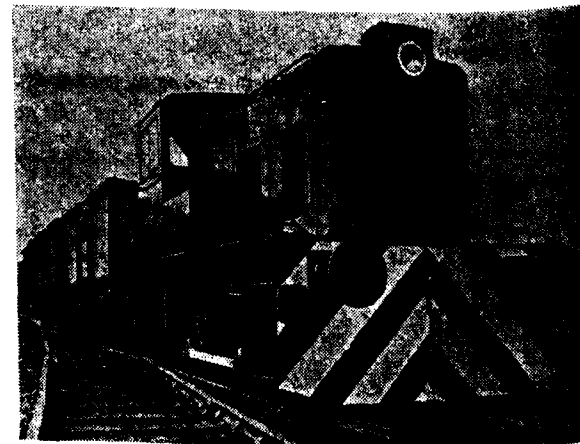


Fig. 2. Yorkshire Engine Company's 170 h.p. locomotive uses a diesel-hydraulic set: it is inexpensive to buy and easy to maintain: driving is simplicity itself.

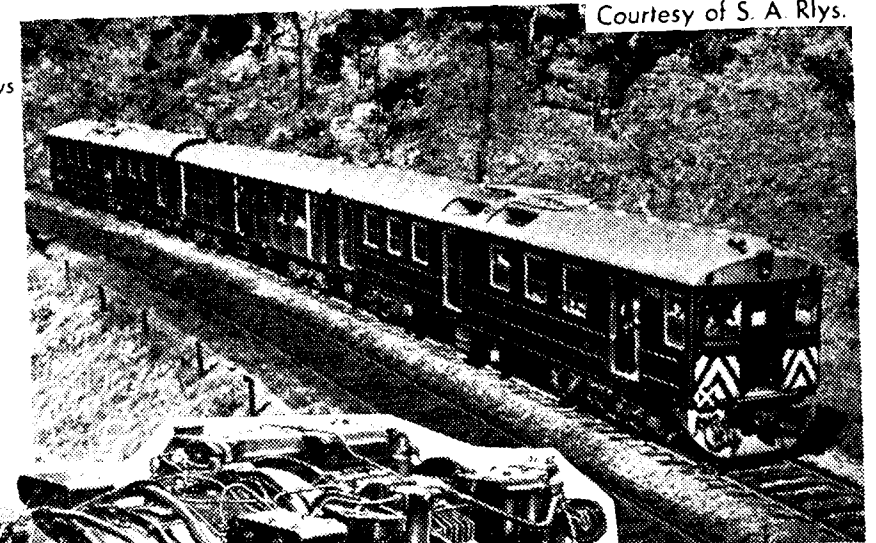
engine speed to the load being driven, so that the engine gives of its best at all times. Since the stall torque ratio can be rather higher than 5:1, there is no need for any auxiliary gearbox, and control of vehicles is simplicity itself.

Various models of torque converter can be supplied, according to what characteristics are required. One model, which automatically allows the engagement of direct mechanical drive from the engine at a predetermined speed, is commonly used in high-speed rolling stock. All models have a similar hydrokinetic fluid circuit, comprising three members—a centrifugal impeller, a turbine wheel, and a stationary member. The turbine wheel has three stages of blades, and the stationary reaction member has two. The circuit is of the Lysholm-Smith type, torque being added in three separate stages.

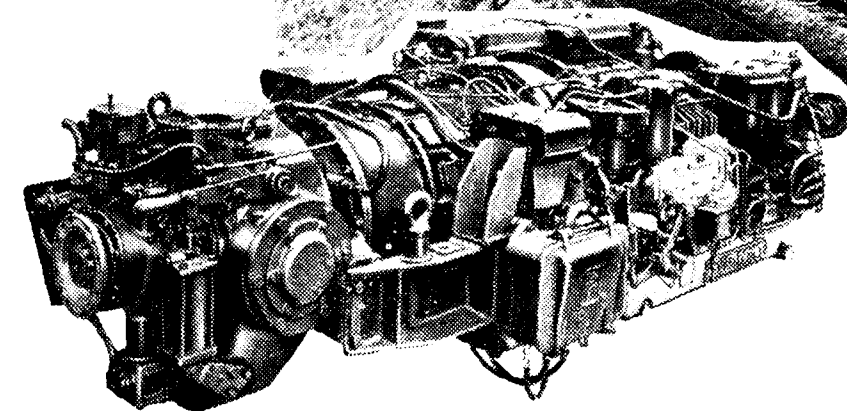
MODERN RAILWAYS ARE USING MORE DIESEL-HYDRAULIC EQUIPMENT

That is why
INCREASING NUMBERS OF
LOCOMOTIVES, RAILCARS & RAILBUSES
are being fitted with
ROLLS-ROYCE
ENGINES, TRANSMISSIONS & CONTROLS

South Australian Railways
three-car train on
suburban service in
Adelaide Hills area.



Courtesy of S. A. Rlys.



The above train is propelled by four of these Rolls Royce supercharged six cylinder 230 h.p. diesel hydraulic units, with attached reversers.

Rolls-Royce Limited
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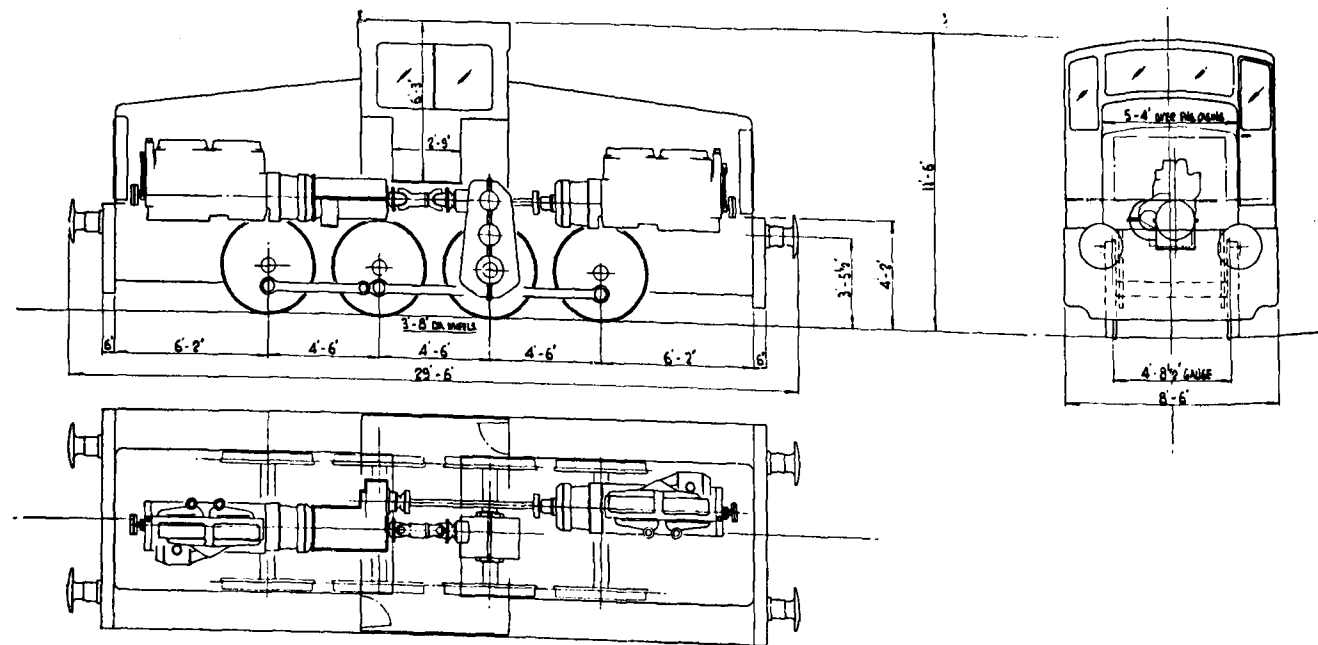


Fig. 3. Layout of Rolls-Royce differential transmission in typical locomotive.

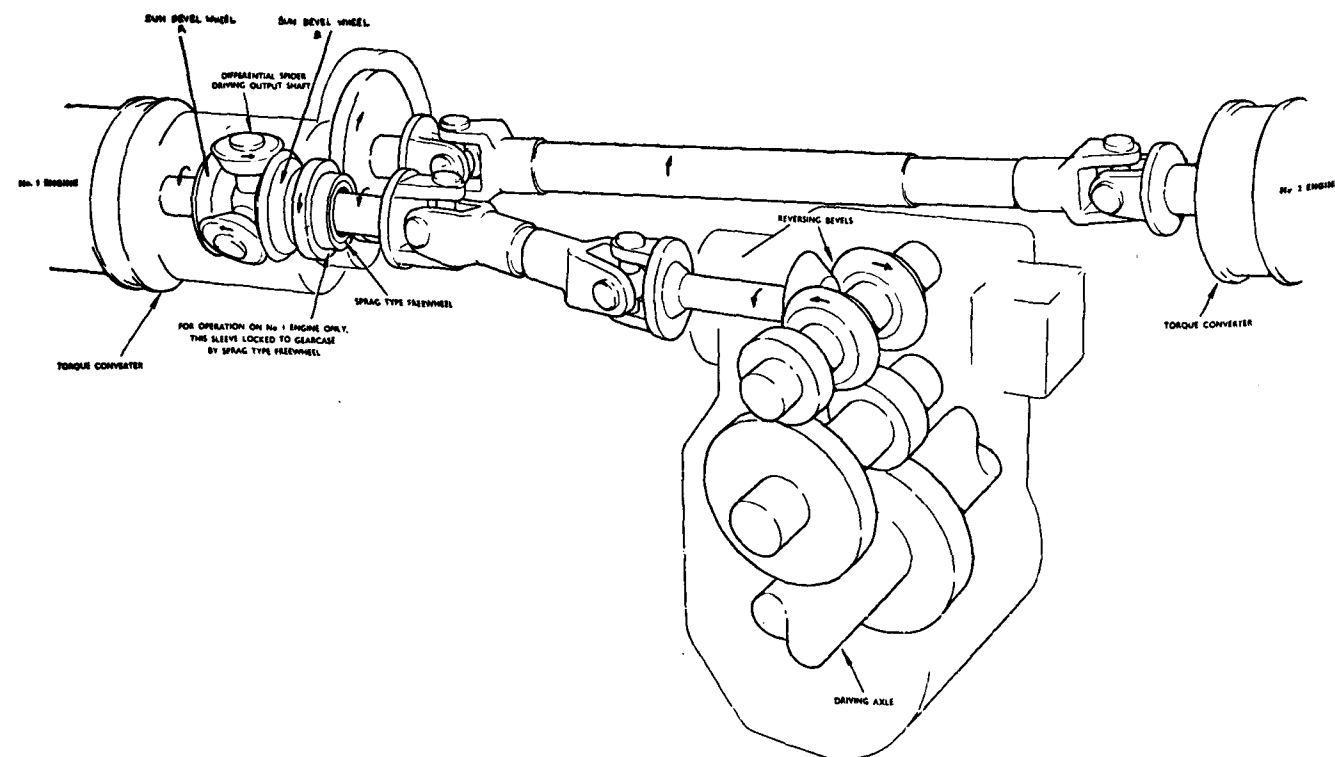


Fig. 4. Principle of operation of differential transmission.

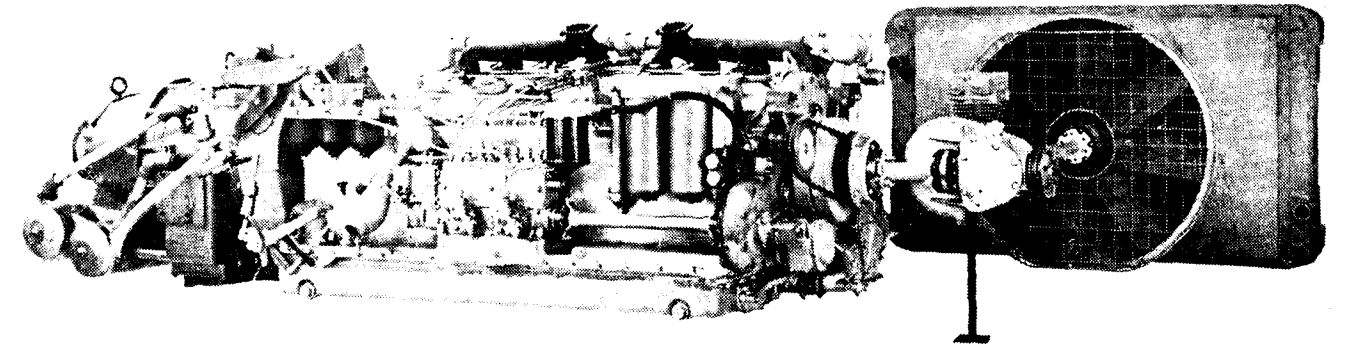


Fig. 5. Underfloor diesel-hydraulic power unit, complete with radiator and fan.

MAINTENANCE AND OVERHAUL

The Rolls-Royce installation can be serviced throughout by mechanical fitters. When an engine overhaul is necessary, after the recommended interval, the engine and torque converter unit is easily detached from the locomotive or railcar frame. The unit may be manoeuvred by the small cranes and pulley blocks kept in local workshops. While one unit is being overhauled, a spare may be fitted, so that rolling stock is kept on the move.

LOCOMOTIVES

Fig. 1 and 2 show a simple diesel-hydraulic power pack and a small shunting locomotive using this type of transmission. Fig. 3 is a diagram of a new twin-engine diesel-hydraulic installation; its principle of operation is shown in Fig. 4. It uses a compounding differential gearbox and only one final drive; the latter contains a triple reduction and reversing mechanism.

It may be thought that the proposal to use more than one engine in a locomotive leads to unnecessary complication and expense. In fact, it will be found that the installation is cheaper: cheaper to buy, and cheaper and more convenient to run.

The low weight of the power equipment (about five tons per power pack) obviates the need to complicate the locomotive structure to save weight; moreover the weight can be evenly disposed over the locomotive axles.

Performance characteristics unobtainable with a single-engine or a conventional twin-engine arrangement are given by the Rolls-Royce differential system. Comparing two locomotives geared to attain the same

top speed, one with the differential and one without, the former has a higher initial tractive effort. What is even more significant is that this initial tractive effort comes from one engine only.

Up to about four miles per hour, the locomotive is always propelled by this one engine; the second engine may be engaged anywhere between about four and thirteen miles per hour. For low-speed operation, as when hump-shunting or weighbridge working, it will be unnecessary to use the second engine. Apart from preserving the second engine, a further economy is that for a given shunting speed, the overall fuel consumption of a locomotive is almost halved, because the working engine is running at a speed where its specific fuel consumption is lower, and its torque converter efficiency higher.

An extension of this arrangement is proposed for locomotives of up to 1400 h. p.

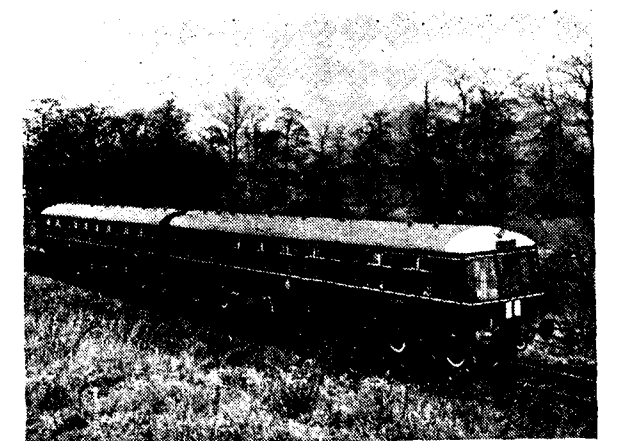


Fig. 6. British Railways' two-car unit. The power car has a twin diesel-hydraulic installation.

RAILCARS AND HIGH SPEED PASSENGER TRAINS

For high-speed passenger trains, there is much to be said for powering every car with an underfloor, mounted horizontal engine and torque converter. Rolls-Royce are very experienced in this kind of installation in railcars (see Fig. 5 and 6).

A powered train is less expensive to buy and to run than a locomotive-hauled train. It is more versatile, since any number of self-powered coaches may be



Fig. 7. Two of these horizontal engines give power for air-conditioning, heating and lighting in British Railways' new Pullman expresses.

coupled or detached for running to different destinations. It occupies less space in station platforms, and dispenses with the need to turn locomotives round at terminals.

REFRACTORIES FOR GLASS FURNACES

The purpose of IS : 1522-1960 Specification for Fireclay Refractories for Glass Melting Tank Furnaces is to fulfil a long standing need of Glass Industry for a standard on the subject. It covers the requirements for fireclay refractories for glass melting tank furnaces up to a maximum size of 60×30×15 cm (or 24×12×6 in.).

The glass manufacturers in India have been complaining about the poor quality of refractories now available for the glass industry. According to them, the most common defects noticed are that the refractories corrode rapidly, produce stone in glass, are laminated, are underfired and shrink considerably on heating. Consequently their life is generally poor and seldom exceeds a year. On the other hand, the refractories makers have pointed out that in the absence of a specification for refractories for the glass industry it would be difficult for them to satisfy the glass manufacturers. As a result of this, several tests were conducted in the Central Glass and Ceramic Research Institute, Calcutta on the refractories at present being used in the glass industry, both indigenous and imported. This standard is based on the results of these investigations.

It is not often realized that a twelve-car train of this type can have more installed horse-power than one hauled by the most powerful single-unit locomotive. It is also lighter, and since the drive is transmitted through more axles, its adhesion and braking is superior. Power from each engine may be taken for air-conditioning in individual vehicles.

OTHER ROLLS-ROYCE RAILWAY INSTALLATIONS

Although this article has discussed only the diesel-hydraulic installation, since this is the type which is finding increasing favour, it should be remembered that Rolls-Royce have supplied many rationalized engines for diesel-electric locomotives.

An interesting recent application of another kind is in British Railways' new inter-city diesel-electric Pullman expresses, in which two underfloor-mounted Rolls-Royce engines drive 150 kVA generators to provide power for air-conditioning, heating and lighting (see Fig. 7).

POWER EQUIPMENT FOR OVERSEAS BUILDERS

The international interests of the Rolls-Royce company have led to the establishment of a world-wide sales and service organization. Engines and transmissions can be supplied to overseas builders wishing to construct their own rolling stock, and the Company provides a consultant service on its power equipment and controls.

DIESEL ENGINE TESTING AND TUNING

By An Engineering Correspondent

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 is 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.

Fire Protection Equipment for Rail Vehicles

By An Engineering Correspondent

WITH the advent of diesel locomotives and rail cars Graviner have advised, designed and supplied fire protection systems for Ceylon Railways, Ulster Transport, Coras Iompair Eireaire (Ireland), Australian Railways, New Zealand Railways and British Railways.

The Graviner installations include Pyrocord fire detectors, resetting detectors, automatic fire extinguishers and mounting brackets, also the spray nozzles which distribute the extinguishant over the source of the fire.

The automatic extinguisher used is one from the Graviner standard range and the extinguishant, Chlorobromomethane, is chosen because it is not only an excellent fire extinguishing medium but also, due to its high boiling point (plus 67°C), it is easily handled for recharging purposes. Filling plants for this extinguisher have already been supplied to Hindustan Air Lines who have all facilities for doing this type of work at their factory in Bangalore.

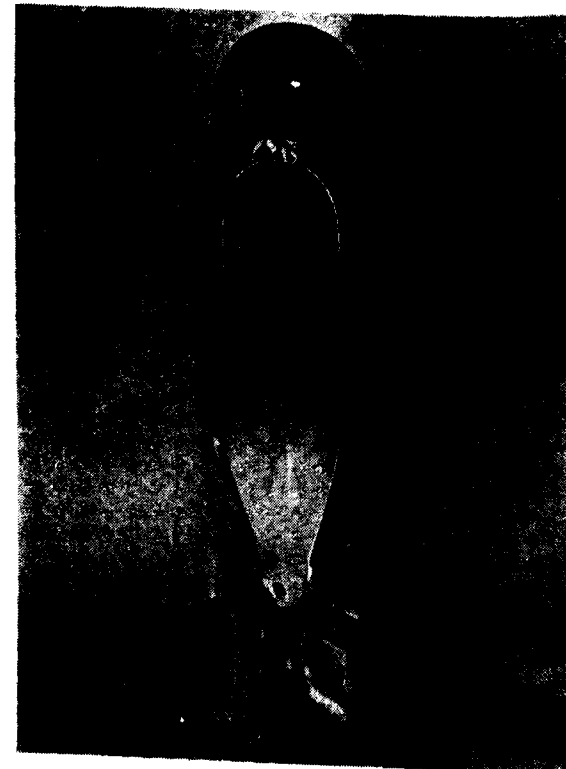
The photograph of a Graviner automatic extinguisher is typical of the range offered for rail vehicles. It has been sectioned to show the detail construction of the operating head and method of operation.

The container is drawn from copper sheet into the form shown and it is screwed at the neck to hold the head which is sweated into position to ensure a gas tight joint. Into this head is machined a frangible diaphragm and there is a platform on which the cartridge unit is mounted.

This cartridge unit is made to suit a Plessey connector and comprises a gunpowder charge which is fired when an electric current is passed.

The head of the extinguisher is a machined brass pressing which contains a plug with an integrally machined diaphragm. It is connected to a port in the side of the head by means of an annulus. When the extinguisher has been installed it is armed by inserting the cartridge unit and connecting it into the 24 Volt electric supply line. Upon detection of a fire, the extinguisher can be discharged manually or automatically by a current passed through the cartridge unit. The gun-

powder which is fired ruptures the diaphragm in the head of the extinguisher and drives the charge plug to the bottom of the junction box to release the extinguishant into the fire zone.



The brackets used with this extinguisher are specially tested to withstand the external loads which may be encountered under crash conditions of modern equipment.

The high soak resetting detector which is used by some railways is of extremely rugged character and will withstand years of hard wear without deviation from its setting. In principle, a pair of low expansion bows are fitted with two electrical contacts held apart at normal temperatures and encased in an outer tube of high expansion stainless steel. Upon rise of temperature the outer case expands and allows the two contacts of the bows to meet to close the circuit of an electrical alarm bell. This detector will reset to open circuit when the temperature falls again.

On the photograph will be seen one of these detectors, and the case has been cut away

GRAVINER

automatic fire protection

Graviner equipment installed on diesel-engined railcars protects both the passengers and the power plant whether the railcar is travelling or at rest.

Full details are available from our Representatives in India, A. R. Haseler Ltd.

GRAVINER • STAINES • ENGLAND

Indian Representative :

A. R. HASELER (PRIVATE) LTD.

Asian Buildings, Ballard Estate, Bombay. Tel: Bombay 261229

to show the detail of the bows construction. The contacts are silver and they are rhodium flashed to ensure good electrical contact and corrosion protection. Also both contacts are insulated from the case by mica so that there are no electrical polarity difficulties during installation.

The Pyrocord fire detector is a continuous capillary which can be wound conveniently around any vulnerable part of an engine to ensure early warning in the event of fire.

The capillary is filled with cotton thread treated with nitrocellulose varnish and impregnated with gunpowder; it is suitable for installation in engine bays and fire zones where the normal ambient temperature does not exceed 110°C. As soon as there is a rise in temperature through fire the expansion of the cordite within the capillary at this temperature operates a plunger in the switch body to close an electrical circuit to the alarm bell and warning light.

In addition to this work Gravier have interested themselves for many years in a very wide field of engineering—aircraft, marine, industrial and nuclear.

For aircraft, Gravier offer fire detectors and extinguishers, crash switches of both inertia and impact type and fuel tank protection against explosions. This equipment is standard throughout the Royal Air Force and it is also used by most civil aircraft of both British and foreign design. In fact, to pinpoint a few, this equipment is used on the SAAB DRAGEN, the BOEING 707, the SUD AVIATION CARAVELLE, the DH COMET 4, the GRUMMAN GULFSTREAM and even the SAUNDERS ROE HOVERCRAFT.

In the industrial field, that is equipment to offer which by nullifying the risk of explosion, permits production to be maintained in spite of the dust hazard associated with certain processes. Plant construction cost can be minimized and danger to personnel eliminated.

In the domestic field, thermostats of very rugged construction are available. They are suitable for use in hot water systems, heater blocks and platens for packaging and plastics industries. They are also suitable not only for over-heat control but also for low temperature detection and thermostat control for the electrical, radio, and scientific equipment industries.

Fire detectors for use with mains conduits are also available.

For marine engineering, oil mist detectors are being produced which sense the formation of excessive oil mist in diesel engine crank cases to give early warning of impending mechanical defect as well as to prevent the danger of explosion.



In the nuclear field, Gravier are fully approved by and produce all types of equipment for the United Kingdom Atomic Energy Authority. The Company specializes in precision graphite machinery for reactors and reflectors, lead shielding bricks and up to 20 tons unit weight lead containers.

In addition to supplying the equipment, Gravier have always been in a position to supply technical advice on the many problems which are associated with such a wide range of equipment and to offer to the industry the experience accumulated by their technical staff over the many years they have been associated with these engineering problems. The Gravier Manufacturing Co. Ltd. is represented in India by A. R. Haseler (Private) Ltd., Bombay-1.

General Electric introduces most powerful U. S. Diesel Locomotive

THE most powerful diesel-electric locomotive ever built in the U. S. A. was introduced recently by the General Electric Locomotive & Car Equipment Department.

Developing 2,500 horsepower, the new locomotive design evolved from the universal type diesel-electric locomotives made by G-E for use on railroads outside of the United States. These locomotives have been supplying motive power for major world railways since 1956 and have completed an estimated 30,000,000 miles of operation.

The new locomotive will become an important tool of the U. S. railroad industry in its competitive struggle with other forms of transportation.

The new locomotive will enable U. S. railroads to haul freight faster and more economically and thus regain the business they have lost to competing forms of transportation.

The new locomotive develops 2,500 horsepower and weighs only 130 tons, an exceptionally favourable power-weight ratio for a diesel-electric. As a result, it is capable of hauling trains at higher speeds.

The new unit is the most powerful diesel-electric manufactured in the United States. It is also the first mainline diesel-electric locomotive offered by G-E to U. S. railroads since the company pioneered the diesel-electric locomotive in the decade beginning in 1925.

In the interval, General Electric continued to manufacture straight electric and gas turbine-electric locomotives for mainline use in the United States. However, the company has made many hundreds of mainline diesel-electrics for export to railroads in countries outside of the U. S. as well as thousands of diesel-electric switching and industrial locomotives for use both at home and abroad.

According to Locomotive Department General Manager Guy W. Wilson, important lessons were learned in the manufacturing and operation of the units made for overseas use. "You might say," he added,

"that the new unit which we are now offering to North American railroads incorporates the results of our excellent experience with our export line."

Wilson made it clear that there will be no diminution of General Electric's international business and that the addition of this new locomotive to the company's diesel-electric locomotive line does not represent any change in overseas marketing plans. "As a matter of fact," he said, "it is entirely probable that lessons learned from our experience with this new unit will be incorporated in future locomotives designed for use outside of the U. S." Wilson pointed out that he was thinking particularly of refinements relating to maintenance.

The new locomotive design, is based also on the specific needs of U. S. railroads for a higher power, lighter weight unit requiring a minimum of maintenance. These criteria were developed by researching the requirements of the railroads in an expanding economy.

Component and design concepts incorporated in the new locomotive have been tested in over 100,000 miles of actual operation on U. S. railroads. The new unit is designated U25B. The "U" indicates its universality of application—it can be used in freight, passenger or switching service. The "25" indicates its 2,500 horsepower rating. The "B" shows that it has four sets of wheels arranged in two 2-axle trucks and that all four axles are powered.

An examination of the new locomotive at the General Electric plant in Erie shows several unusual features. For one thing, a 60% reduction in electrical components establishes a new standard of reliability. Filtered, pressurized air is used throughout the locomotive, ensuring complete freedom from dirt—a principal cause of electrical and mechanical failure. A simplified engine cooling system eliminates all electrical apparatus, radiator shutters and clutch devices. Accessibility of parts for inspection and maintenance minimizes delay and expense. In addition to being supplied with filtered air, the operator's cab is even sound insulated.

ALCO's Contribution to the Diesel Electric Locomotive Industry

By O. G. Dellacanonica

Chief Engineer - Transportation Products
ALCO Products Export Company

THE FIRST UNITS

THE history of diesel railway traction begins early in the century. It is well known that the first diesel locomotive, the 1000 BHP diesel Sulzer Klose, direct-drive locomotive of 1913, was a failure, but it served to prove conclusively that the future of diesel traction was directly linked with the development of a flexible transmission.

Almost simultaneously after this failure, the development of electric, hydraulic and mechanical transmissions began.

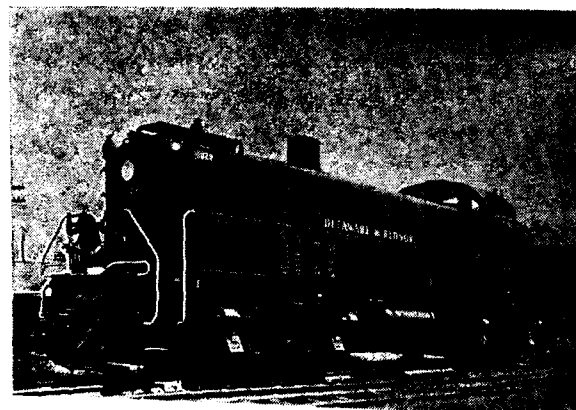
The year 1924 saw the first diesel-electric locomotive built in America, enter service in the lines of the Jersey Central Railway. It was built by ALCO.

This locomotive is illustrated in Figure 1. It was powered by an Ingersoll-Rand, 6-cylinder, 4-stroke, normally aspirated diesel engine, of 10 inches bore and 12 inches stroke, developing 300 BHP. This locomotive weighed 56 long tons; its maximum speed

was 30 MPH, and its continuous tractive effort was 7,900 pounds.

The Jersey Central locomotive, at 10 MPH for a rail horsepower of 210, gave 34 years of continuous service, a notable record for a first unit.

It was followed by a number of units of the same characteristics, that were built from 1924 through 1930.

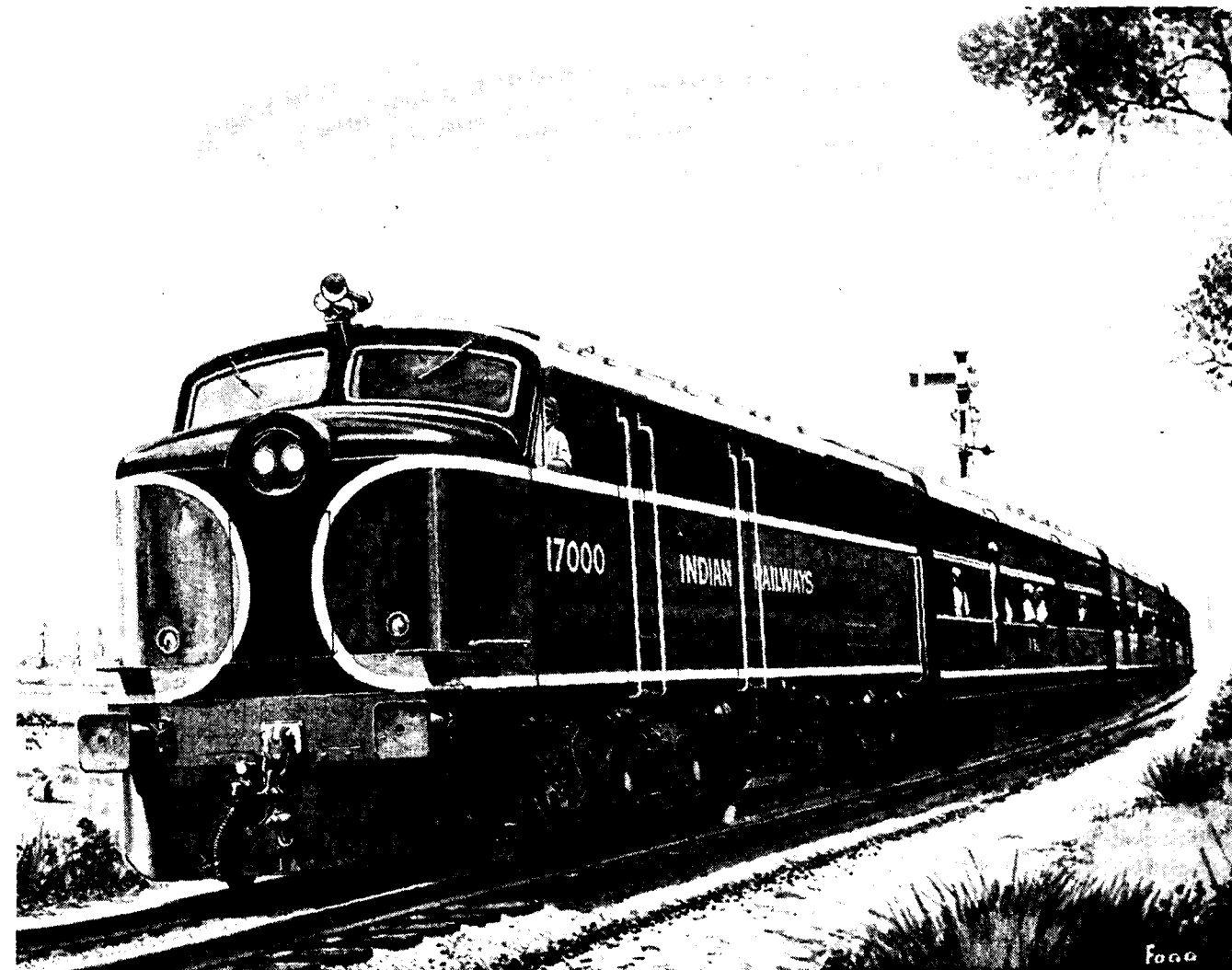


A typical ALCO road switcher of the post-World War 2 era is shown in Figure 2.

Various railways in the United States were at that time becoming more and more interested in diesel traction and the American Locomotive Company, as ALCO was then known, turned out 300 and 600 BHP shunters; three-power locomotives able to operate from diesel engine power, batteries or third rail, and other units of a more or less experimental nature.

ALCO's OWN DIESEL ENGINES— THE FIRST PASSENGER LOCOMOTIVE

The management of ALCO concluded very early that diesel traction would soon become an accepted form which would compete with steam on equal terms and gradually displace it. It was decided that the development of diesel engines suitable for rail traction should be undertaken without delay.



From the ALCO collection—write for 29 x 12 1/2 inch color reproduction, suitable for framing.

Proved around the world, this ALCO "World" locomotive is built for any gauge track, and operates in high-speed passenger or freight service.

INDIA GOES DIESEL WITH 100 ALCO "WORLDS"

A major step in the dieselization of the Indian Railways has been completed. Deliveries of ALCO diesel-electric "World" locomotives have been made on one of the largest locomotive orders ever placed from India.

The 100 new streamlined "World" locomotives are the first broad-gauge, main-line diesels to be used in India. Designed exclusively for overseas service, these 1950-hp ALCO locomotives are contributing to the economic progress of forward-looking countries throughout the world. Now also operating in Argentina, Spain, Peru,

Pakistan and Australia, they have been proved in service on nearly every continent of the globe.

The "World" locomotives are powered by the turbo-supercharged ALCO 251 diesel engine and utilize ALCO's famed running gear. They operate in high-speed passenger or freight service and feature high availability, simplified maintenance and low operating cost.

Built by the world's most experienced locomotive manufacturer, established in 1848, ALCO diesel-electrics mean progress the world over.

ALCO PRODUCTS, INC., 30 Church St., New York, U.S.A. Cable Address: Locomotive, N.Y.
FOREIGN ASSOCIATES AND LICENSEES: ALCO Products Export Company, Inc., 25 Victoria St., London S.W.1, England; Montreal Locomotive Works, Ltd., P.O. Box 1000, Place d'Armes, Montreal, Que., Canada; A. E. Goodwin, Ltd., 315 Parramatta Rd., Auburn, N.S.W., Australia. Agents throughout the world.

ALCO

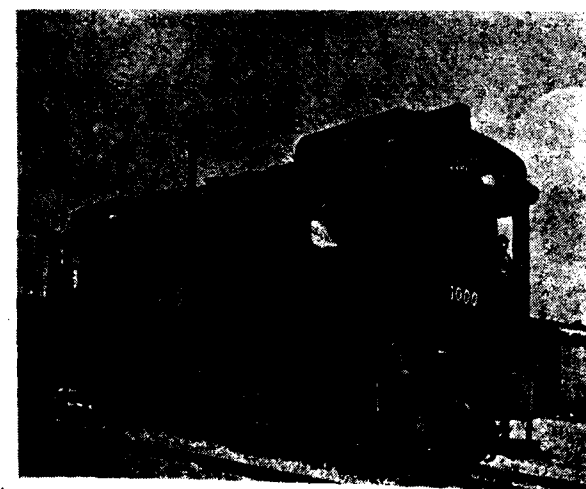


Figure 1 is a picture of the first diesel-electric locomotive built in America, which went into operation on the Jersey Central line in 1924 and gave 34 years of continuous service. It was built by ALCO Products, Inc.

Briefly, engines had to be made lighter and quicker running, but dependability and good specific fuel consumption could not be sacrificed.

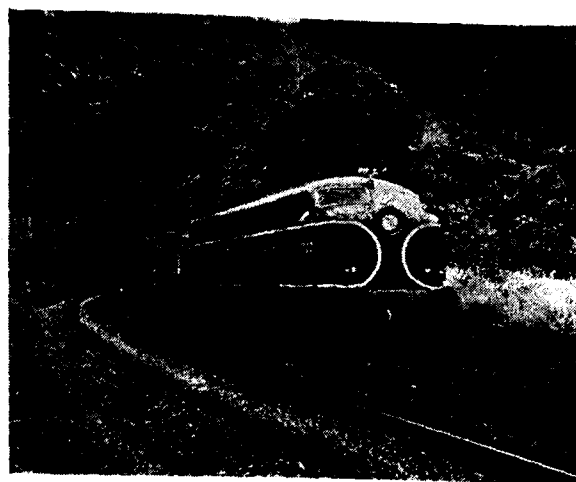
Two major designs appeared then in the early thirties. One was a $9\frac{1}{2}$ by $10\frac{1}{2}$, 700 RPM, 74 psi brake mean effective pressure normally-aspirated engine, of which quite a number of 6-cylinder units were built and installed in shunting locomotives.

The $9\frac{1}{2}$ x $10\frac{1}{2}$, 700 RPM engine is of particular interest because it must be considered the direct ancestor of the 1000 RPM post-war ALCO engines, the Models 244 and 251 of which several thousand are in service all over the world.

The other was a 12 $\frac{1}{2}$ in. by 13 in. 4 stroke engine, first built for railway service as a 6-cylinder, normally-aspirated unit developing 600 BHP at 740 RPM. It was a particularly successful design, and quickly became well known for its reliability.

By this time, however, experimentation on turbosupercharging was well under way, and by the beginning of 1936 a number of 900 BHP turbosupercharged engines had been installed in heavy shunting locomotives.

Early in 1940 the supercharged engine was pushed to 1000 BHP. These engines have been in constant production, the turbosupercharged unit to this day.



An ALCO "World" locomotive in operation between Dhanbad and Moghalsarai was photographed for Figure 3. One hundred of these locomotives are in service on the lines of the Indian Railways.

THE ROAD SWITCHER DESIGN—THE CONCEPT OF STANDARD LOCOMOTIVES

An interesting ALCO "first," dating from the war years, was the "road switcher" or hood type, all-purpose design. These were built first for the U. S. Army on a CoCo wheel arrangement and saw service in various war theatres, particularly in Iran. Figure 2 shows a typical road switcher of the post-war era.

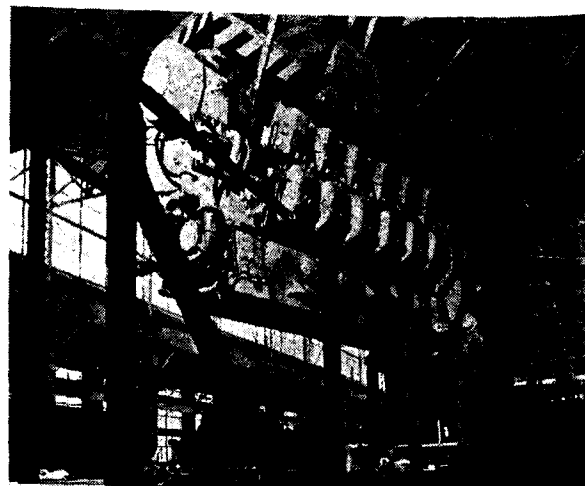


Figure 4 shows a 12-cylinder, 1950 BHP engine being lowered by crane onto a diesel-electric locomotive frame in the erection shop at ALCO's Schenectady, New York plant.

THE 244 ENGINE

About 1935 ALCO started experimentation of turbosupercharging on a 3-cylinder, $9\frac{1}{2}$ x $10\frac{1}{2}$ engine. This work was continued through 1940, when a 2-cylinder, vee-type 9 x $10\frac{1}{2}$ engine was built, to study scavenging and other matters. Finally in 1943 a prototype locomotive engine was built, but by then the war was on and ALCO was ordered to build steam locomotives, and to limit its diesel locomotive production to shunters and hood type general purpose units of the type described above.

As soon as hostilities ceased, ALCO put on the market a 12-cylinder, 9 x $10\frac{1}{2}$ engine, turbosupercharged, developing originally 1580 BHP at 1000 RPM, 157 psi brake mean effective pressure. The 244 engine, as it was called, was the first truly modern diesel engine for locomotive service, using fairly high (for the time) brake mean effective pressures and high pressure turbosupercharging.

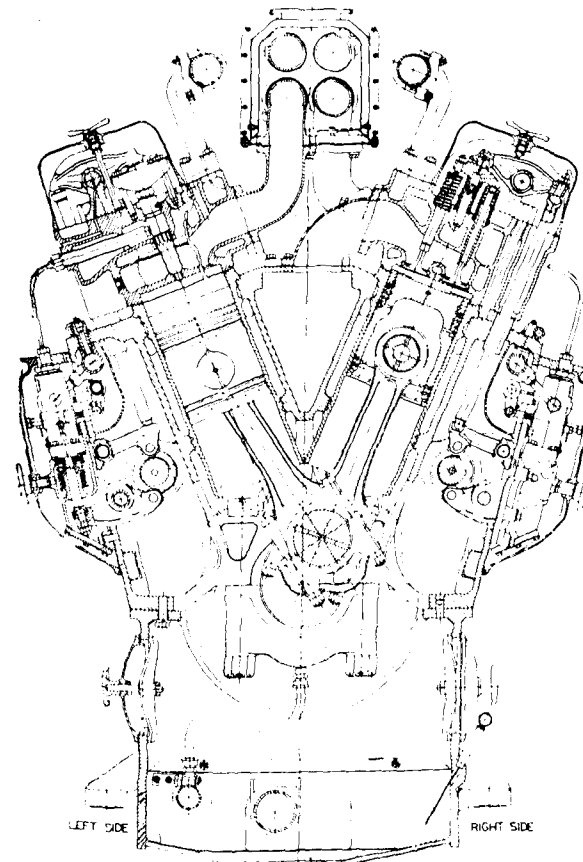
single 16-cylinder engine and geared for speeds up to 120 MPH.

THE INCREASE IN EXPORT BUSINESS—THE FIRST STANDARD EXPORT MODEL

The post-war period saw the beginning of the expansion of ALCO's export business. Strict adherence to the basic principles of standard locomotive production, in large numbers by assembly-line methods, had resulted in the availability of models of well-tried and proven features, offering a degree of economical and dependable operation unattainable in custom-tailored locomotives.

During the Pan-American Railway Congress in 1953 ALCO unveiled the "World" type locomotive. This was a streamlined cab unit of very moderate axle load (from 16 long tons), with the same power plant and auxiliaries of the United States locomotives. It fully met the limitations of the Berne Conference International clearance diagram.

The locomotive was fitted with six traction motors, giving it a continuous tractive effort of 45,900 pounds,



CROSS SECTION THRU VEE 251 ENGINE
LOOKING FROM GENERATOR END

The cross section in Figure 5 is that of a vee-type Model 251 diesel engine, which was designed and put into production by ALCO Products, Inc. during the last decade.

The first locomotives powered with this new engine were four axle streamliners for goods service, weighing 108 long tons. The continuous tractive effort was, even then, as high as 42,500 pounds. These locomotives were used four "in multiple" and greatly increased the tonnages hauled by railways throughout United States and Canada.

At that time passenger locomotives, with an approximate power requirement of 2,000 BHP per unit, were built with two power plants. The reason for this was (and still is, in those cases where twin-engine locomotives are still being built) the unavailability of a reliable single engine power plant of sufficient capacity.

This led to yet another ALCO "first." In 1946 ALCO delivered the first of many passenger locomotives of 200 HP net generator input powered by a



Three of the ALCO DL-640 locomotives are shown in Figure 6 at the head of a goods train in the snow near Schenectady, New York.

more than sufficient for the requirements of the great majority of overseas railways. The "World" locomotive was carried on two high-speed bogies of ALCO design. These 3-axle, 3-motor, double-suspension, swing-bolster, cast steel bogies could provide an excellent ride at all speeds on tracks in poor condition or lightly ballasted.

About 300 "World" locomotives have been built since, including 100 units now operating on the Indian Railways. One of these is illustrated in Figure 3 working a goods train between Dhanbad and Moghalsarai.

These locomotives have a CoCo wheel arrangement for 5 ft. 6 in. gauge track; overall length is 58 ft. 11 in., with weight of 246,000 pounds, all on drivers. Their axle load is 18.3 long tons and they have a continuous tractive effort of 45,900 pounds at 11.7 MPH, and a maximum speed of 65 MPH.

These locomotives are powered by a 12-cylinder 1950 BHP Model 251 engine, and are earning high daily mileages and have contributed greatly to the working of heavy goods trains in graded sections of the Indian Railways.

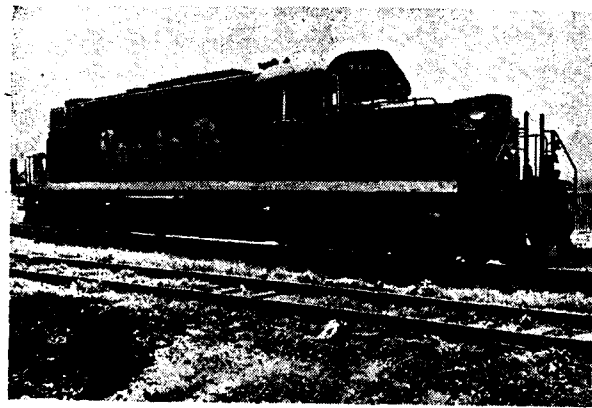


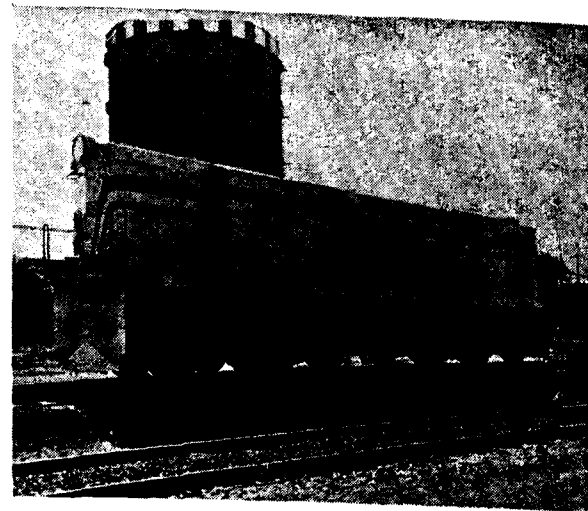
Figure 7 shows a picture of the DL-600, which is a 2600 BHP, 6-motor all-purpose, heavy-duty locomotive. The design pictured here is one of the new low-hood models which affords increased visibility for the engineer.

THE 251 DIESEL ENGINE

ALCO decided that, in order to put to best use the invaluable experience gained in building several thousand Model 244 engines, a new engine should be built which would incorporate the advances made in design and metallurgy, and utilizing charge air cooling.

In 1951 the prototype engine was assembled in the laboratory at Schenectady, New York, and a very long period of experimentation began.

The 251 engine retained the basic dimensions of the 244, that is, 9-in. bore by 10½ in. stroke, and carried its rated load at 1000 RPM and 193.5 psi BMEP. From the beginning the 251 engine was built in three sizes: six cylinder, in-line rated at 975 BHP; twelve cylinder, vee-form rated at 1950 BHP, and sixteen cylinder, vee-form rated 2600 BHP. The present rating



The lightweight, 1050 BHP all-purpose locomotive which appears in Figure 8 has been put into service by railroads in many parts of the world.

for the 6-cylinder engine is 1050 BHP at 1025 RPM, but the ultimate power output of this basic engine configuration is far from reached. Advances are made every day in fuel and air handling and improvements are introduced in the mechanical features of the engine.

Figure 4 shows a 12-cylinder, 1950 BHP engine ready to be lowered onto a locomotive frame. Figure 5 is a cross-section of a vee-type engine.

In order to give this engine the long life, reliability and economical operation that are essential for railway service the following features, among others, were incorporated in the design:

1. The welded steel block was made especially rigid and strong, having in mind future horsepower gains through higher mean effective pressures.
2. Grooveless design bearings were introduced, to increase their load-carrying capacity.

3. The combustion chamber design was carefully studied, and a form was adopted promoting intimate mixing of fuel and air.
4. Air flow patterns were studied until perfect scavenging with reasonable air economy was obtained.
5. Hard alloy replaceable valve seat inserts were used in the cylinder heads.
6. The aluminum oil-cooled pistons were fitted with a nickel alloy (Ni-resist) carrier for the top compression ring.
7. The efficient water-cooled high-pressure turbo-supercharger of ALCO design and construction used in the 244 engines was improved.
8. As explained before, after cooling, or charge air cooling as it is sometimes called, was incorporated.

In aftercooled engines the air leaving the turbo-supercharger compressor is led through a heat exchanger, water cooled, prior to its introduction into the engine cylinders. The cooling of the air at practically constant pressure results in a far denser air charge into the cylinders and permits higher powers to be obtained at favourable air-fuel ratios, with good

scavenging and moderate peak pressures and exhaust temperatures.

The combination of all these factors has made the ALCO 251 engine an exceptionally successful one.

As the 251 engines begin to reach high mileages, the results of these features are beginning to appear. Although it is outside the scope of this article to analyze operating results, it can be mentioned that periods of three and even four years of heavy service between light overhauls are being reached, with cylinder wear rates in the range of 0.0002 in./100,000 miles.

The present ALCO standard line covers locomotives basically suited to United States needs and others designed specifically for export, ranging from a 975 BHP U. S. A. type shunter to a 180-ton, 6-axle, 6-motor, 2600 BHP heavy-duty, all-purpose locomotive.

It is impossible within the confines of this article to describe in detail all of these locomotives, but we refer the reader to Figures 6 and 7, which illustrate the two most powerful locomotives in the United States-type ALCO line. They are the 2600 BHP 4-motor DL-640 high-speed goods locomotive, and the 2600 BHP 6-motor, all-purpose, heavy-duty DL-600 locomotive. The DL-600 develops the highest continuous tractive effort among all present-day diesel-powered locomotives. Figure 8 illustrates a 1050 BHP lightweight, all-purpose locomotive in use by many railways of the world.

BOOKLET DESCRIBING LIGHTWEIGHT G-E DIESEL-ELECTRIC LOCOMOTIVE

General Electric's (U. S. A.) new lightweight, high power model U6B diesel-electric universal locomotive is described in a specification made recently by the firm's Locomotive & Car Equipment Department in Erie, Pennsylvania.

The publication gives complete specifications of the 700 gross horsepower, 52-ton U6B locomotive, the lightest in G-E's line-up of universal type units. Speed-tractive effort and speed-dynamic braking curves are presented as are details concerning the diesel engine, traction motors, generator and other major components.

Copies of the 14-page, well illustrated specification may be obtained by railroad officials and technical personnel, and government transportation officers by writing to General Electric Company, Locomotive & Car Equipment Department, Erie, Pennsylvania, and asking for specification number 4836A.

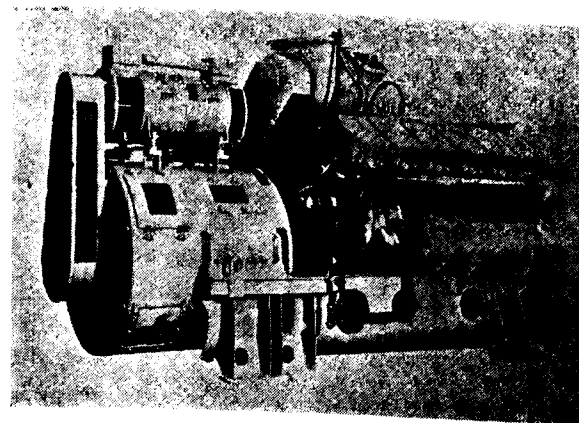
ITALIAN LIGHT BOGIE LOCOMOTIVES

Diesel-electric design for 13-ton axle loads and 50 m.p.h. top speed

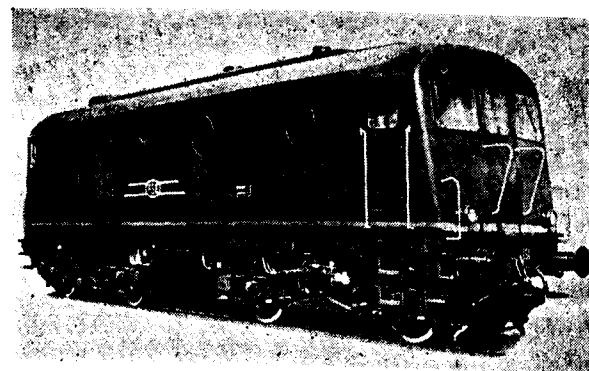
INCREASING construction of diesel motive power by Italian builders is not merely to orders of the Italian State Railways and of certain foreign railways; but is also for Italian private railways, both on the mainland and in Sardinia. Among these last-named are 13 double-bogie standard-gauge diesel-electric locomotives of 825 b. h. p. and 13 tonnes maximum axle load now in course of delivery to the Ferrovie del Sud-Est, a system almost 300 route miles 1475 km. in length, and which already has ten or a dozen diesel railcars in traffic. These locomotives are being built by Nuove Reggiane as to the mechanical and engine portions, and by Ercole Marelli for the electrical transmission and control equipment. Nuove Reggiane has, and has had for some long time, an M. A. N. engine licence.

A Bo-Bo double-cab design with full-width superstructure has been adopted, but multiple-unit control is not normally embodied, though facilities for its installation have been provided. General dimensions

and layout of equipment are shown on the diagram elsewhere in this article. All power, control and auxiliary equipment is installed in one large machine room extending between the two cabs, and includes a train heating boiler with a capacity of 300 kg. (660 lb.) an hr. plus two side boiler water tanks holding about 1,500 kg. (330 gal.) total. Fuel tank capacity is 1700 kg. (450 gal.), and the fuel tank is slung below the underframe between the bogies. The bogies themselves are on the principles widely adopted for Italian diesel locomotives and railcars, with hollow box-section frames, roller-bearing axleboxes supported on each side by helical springs, and a bolster supported on each side by an inverted laminated spring. Westing-house air brakes, with Breda distributor are fitted—straight air brakes for the locomotive and automatic equipment for the train, and the straight



A view of the Generator.



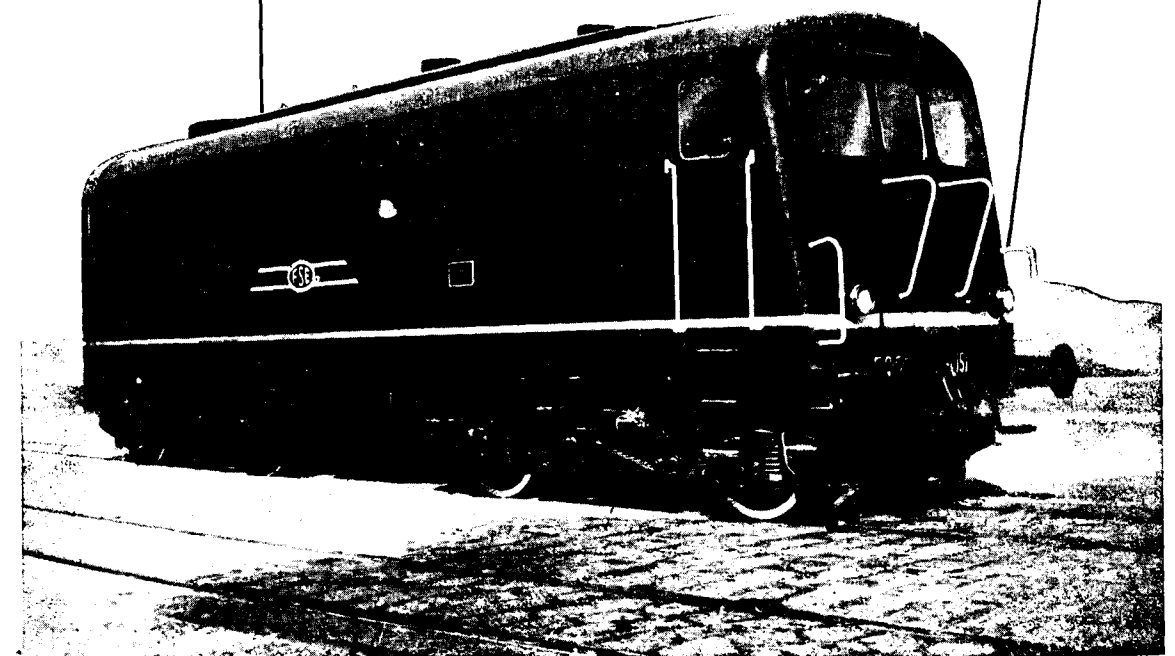
*Diesel-electric Locomotive
for "Ferrovie Del Sud-Est - S.p.A." Rome*



Another view of the Generator.

Marelli

COMPLETE ELECTRICAL EQUIPMENT FOR D.C., A.C.
DIESEL-ELECTRIC LOCOMOTIVES
AND FOR METROPOLITAN RAILWAYS



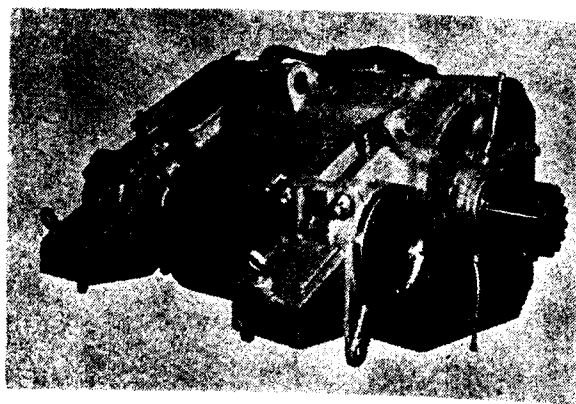
DIESEL-ELECTRIC locomotive built by MARELLI-NUOVE REGGIANE for the South-East Railways S. P. A. Type Standard « UNIFER B 13 ». — U. I. C. continuous power 825 HP — 13 units are being built.

280 1350 HP DIESEL-ELECTRIC locomotives, type Co-Co, are being constructed for the Argentine Railways by the ITALIAN and ARGENTINE group G. A. I. A. Projects and design are by E. MARELLI & C., S. P. A. The electric traction equipments are of the same design as above.

ERCOLE MARELLI & C. - S.p.A. - MILANO



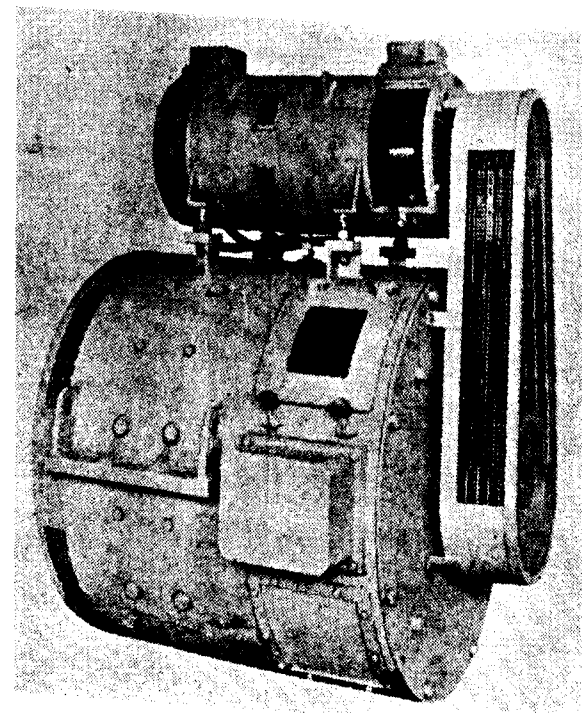
Driver Cab.



Traction motor type MCT 80 B 60

brakes apply two blocks per wheel. Air from the brake system is used for the sanding, applied to the outside of each wheel.

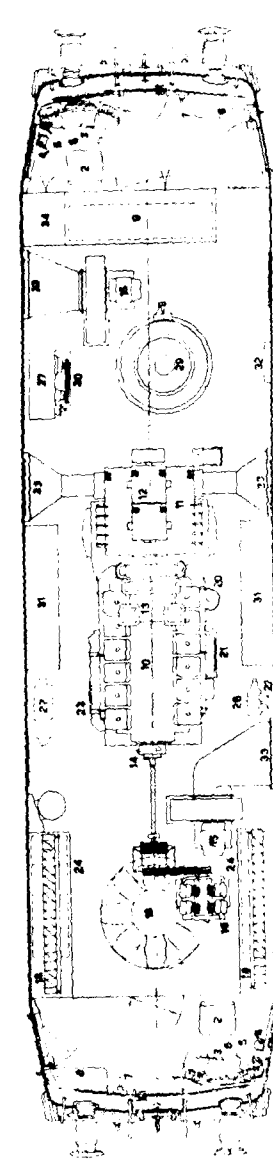
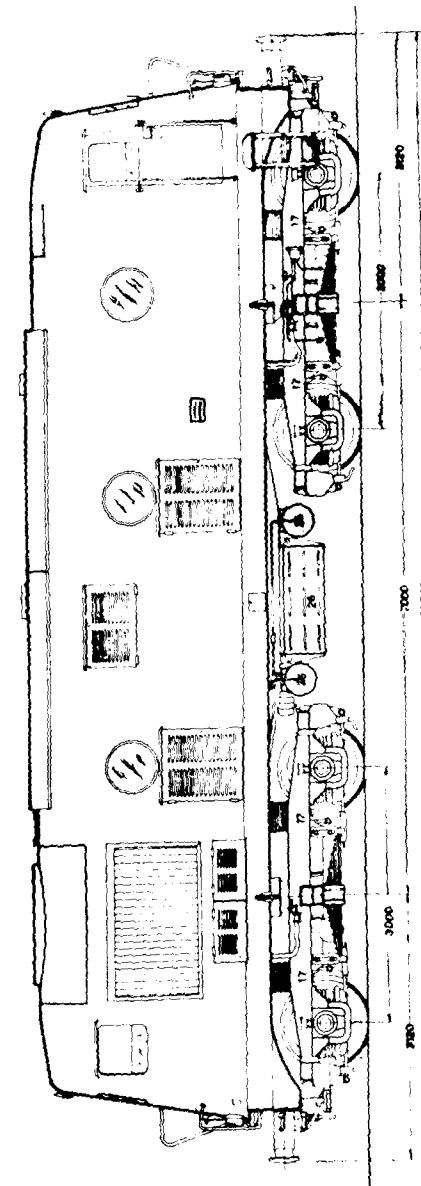
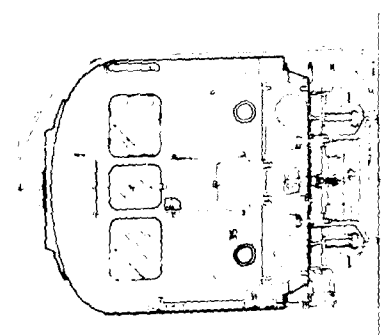
Empty weight of a locomotive is 49.4 tonnes, fully-laden weight 53.25 tonnes, and weight with two-thirds supplies about 52 tonnes. Starting tractive effort is 14,000 kg. (30,800 lb.), equal to about 27 per cent adhesion, but this value is available up to approximately 10 km. p. h. (6.2 m. p. h.). Top designed speed is 80 km. p. h. (50 m. p. h.) and at this speed



Main generator type MCL 140 D 60 with auxiliary group.

2,100 kg. (4,625 lb.) of tractive effort are available at the wheel rims. Continuous rated tractive effort at the wheel rims is 7,300 kg. at 23 km. p. h. (16,050 lb. at 14.6 m. p. h.), and one-hour rim tractive effort is 8,400 kg. at 20 km. p. h. (18,500 lb. at 12.5 m. p. h.). Wheel dia. is 1,000 mm. (39.37 in.) and traction motor gear ratio is 14 : 67. Curves of 80 metres (262 ft.) radius can be traversed at slow speed.

Motive and auxiliary power is furnished by a Nuove Reggiane M. A. N. type L 12 V 17.5/21A engine, a 12-cylinder V of the model preceding the L 12 V 18/21A engine now being used in Great Britain and Germany. Though it is considered to have a one-hour output of 920 b. h. p. at 1400 r. p. m., in this particular installation the traction rating is 825 b. h. p. at 1,300 r. p. m. Dry weight of this turbo pressure-charged unit is 3,500 kg. (7,700 lb.), or 4.25 kg. (9.4 lb.) per b. h. p. An auxiliary-drive shaft is taken off the front of the engine, a furnish power to the four-cylinder V reciprocating air compressor and the cooling radiator fan. The radiator banks are on the locomotive sides and the fan in the roof, and a pre-heater is included in the water circuit. A heat-exchanger is attached to one side of the crankcase for the cooling of the engine lubricating oil, and the oil is passed through a bank of Savara filters on the other side of the crankcase.



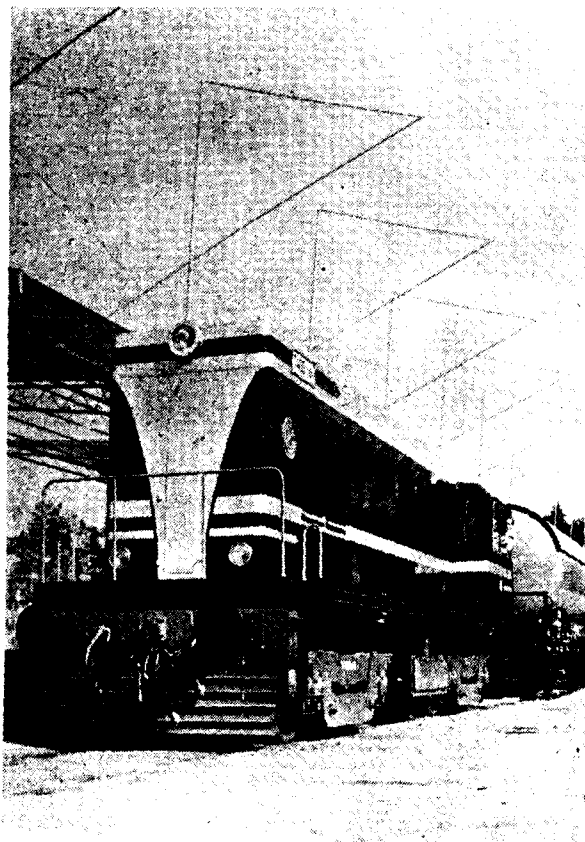
LOCATION OF PRINCIPAL PARTS

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

Engine and generator group are supported on a common welded steel underbed carried on the locomotive underframe through four semi-resilient mountings; and this underbed is unusual in being carried right round under the engine crankcase and sump. The Marelli main generator is an eight-pole separately-excited machine weighing 3,400 kg. (7,500 lb.), and traction input to it is up to 770 h.p. This machine, and its over-mounted belt-driven auxiliary generator-exciter unit, though self-ventilated machines, draw in their air through panel filters on the locomotive sides, with ducting thence to the main generator intake. The auxiliary machine provides current for battery-charging, two traction-motor blower groups, and the control and lighting circuits. The exciter is a special machine with six poles on which are carried three groups of windings, viz.,

self-exciting, a differential field winding carrying the current of the main generator, and a winding excited by the storage battery and regulated by a rheostat on the Woodward PG-type governor on the engine. The four nose-suspended traction motors are four-pole series-wound force-ventilated machines with cast-steel frames, and, with pinion and gearcase, weigh 1,660 kg. (3,590 lb.) each. Automatic shunting of the fields comes into operation at a predetermined track speed. The two ventilating blowers have individual electric driving motors, and each draws its air through a panel filter on the locomotive sides. Control is on the Marelli-Westinghouse Autoload system, and its auxiliary circuits include an automatic wheel-slip correction embodying automatic application of sand and reduction of current as well as other conventional features.

ČKD T 435.0 TYPE HEAVY DUTY DIESEL-ELECTRIC LOCOMOTIVE



The works manufacturing the ČKD T 435.0 Type diesel-electric locomotive has a 30-year old tradition in making diesel traction vehicles.

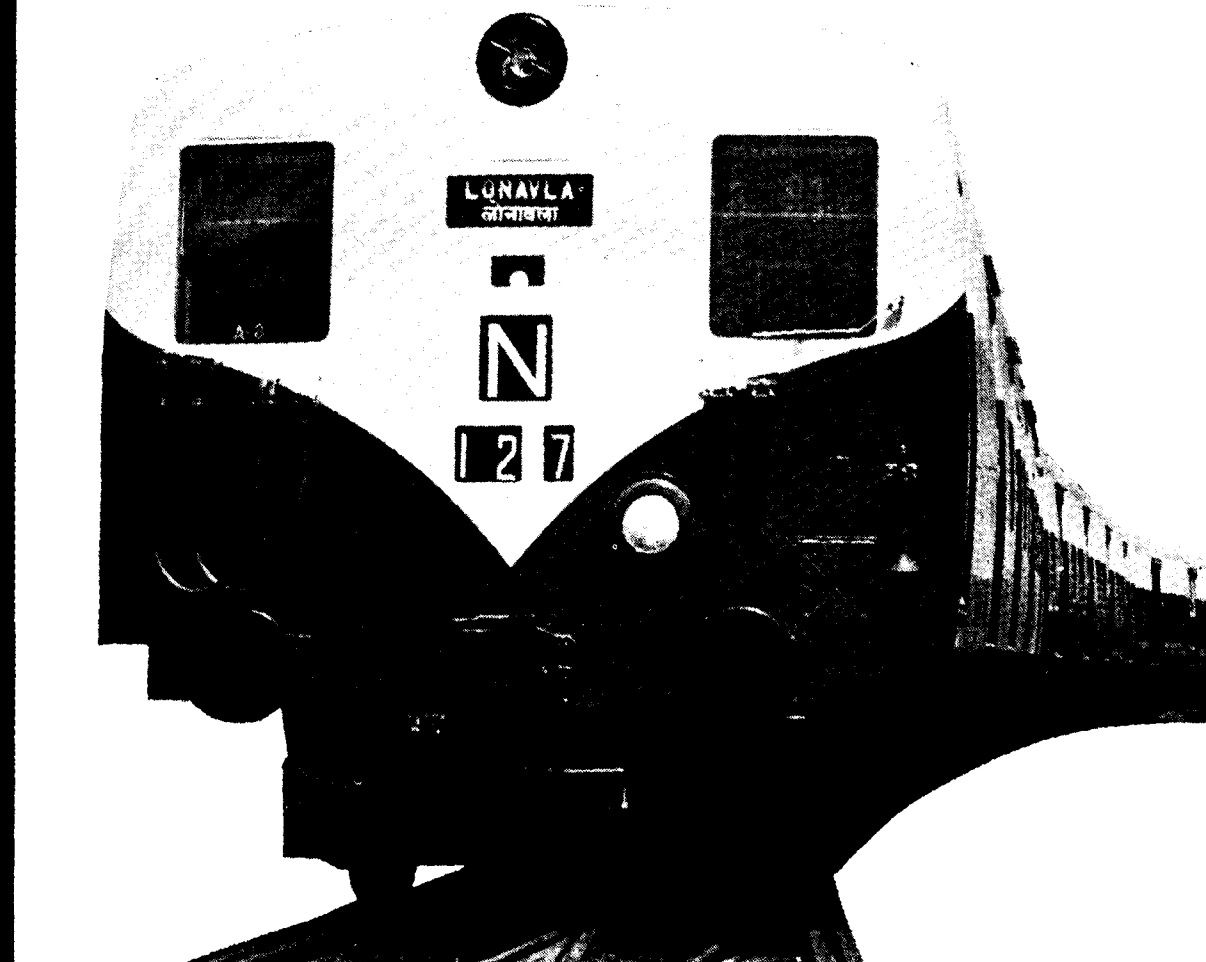
This locomotive is used mainly for shunting purposes in railway shunting yards but it is also well suited for servicing main and branch line freight trains and for shunting work in plant yards. Its maximum speed, tractive force and axle load correspond to the said versatility of the locomotive.

Its engine is a robust ČKD low-speed engine which secures a faultless supply of power even under the most difficult conditions encountered in the shunting yards.

Here are the main technical data: wheel arrangement Bo' Bo', rail gauge 1,435 mm to 1,676 mm (4'—8 1/2" to 5'—6"), output 750 HP, weight 60 tons (59 long tons) maximum speed 60 to 70 kms/hour (45 to 49 miles/hour).

If required, this ingeniously designed locomotive can be adapted for work in extreme temperatures varying between +40 and —50 grades Celsius (+ 104 and —58 grades Fahrenheit).

ELECTRIC COACHES



Speedy, dependable transportation is the backbone of a nation's industries and economy, and Toshiba rolling stock, like the electric multiple unit coaches shown above, are doing their part in speeding the industrialization of India. These sleek, efficient coaches have robust bogie frames, powerful traction motors, efficient brake systems and deluxe interiors to insure comfort and safety for passengers. Toshiba looks forward to further serving the railways of India.

Toshiba TOKYO SHIBAURA ELECTRIC CO., LTD.

Ginza Nishi 5-chome, Chuo-ku, Tokyo, Japan Cable : TOSHIBA TOKYO

The Recent Tendencies in Japanese Railways

By Mr. T. Kawai

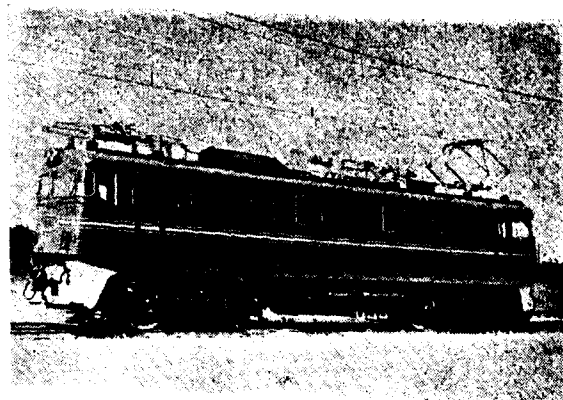
Technical Section, Overseas Division, Hitachi Ltd., Tokyo, Japan

ELECTRIFICATION of the Japanese National Railways (herein after referred to as J.N.R.) on A.C. 20 KV, single-phase 50-cycle system is progressing at a fairly rapid pace. A long-term comparative test which has been conducted on the Tohoku line, Japan's first A.C. electrified trunk line, to determine the type of mercury rectifier to be used on Type ED 71 electric locomotive has ended recently to prove the superiority of "Excitron" system over "Ignitron" system. The "Excitron" system mercury rectifiers now in use on the J.N.R.'s A.C. locomotives have all been supplied by Hitachi, Ltd.

This 64-ton, Type ED 71 locomotive with the one-hour rating output of 2,040 kW is designed for service of both passenger and freight cars (i.e., dual purpose type). It should be able to start on 1% upgrade hauling 1,200-ton load. In order to fulfil these conditions, various new mechanical and

electrical designs have been incorporated in this locomotive whereby to increase its adhesive character.

Another new electric locomotive has recently been developed. This is an A.C.—D.C. two-way Type ED 46 locomotive and is intended for use on the Jobal Line which will be changed over to A.C. this year. Joban line is connected with D.C.-electrified sections. However, by the use of this new locomotive, the train can run from A.C. sections to D.C. sections or vice versa without changing its locomotive.

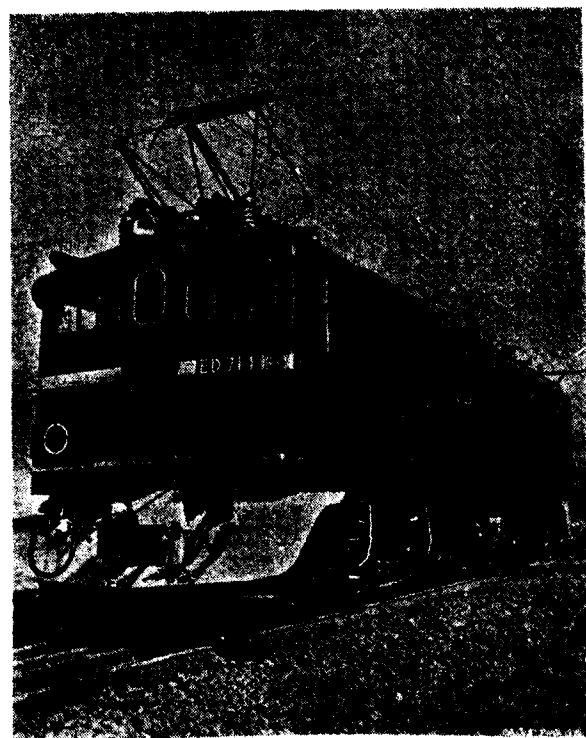


Type ED 46, AC 20 KV, 50 ϕ , AC, DC, Two Way Electric Locomotive.

This locomotive is operated as an "Excitron" mercury rectifier locomotive so far as it is within A.C. 20 kV section. In D.C. 1,500 V section, its mercury rectifier are used as inverter from which to obtain A.C. source for train heating equipments.

This 64-ton electric locomotive has an output of 1,400 kW and is designed as one truck-one motor system powered by two 700 kW traction motors.

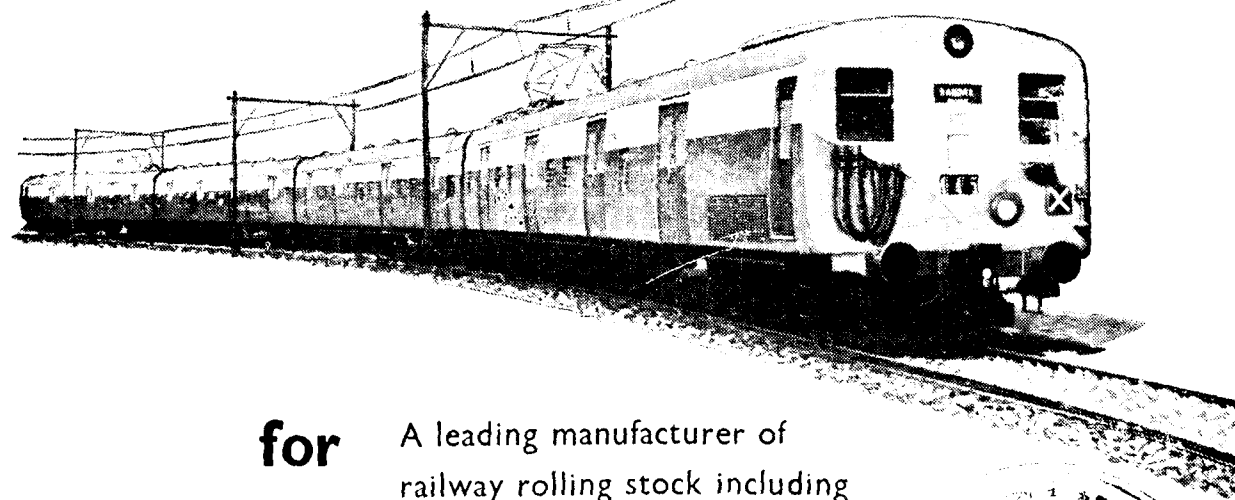
Changing-over between A.C. and D.C. can be performed by means of a commutating switch installed on the locomotive, without bringing the car into a stop.



Type ED 71, 'Excitron' Mercury Rectifier system AC. 20 KV, 50 ϕ , Electric Locomotive.

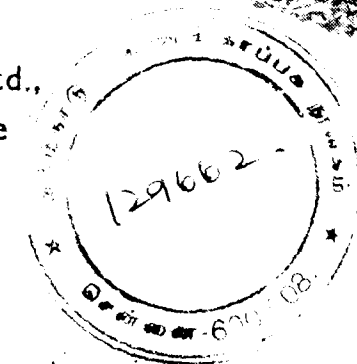
Hitachi

'EMU' Coaches manufactured by Messrs. Hitachi Ltd. and supplied to the Western Railway.



for
Indian
Railways

A leading manufacturer of railway rolling stock including electric locomotives Hitachi Ltd., Tokyo, Japan, also manufacture a large range of heavy electrical equipment.



MAIN PRODUCTS:

Electric Locomotives; Electric Multiple Unit Coaches; Steam, Diesel-Electric and Diesel-Hydraulic Locos; Passenger Coaches; Wagons; Hydro-Electric and Thermal Power Plants and Transformers of the largest size; H.T. & L.T. Switchgear, Substation Equipment; Electric Overhead Travelling Cranes.



Sale Agents in India:

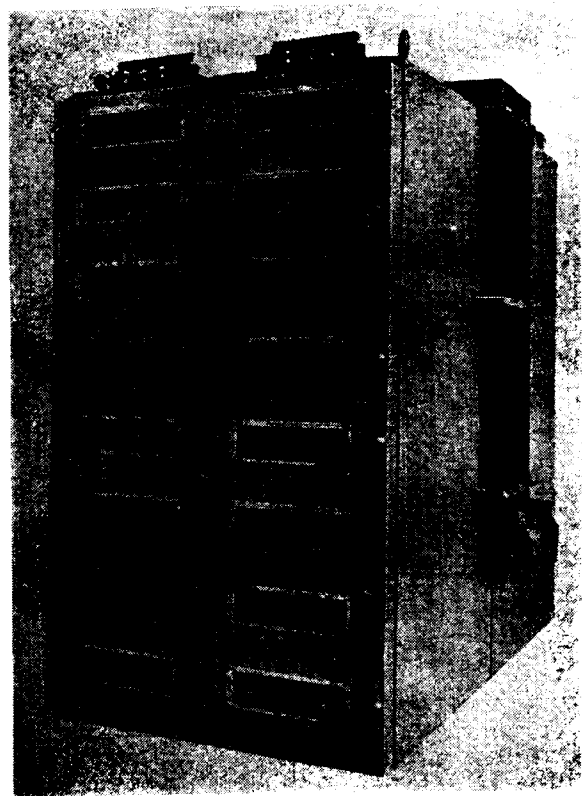
William Jacks & Co. Ltd.

(Incorporated in England. Liability of Members Limited)

Calcutta Bombay Madras New Delhi.

Type ED 4521 A.C. electric locomotive is originally manufactured as an "Excitron" mercury rectifier system and has proved its excellent performance during its service run since 1957. In 1959, the mercury rectifier on this locomotive was changed to a silicon rectifier, which was designed and manufactured by Hitachi, Ltd. Its specification is as follows: 1,600 kW, 650 V, 2,460 A (continuous), forced ventilation system.

This ED 4521 locomotive is 60 tons in weight and has a continuous rating output of 1,500 kW. With



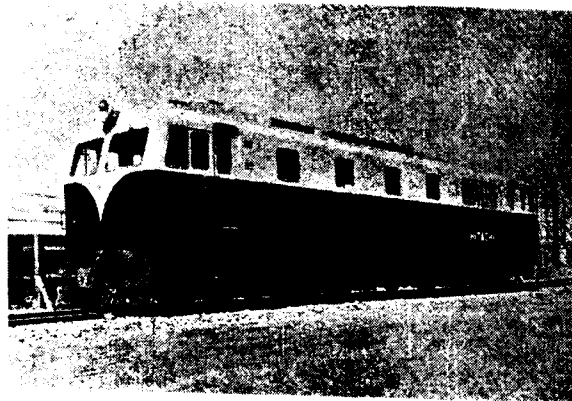
1,600 KW Silicon Rectifier for ED 4521 AC, 20 KV, 50 c/s, Electric Locomotive.

a high tension tap changing system incorporated, this is the first silicon rectifier system locomotive ever built in Japan, capable of starting on 2.5% upgrade hauling 500-ton load.

In view of its small size, light weight and simple construction as well as easy handling characteristic,

this silicon rectifier is expected to be favoured increasingly for use on A.C. locomotives and coaches in the world.

Dieselization is another world-wide trend, noticeable in the South East Asian Nations, too. Hitachi exported many Diesel electric locomotives to Thailand and Taiwan. These locomotives are powered by



1,100 HP Diesel Hydraulic Locomotive for J.N.R.

Type Hitachi-M. A. N. Diesel engines, and those supplied to Thailand are of 72-ton, 950 BHP and those for Taiwan are of 81-ton, 1,560 BHP.

As compared to the Diesel electric locomotive, the Diesel hydraulic locomotive is simpler in construction and more economical, and because of these favourable features, this type of locomotive is being manufactured for large HP ratings, partly due to the recent improvement of hydraulic torque converter.

The J. N. R. is proceeding with a plan for replacing the present Diesel electric locomotives with the Diesel hydraulic locomotives in the range not exceeding 1,000 BHP class, with the objective of cutting down railway expenses.

Hitachi, Ltd., being well aware of this trend, has recently developed a 1,100 HP Diesel hydraulic locomotive in which a torque converter of Hitachi's unique design is used. This locomotive is scheduled to be run on the J. N. R.'s network for trial.

Large Light Metal Pistons with Oil-Cooling Systems

By Dipl.-Ing. J. Gadow*

IN a short survey the author discusses the different kinds of oil-cooling systems for light metal pistons. Of a multitude of proposals a few have been selected and used successfully and economically for series production.

In addition to the various methods used for cooling cast pistons, a method for pressed pistons is also shown and the cooling effect of the more important designs compared.

INTRODUCTORY REMARKS

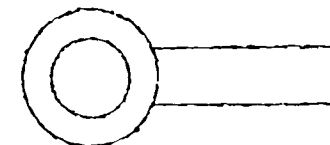
One of the main reasons for the introduction of light metal pistons in medium-sized and large engines—as far as truck type pistons are employed—

was that such pistons could dissipate heat better without requiring a special cooling system, a fact important enough to drop in many cases the more complicated and more expensive cooled pistons made of cast iron.

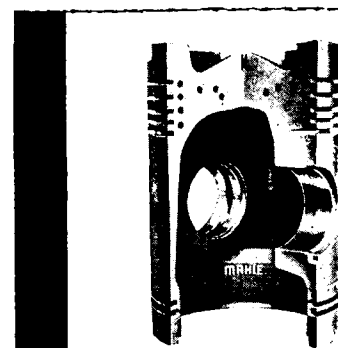
In recent years also in light metal piston construction one is increasingly concerned with oil cooling systems because of rising specific piston loading and higher engine speeds resulting in higher thermal and mechanical loading of the piston.

In the following a few oil cooling systems for cast and forged pistons are shown and the various types shall be discussed critically in order to show up a

Precision-made pistons for all types of high-speed and low-speed oil engines from 125 mm. to 325 mm. dia. for all types of railway motive power.



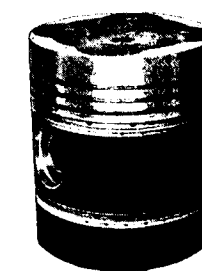
MAHLE



Piston with cast-in cooling device 12 1/4" bore = 323,85 mm.



Piston with cast-in ring carrier and cooling device 12 1/4" bore = 317,50 mm.



Forged aluminium piston with graphite-lined skirt 7.086" bore = 180 mm.

MAHLE Komm.-Ges. Stuttgart-Bad Cannstatt, Germany

*Report of the Research and Development Department of Mahle KG, Stuttgart-Bad Cannstatt (Germany).

few useful and promising solutions for practical application.

The thermal critical points on a piston are in the region of the crown and in the ring belt area. Crown temperatures should not exceed $330-350^{\circ}\text{C}$, ($630 \div 665^{\circ}\text{F}$) and should not go beyond $200-230^{\circ}\text{C}$ ($380 \div 445^{\circ}\text{F}$) at the first ring groove. If the crown shows local temperature peaks dependent on the combustion process and exceeding the cited limits there is a danger of fissures forming in the material of the crown and the temperature at the first ring groove should not exceed the above mentioned limits because otherwise the oil might be cracked.

Before thinking of adding a separate oil cooling system, all efforts should be made to exploit the simpler constructional possibilities to obtain a higher cooling efficacy. Among such structural means are improved heat flow cross sections to carry the heat from the crown to the ring belt area and the skirt. For thicker crowns and improved transition to the ring section a lowering of temperature from $10-20^{\circ}\text{C}$ ($18-36^{\circ}\text{F}$), e. g. at the crown, was measured.

The clearance of the piston can also influence the temperatures, particularly near the ring zone, because a well guided piston will not be subjected to additional influx of heat.

Before making a decision in favour of an oil cooling system the desired degree of cooling should be determined first. This is done most effectively by measuring the temperatures of a non-cooled piston to find out how much the temperatures exceed the permissible maximum limits.

Besides making a decision for a certain oil cooling system, the cooling oil circuit must be laid down. The considerations may be made according to the circuiting of the cooling oil e. g.

if the cooling oil is drawn from the lubricating oil circuit, or if the cooling oil has its own separate circuit.

Since the different types of pistons often permit the use of one or the other of the above circuits, in the following the various kinds of oil cooling systems will be discussed.

OIL COOLING SYSTEMS

1. Spray Cooling

The simplest method of oil cooling is the spray

cooling of the inside surface of the piston crown. The oil flow should be constantly directed against the crown. The oil comes from the lubricating oil circuit over the connecting rod and a nozzle on the small end of the rod, or over a nozzle attached to the bottom of the cylinder. Fig. 1 shows a schematic view of such an arrangement. The method is often used because it requires little structural changes and in most cases only the oil circulation must be increased.

2. Splash Cooling with Splash Chambers (Shaker)

If the system of spraying oil against the piston crown is to be still further improved, the splash cooling method is the answer (Fig. 2). In this method the oil is much longer in contact with the inside surface of the piston and will thus carry off more heat.

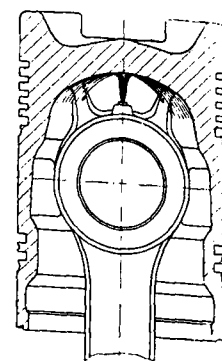


Fig. 1.
Cooling by spraying oil on inside of piston crown. Nozzle on small end of piston rod.

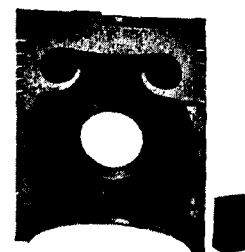


Fig. 2.
Splash cooling by means of cast-in cooling chamber (Shaker).

The desire to get the cooling oil into the flow of heat between piston crown and ring section should not tempt the designer to reduce the wall thickness at the ring section beyond permissible limits. There should still be a sufficiently thick cross section next to the splash chamber to allow for satisfactory dissipation of heat even if the cooling oil supply should fall out, which may happen during the starting period or when bearing clearances are too high.

If the cooling action is to be still further increased and the coolant is expected to dissipate even more heat, the splash chambers should be of the closed type. Such chambers are hard to manufacture because either cores or cast-in sheet bodies must be

used. Cooling oil may be supplied by a nozzle on the small end of the rod, or a collecting funnel at the lower skirt end may be used, into which oil is sprayed by means of a fixed nozzle.

The disadvantage of cast-in sheet bodies is that their very presence obstructs the heat flow from the piston body to the cooling oil, while on the other hand manufacturing costs may be lower.

However, this type of cooling requires already considerable structural means, and the additional step to the more effective oil-cooling by forced circulation is but a small one.

3. Forced Circulation Oil-Cooling

Forced circulation oil-cooling means that an uninterrupted and controlled cooling oil supply is led to the areas requiring cooling. Telescopic tubes or pipes may be used for the purpose, permitting independent circulation of the cooling oil. Or the oil flows over connecting rod and wrist pin towards the cooling area as a separate branch of the lubricating oil circuit.

Fig. 3 shows a piston with a cast-in cooling coil in which the oil flow is arranged in such a manner that the piston crown and the ring belt area are cooled. The gudgeon pin bore shows a slot through which the oil is taken vertically upward to the cooling coil.

This system has been efficiently employed in many engines.

Fig. 4 shows a piston with a ring section subsequently shrunk on and welded. Here, the oil flow areas may be machined in such a manner that they cover the entire ring zone and allow for direct heat transfer from the piston material to the oil.

The oil is supplied over the gudgeon pins and annular oil ducts, a technically complex cooling system.

Assembled pistons, that is, pistons with a light metal skirt and screwed-on steel crown facilitate the inclusion of cooling chambers. Stool-type pistons preferred particularly for two-stroke engines belong to this type.

For such pistons both methods of supplying cooling oil described may be employed. The constructional means are however high.

In certain cases the strength expected of the piston material may be so high that cast light metal pistons are no longer sufficiently safe. Forged pistons will then be used, which offer for the same alloy a higher degree of strength.

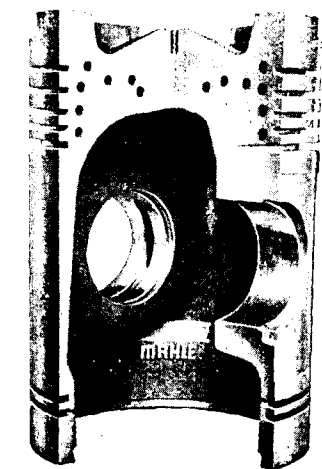


Fig. 3.
Cooling of piston crown and ring zone by means of cast-in cooling coil.

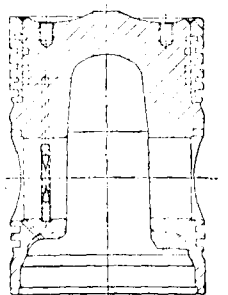


Fig. 4.
Machined cooling channels of piston with shrunk-on and welded ring belt. Oil supplied through gudgeon pin bore.

The piston shown in Fig. 4 can be made of a raw forging. Another possibility of effectively cooling forged pistons is the method of cutting-in grooves and closing them by welding. This raised the problem of eliminating the creation of sharp edges during the closing of the cooling ducts. A solution was found by closing the groove with a round wire, which is protected in such a manner that it will not be damaged by the following welding process (West German Pat. pending).

Fig. 5 shows a ground section of a cooling zone, covered and welded as described above.

The method has been highly efficient for engines having high thermal loads.

The direct heat transfer from piston material to cooling medium thus resulting leads to a highly efficient cooling system.

COMPARATIVE CONSIDERATIONS

The table below shows temperature drops possible for the successful oil cooling methods described above. However, it should be noted that the cooling

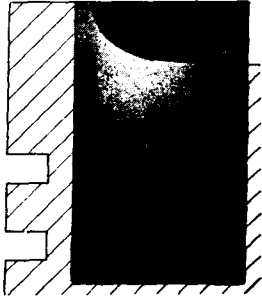


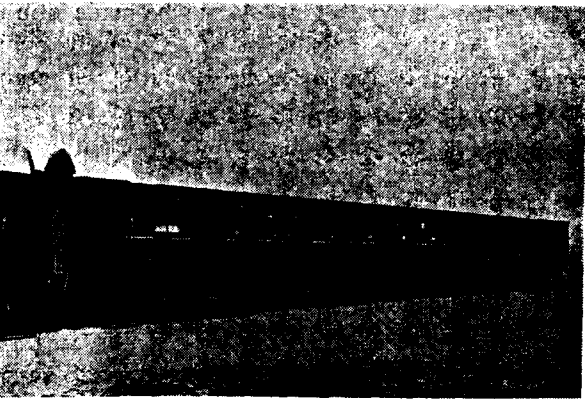
Fig. 5.
Cut-in cooling ducts in forged piston, sealed by round wire. Ground section showing weld and wire.

effect also depends on the temperature gradient, that is, on the height of the temperature of a given piston.

The values should therefore be taken more or less as a general means of comparison in judging the efficiency of the different systems.

BUFFET CAR BRa TATRA

In connection with the increasing claims on railway travel the Czechoslovak Wagon Industry has added to its assortment of products the type BRa car which has



been derived from the basic range of I-st and II-nd class passenger carriages. It has four 2nd class compartments and a buffet compartment separated from the corridor and fitted with a buffet table, a kitchen and a dining compartment seating 17 passengers.

The underframe and body of the carriage form an electrically welded self-supporting structure. The side

Table
Temperature Reduction as a Result of Different Methods of Oil-Cooling.

Method	Temperature Reduction center of crown	Temperature Reduction 1st ring groove
Spray cooling	40° C (72° F)	40° C (72° F)
Splash cooling	40° C (72° F)	50° C (90° F)
Coil	50° C (90° F)	60° C (108° F)
Cut-in grooves	80° C (144° F)	90° C (162° F)

1° C = 1.8° F

CONDITION OF OIL

The quantity of cooling oil must be specially determined for each case. A good reference value would be 3 kg/PSh (6.6 lbs/HPh). Oil temperature should not rise above 80° C (176° F), particularly when the cooling oil is taken from the normal oil circuit. In many cases special oil coolers will be required. When the oil is taken from the lubricating oil circuit, the increased oxidation may cause the oil to age quicker and shorter oil change periods are recommended.

walls and roof are perfectly insulated against heat and sound. The interior arrangement is tasteful and modern, the panelling, moulding, fittings and



up-holstery forming and agreeable and harmonious whole.

The Tatra BRa car enables improvement of the comfort of passengers even on those railway lines on which the use of a dining car of classical construction would be uneconomical.

RESIN-BONDED FABRIC BEARINGS & SPRINGS SUPPLEMENT

RESIN-BONDED FABRIC BEARINGS

By P. R. Joy, B. Sc.*

RESIN-BONDED fabric bearings have been used successfully in the steel-rolling industry for over twenty-five years. The many advances made in the plastics and textile industries during this period are reflected in the improvement in properties of fabric bearing materials which are now accepted as reliable engineering materials possessing many unique and valuable properties.

The basic materials are made by first impregnating woven fabric or chopped fibre with a thermosetting resin. The impregnated cloth or fibre is formed in or on a mould and the resin caused to set or cure by the application of heat and pressure or by chemical means. The solid form is then removed from the mould for machining to the required dimensions. The resins employed are always of the thermosetting type which cure to form high molecular weight, three dimensional polymers which do not soften on heating. The finished material then consists of layers of fabric embedded in the solid continuous matrix of the resin.

A wide choice of fabric resin combinations is open to the manufacturer of fabric bearings and different combinations are usually provided to suit differing conditions of use. In practice, the success of a bearing depends largely on the use of the right resin with the right fabric. Table I gives the properties of one type of fabric bearing material.

TABLE I
Properties of 'Orkot' Resin-Bonded Fabric Bearings

Physical properties	
Specific gravity	1.25
Compressive strength (flatwise)	36,000 p. s. i.
Tensile strength (lengthwise)	10,500 p. s. i.
(crosswise)	7,500 p. s. i.
Shear strength	15,500 p. s. i.
Young's modulus (in flexure)	550,000 p. s. i.
Impact strength (Izod)	3.5 ft. lb.
Hardness (Rockwell M)	110

*United Coke and Chemicals Company Limited.

Thermal properties	
Thermal conductivity (average)	7×10^{-4} g.cal (sec) (cm ²) (°C./cm)
Linear expansion coefficient	20—100°C (per °C)
(i) Parallel to laminations	1.4×10^{-5}
(ii) Right angles to laminations	7.9×10^{-5}
'Orkot' is not normally recommended for use at temperatures above 220°F (105°C)	

Electrical properties	
Insulation resistance (BSS. 972)	30 megohms (aver.)
Electric strength after water immersion (BSS. 972)	Passes proof 3 kV
Electric strength at 90°C (BSS.972)	Passes proof of 3 kV

Water absorption	
BSS. 2966 1 in. thick (24 hr. immersion)	0.4 per cent
(100 hr. immersion)	1.05 per cent

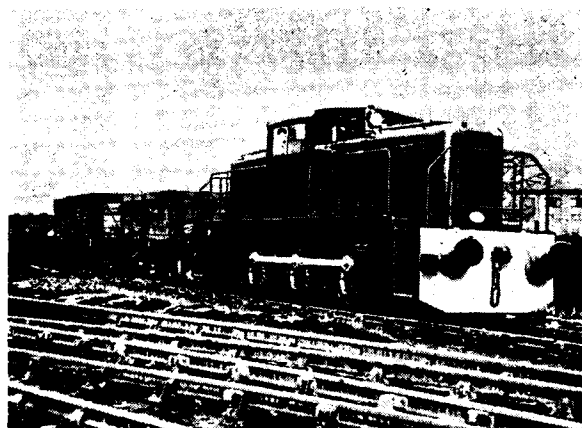
Radiation resistance	
Total radiation dose	Per cent loss in compressive strength
1×10^8 röntgens	5
3×10^8 röntgens	20
10×10^8 röntgens	50

THEORETICAL CONSIDERATIONS

Fabric bearings are characterised by their low frictional coefficients, their low rate of wear and their versatility with regard to lubrication. In particular, exceptional results are obtained when some types of fabric bearings are used with water lubrication. It is interesting to examine the properties and performance of resin-bonded fabrics in the light of modern theories of bearing friction, lubrication and wear.

(a) FRICTION

When two nominally flat surfaces are brought into



Diesel-Electric shunting locomotive brake shoe gear fitted with dry running fabric bushes.

contact they will, in fact, only touch at a few isolated points because surface irregularities are large in relation to molecular size. It has been shown¹ that the sum total of these local areas under normal design loads is seldom greater than 1/100 and is often as small as 1/10,000 of the apparent area of contact. It follows then that even under relatively light loads the local pressures are extremely high and usually exceed the yield point of the softer of the two materials in contact. As a result, slow moving or static surfaces form cold welds at the points of high pressure and at higher speeds temporary welding is assisted by softening or melting at these points due to the formation of hot spots.

With continuous sliding, these welds are sheared and much of the work necessary to slide one surface over another is considered to be due to the shearing of these micro-welds which are constantly being broken and reformed. The fact that thermosetting resins do not soften or melt as the temperature is raised means that although contact of surface asperities will lead to hot spots micro-welding cannot occur. Consequently, less work is necessary to move metal surfaces over such materials and a lower coefficient of friction is obtained. In addition, if temperatures at points of contact are sufficiently high, the surface asperities of a fabric bearing will tend to char away leaving a smoother surface and small quantities of carbon which even in non-graphitic forms is an efficient solid lubricant.

Bowden and Hughes² have derived a theory that polishing of a surface is due to the smearing over of surface high spots and experiments have confirmed that the effectiveness of polisher on a given surface depends more on relative melting points than on

relative hardness. The thermosetting character of the resins used in fabric bearings in conjunction with their low thermal conductivity will thus result in the slow polishing of metal shafts running in these bearings and thus contribute to reduce friction.

(b) LUBRICATION

The function of a bearing lubricant is to separate the moving surfaces and hence reduce friction and wear. Two distinct conditions of lubrication occur, namely, fluid film and boundary conditions. Under fluid film conditions, the lubricant film is continuous and is caused to flow by the rotation of the shaft; hydrodynamic pressure develops in the film which then supports the load on the shaft. The resistance to shaft motion under these conditions is due entirely to lubricant viscosity and a comparison of oil and water viscosities, (Table II), indicates that comparatively lower coefficients of friction should be obtained on high speed bearings if water is employed as lubricant in place of oil. In fact, values approaching those of roller bearings (0.001 — 0.003) have been recorded.

TABLE II
Relative oil and water viscosities at different temperatures

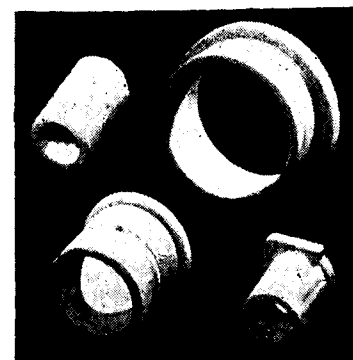
Temperature	Viscosity (centistokes)		Viscosity ratio (oil/water)
	Typical turbine lubricating oil	Water	
100 deg F	64.5	0.68	95
125 deg F	35.0	0.54	65
150 deg F	20.0	0.42	49



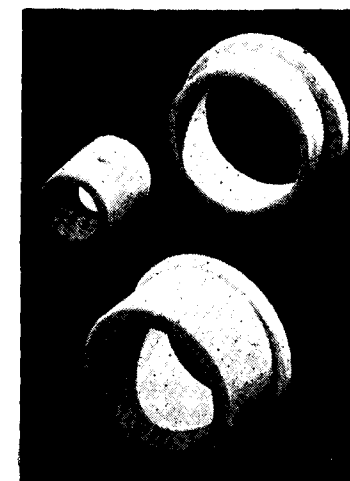
A set of Fabric Bearings and the 28" Section Mill in which they are used.

Negligible
shaft wear
with
* these bushes

'ORKOT' Bearings, first proved in rolling mills, are now available for bushing and general bearing applications.



* **Orkot**
BUSHES



If your bearing problem is one of

CHEMICAL ATTACK

SHAFT WEAR

BEARING LIFE

MAINTENANCE

LUBRICATION

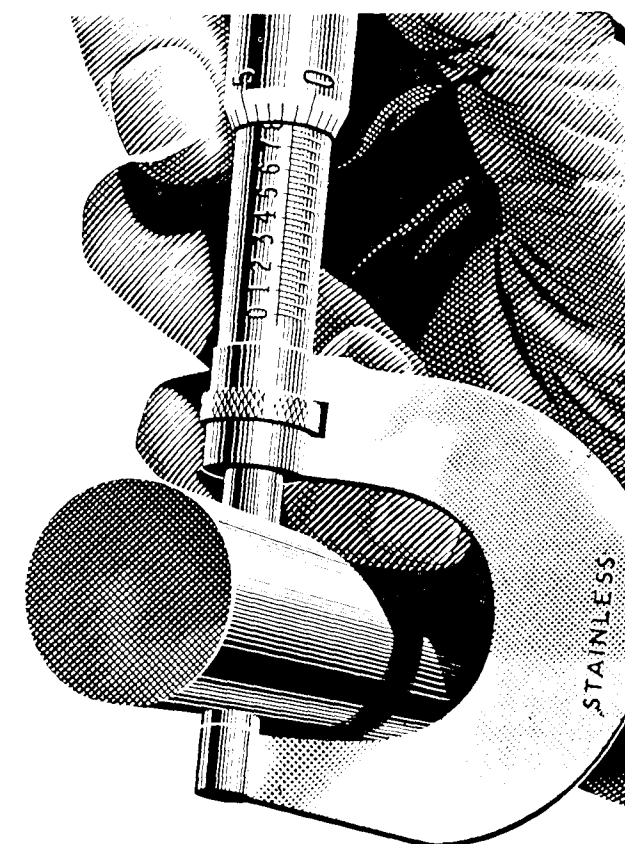
BEARING POWER LOSS

'Orkot' may be the answer

Further information is available, on request, from

UNITED COKE & CHEMICALS COMPANY LIMITED

(SALES DEPARTMENT) P. O. BOX 136, HANDSWORTH, SHEFFIELD 13 - ENGLAND
TELEGRAMS: 'UNICHEM', SHEFFIELD - ENGLAND



It is also worth noting that, compared with most metals, fabric bearing materials have a low modulus of elasticity (approx. 0.5×10^6 p. s. i.). A fabric bearing liner is thus able to distort slightly under high loads in such a way that a more even distribution of pressure results and breakdown of the lubricant film is avoided.

When shaft speeds are low or loads are high, boundary lubrication conditions occur. The lubricant does not flow and the surfaces concerned are separated by a thin, often discontinuous, lubricant film through which surface irregularities protrude (Fig. 1). Although part of the load is supported by pockets of lubricant, the greatest surface asperities do make direct contact and the welding and shearing action described earlier can take place when metal surfaces are involved.

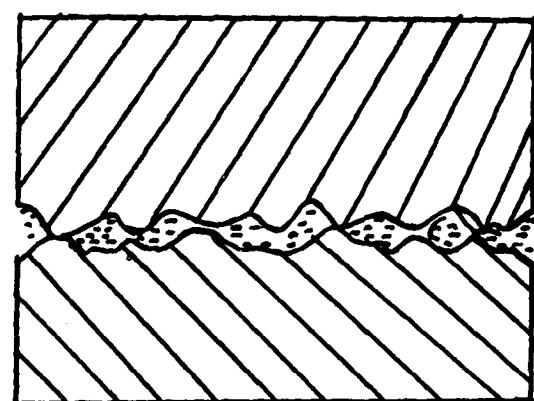


FIG. 1. BEARING SURFACE SHOWING TRAPPED LUBRICANT.

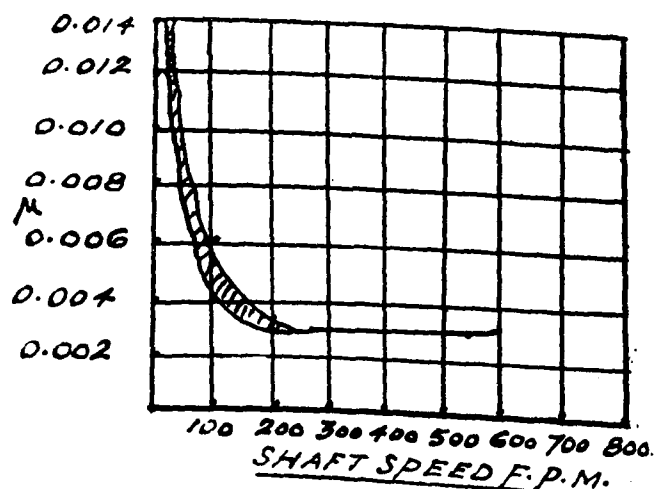


FIG. 2. COEFFICIENT OF FRICTION OF 'ORKOT' FABRIC BEARINGS UNDER A WIDE RANGE OF CONDITIONS.

Under these conditions, the effectiveness of a lubricant is measured by its ability to maintain a continuous film, i. e. on how readily the film can be broken down to allow surface contact. The rather surprising effectiveness of water as a lubricant for fabric bearings under boundary conditions can be accounted for by the strong adsorption of water by the surface of the bearing. Rowell³ suggests that the working surface of fabric bearings consists of a forest of microscopic fibres impregnated with water and holding water between them by capillary action. This theory is well supported by the observed effects of the fabric: resin ratio and the nature of the reinforcement (whether hydrophilic or hydrophobic) on performance. Fig. 2 shows the coefficients of friction obtained for one type of fabric bearing with water lubrication under a wide range of conditions.

surface layer and that these micro-welds are continually being sheared due to the relative movement of the two layers. While they often shear along their original surface of contact a certain fraction of the welds will be stronger, owing to work hardening, than the softer of the two base materials and shearing will occur to one side, usually in the softer of the two materials. In this case, wear, according to the original definition, has taken place. We have already seen that fabric bearings cannot form micro-welds with metal surfaces in contact with them and hence adhesive wear cannot take place.

ABRASIVE WEAR

In this type of wear, removal of solid material from



Hook Coil Conveyor fitted with Fabric Bushes.

a surface is accomplished by its being gouged or ploughed out by a much harder surface or body. Abrasive wear occurs when there is a great dissimilarity in hardness between the rubbing surfaces and in addition the harder of the two possesses a certain amount of roughness. It is, therefore, important that shafts running in fabric bearings have a good finish and are not allowed to become pitted or corroded. If these conditions are observed, wear of a bearing from this cause becomes unimportant. The slow polishing of shafts running in fabric bearings also tends to reduce wear of this type.

A second type of abrasive wear occurs when the hard surface is a third body such as a particle of grit caught between the two surfaces and sufficiently hard to abrade either or both of them. This type of wear is an extremely important factor and is probably responsible for a large amount of the wear in industrial machinery today. External dust and grit is the usual source of the hard abrasive particles although corrosive wear particles may also be present. The abrasion resistance of a material depends on several factors, most important of which are surface hardness and elastic modulus. The hardness of the abrasive particles is also of importance. Oberle⁴ has pointed out that the amount of elastic deformation that a surface can sustain is probably a truer measure of wear resistance than surface hardness. In the presence of a harder abrasive particle the surface in question deforms elastically but after the particle has passed on it returns elastically to its original shape with no plastic deformation or permanent damage. The larger the elastic limit of strain, the better should be the resistance of a surface to abrasive wear. Burwell⁵ has derived the following expression relating the elastic limit of strain to surface hardness and elastic modulus:—

$$E. \lim. \propto H/E \text{ where } H = \text{indentation hardness} \\ E = \text{modulus of elasticity}$$

It can be seen that this equation predicts that the elastic limit of strain and hence the wear resistance increases as the hardness increases, and decreases with increasing elastic modulus. A comparison of fabric bearing materials with other materials on this basis (Table III) indicates that fabrics in general have a high resistance to abrasive wear although the relevant physical properties vary considerably over a wide range of resin/fabric combinations. Where resistance to abrasive wear is of primary importance the above expression should provide a guide to the selection of a suitable bearing material.

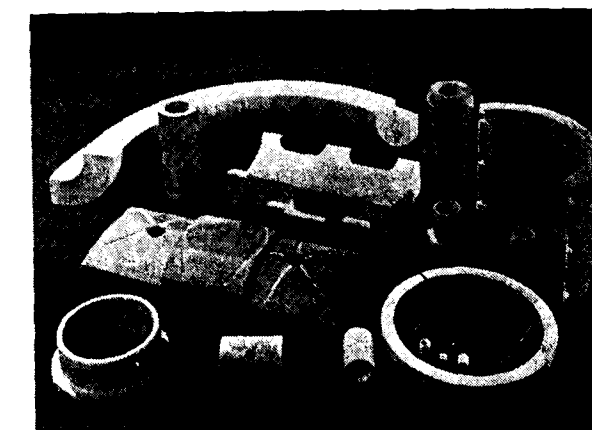
TABLE III
Values of H/E for Various Materials

Material	Condition	B.H.N.* (in mix- E $\times 10^{-6}$ ed units)
Alundum (Al_2O_3)	bonded	143
Resin-bonded fabric	laminated sheet	25—90
Chrome Plate	bright	83
Tungsten Carbide	9% Co.	22
Cast Iron	—	10—14
Phosphor Bronze	—	4—13
Aluminium	Pure	2
Tin	Pure	0.7

*Brinell Hardness Number

CORROSIVE WEAR

This type of wear takes place when a corrosive environment produces a reaction product on one or both of the rubbing surfaces. This reaction product, usually a metal oxide, is then removed by the rubbing together



A selection of Fabric Bushes and Bearings showing the complexity of shapes possible.

(c) WEAR

Wear may be defined as the unwanted removal of solid material from rubbing surfaces. In a consideration of sliding surfaces, we can divide wear into three main types:—

- (1) Adhesive or galling wear
- (2) Abrasive wear
- (3) Corrosive wear

ADHESIVE WEAR

It has already been noted that on sliding surfaces in contact micro-welding occurs at high points on the

of the two surfaces and the wear particles thus produced may themselves cause further abrasive wear to take place. Fabric bearings do not corrode and in addition are resistant to a wide range of chemicals and chemical solutions. Corrosive wear is, therefore, limited to the metal journal or shaft. Where oil or grease lubrication is used, the lubricant itself provides protection from corrosion. However, when water is used as lubricant, corrosive wear of the shaft or journal is accelerated and steps must be taken to prevent excessive corrosion in such cases. In the case of smaller bushes and bearings operating perhaps in aqueous process liquors, the use of stainless steel shafts is necessary. In the steel rolling industry, greasing of roll necks during mill stoppages is widely practised.

OTHER TYPES OF WEAR

It has already been noted that if temperatures at points of contact are sufficiently high, the surface asperities of a fabric bearing will char away. Fabric bearing materials are very poor conductors of heat and under heavy loads heat build up may cause excessive charring or burning of the bearing surface. This type of wear can occur in the bearings of hot rolling mills where heat conducted through the rolls must be removed by the lubricant which also acts as a coolant. Insufficient cooling or breakdown in the water supply results in charring and burning causing extensive damage to the bearing.

DESIGN FACTORS

(i) Choice of lubricant.

It has been previously stated that fabric bearings give excellent performance with water lubrication. It follows, therefore, that aqueous solutions are also satisfactory lubricants provided that the solution does not attack either the resin or the reinforcement. In many instances, process liquors provide the only lubricant for fabric bearings which operate satisfactorily in dilute acids, dilute alkalis, brine, detergents, sewage, inorganic salt solutions and many organic liquors. This fact can often be utilised to advantage in simplifying bearing design.

Fabric bearings can also be lubricated with soluble oils, oils and greases and coefficients of friction, although usually lower than those obtained with metal bearings, are higher than for water lubricated fabrics. This is probably due to the fact that the fabric fibres are not as efficiently wetted with these lubricants and

the film of lubricant is more easily broken down. Some comparative friction coefficients obtained with different lubricants are given in Table IV.

TABLE IV
Coefficients of friction obtained with an 18/8 stainless steel shaft running in 'Orkot' bearings. Rubbing speed 90 f. p. m.; load 2,240 p. s. i.

Lubricant	Water	Soluble Oil	Grease/water	Oil	Grease	Dry
"	0.006	0.015	0.016	0.017	0.062	0.21

(ii) Other factors.

All fabric bearing materials absorb water to some extent resulting in dimensional changes when water lubrication is employed. This effect is most serious in 360° bearings and bushes and some allowance must be made for swelling which may cause significant diametrical change. The effect can be considerably reduced by the use of hydrophobic reinforcements although this inevitably results in some increase in the coefficient of friction. Absorption of oil takes place less readily and dimensional changes under such conditions are usually negligible.

The thermal conductivity of fabrics is very low compared with metals and under hot working conditions provision must be made for the removal of heat. Thermal expansion is also slightly higher than for metals and under relatively hot working conditions allowances may have to be made for this factor. In addition, temperature limitations exist and fabric bearings cannot be used at temperatures exceeding the manufacturers specified limits without serious loss in strength and performance.

DRY-RUNNING BEARINGS

The demand for bearings and bushes operating without additional lubrication has grown considerably during the past decade. Bearings may be required to work in assemblies where lubrication is impossible or infrequent and in some cases where contamination by oil and grease is undesirable. Fabric bearings can be impregnated with a solid lubricant such as graphite or molybdenum disulphide to provide a bearing material capable of operating without additional lubrication. The solid lubricant is usually incorporated into the resin before setting and the bearing is thus impregnated throughout and any wear at the surface releases a fresh supply of lubricant. In most types of fabric bearings,

impregnation with graphite or molybdenum disulphide results in some loss of interlaminar adhesion and a consequent deterioration in strength. This factor governs to a considerable extent the amount of solid lubricant it is possible to incorporate satisfactorily in a bearing. The low thermal conductivity of fabric bearing materials is a further limiting factor in the use of dry running bearings as the absence a flow of lubricant to remove frictional heat may result in heat build-up. Consequently, PV factors for such bearings cannot be high. However, in applications where loads and speeds are not high and other forms of lubrication are impossible or infrequent, impregnated

bearings can often be used to advantage.

FABRIC BEARINGS IN PRACTICE

(i) Rolling mill bearings.

It would appear then from theoretical considerations that fabric bearings show considerable advantages over metal alloy bearings in that they exhibit lower coefficients of friction and low rates of wear. How far is this substantiated in practice? Table V gives representative figures taken from the records of The United Steel Companies Limited over a period of several years.

TABLE V
Examples of economies achieved with resin-bonded fabric bearings (Orkot)

Bearing type	Lubrication	Average Bearing life	Power Saving	Saving in bearing and power costs
10-in and 14-in section mill. Multi-stand, unidirectional hand mill	Phosphor-bronze with white metal inserts. Fabric ('Orkot')	Grease/water water	1,165 tons 10,100 tons	43% £5,000 p. a.
Bar Mill. Multi-stand cross-country merchant mill	White metal with phosphor-bronze inserts. Fabric ('Orkot')	Grease/water water	1,190 tons 15,500 tons	22% £6,500 p. a.
28-in sleeper plate mill. Multi-stand reversing	Phosphor-bronze with white metal inserts. Fabric ('Orkot')	Grease/water water	1,300 tons 20,000 tons	15% (estimated) £5,000 p. a. (extensive fire cracking of roll necks also eliminated)

These figures give an indication of economies achieved by replacing metal bearings with fabrics in various types of rolling mills. Detailed analyses of comparative rolling costs for specific mills have frequently been carried out and are widely reported in the literature 6,7. In all cases, the low coefficients of friction and low rates of wear of fabric bearings are reflected in significant savings in power and increased bearing life.

(ii) Bushes and Bearings—General uses.

Bushes and bearings are used in every branch of the engineering industry and conditions encountered vary widely. Loads may range from a few pounds to several tons per square inch and rubbing speeds from hundreds of feet per minute down to a few inches per minute with continuous or reversing rotation. Lubri-

cation available may be water, sludges, acids, alkalis, detergents, chemical solutions, soluble oils, oils or greases. In addition, lubricant supply in many cases may be intermittent or non-existent. Table VI gives a few of many applications in which 'Orkot' fabric bearings have been successfully used and where possible comparison with metal alloy bearings in the same application is made.

RAILWAY APPLICATIONS

Potentially one of the largest users, the railways consume large quantities of fabric bushes annually in brake gear, shoe gear and signalling equipment. Many other applications such as axle bearings, axle thrust pads and wagon bearings are possible.

Tests carried out on axle thrust pads indicate that

TABLE VI

Application	Load and type of shaft motion	Lubrication	Remarks
Hook coil conveyor bushes	100 p. s. i. Continuous rotation	Occasional hand greasing	Phosphor bronze—life 9 months Fabric (Orkot) 2 years
Articulated vehicle trailing axle suspension bushes	1,800 p. s. i. and higher shock loads—reciprocating rotation	Automatic oil system	Phosphor bronze—40,000 miles (bush and pin replaced) Fabric (Orkot)—120,000 miles (no wear measured)
Commercial vehicle suspension bushes	350 p. s. i. and higher shock loads—reciprocating rotation	Intermittent greasing	Case hardened steel—30,000 miles (bush and pin replaced) Fabric (Orkot)—> 60,000 miles (bush still in use)
Textile machinery bushes	50 p. s. i. continuous rotation	Dilute sulphuric acid	Phosphor bronze—life 6 months Fabric (Orkot)—life > 18 months (bushes still in use)
Textile spinning frame bushes	Up to 1,200 p. s. i. Continuous rotation	(i) P. B. oil lubricated (ii) Fabric (Orkot)—dry running	Oil lubrication caused contamination of fibres. P B. replaced by Fabric (graphite impregnated)
Diesel Loco. Brake Shoe gear bushes	Up to 1,200 p. s. i. with higher shock loads. Reciprocating rotation	Dry running	MoS ₂ impregnated 'Orkot' used to remove need for lubrication.
Effluent equipment bushes	50 p. s. i. Continuous rotation.	Sulphite liquor	Phosphor bronze bushes badly corroded. Orkot unattacked

the wear properties of fabrics in this application are superior to phosphor bronze pads. In addition, should a thrust pad fail due to faulty adjustment or excessive loading, the pad will 'burn out' but no damage will occur to the axle or axle box.

Large scale trials have been carried out with molybdenum disulphide impregnated bushes in the brake mechanism of diesel shunting engines. Under loads of the order of 1,200 p. s. i. these bushes operated satisfactorily without the need for additional lubrication. The success of these trials has led to the extension of testing in other diesel locos where loadings on brake gear bushes are considerably greater, in some cases over 10,000 p. s. i. For this purpose, a special reinforcement is used which gives a bearing material having a compressive strength of approximately 50,000 p. s. i.

Wagon bearings have also undergone testing and have performed well on internal transport. However, some manufacturing problems are presented by the present design of these bearings.

CONCLUSIONS

The behaviour of resin-bonded fabric bearings predicted by modern theories of friction, lubrication and wear is amply borne out in practice. Low coefficients of friction are obtained with a wide variety of lubricants and rates of wear are lower than with metal alloy bearings. The polishing of metal shafts running in fabric bearings contributes to reduced friction and wear of shafts is virtually eliminated. The impregnation of fabrics with solid lubricants is a fairly simple process and makes possible the economic production of bearings capable of operating without additional lubrication.

To balance the picture, the disadvantages of these bearings should be kept in mind. In particular the ability of fabrics to absorb liquids results in some dimensional instability which may become critical in 360° bearings. Also, the poor thermal conductivity of these materials necessitates some provision being made for the dissipation of radiated and conducted heat.

Wide experience has been gained of the successful application of fabric bearing under varying conditions within many diversified industries. However, a considerable undeveloped potential remains and the engineer facing bearing problems has available and economic and reliable range of materials which he cannot afford to ignore.

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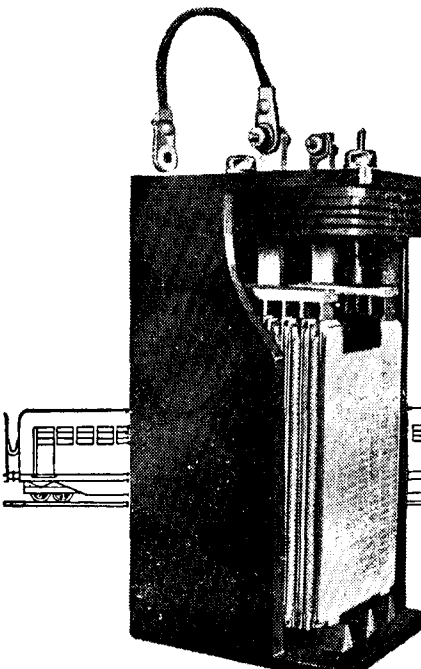
Indian Delegation to Congress on Bridges

India was represented by a two-member delegation at the Sixth Congress of the International Association for Bridge and Structural Engineering held at Stockholm from June 27 to July 1, 1960.

Shri S. L. Bazaz, Additional Consulting Engineer (Bridges), Ministry of Transport and Communications,

led the delegation, Shri O. Muthachen, Officer on Special Duty, Department of Food, was the other member of the delegation.

The Congress discussed important technical problems relating to bridges and structural engineering. The delegation left India for Stockholm on June 25.



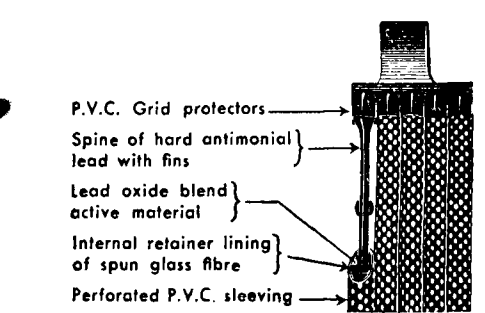
Cross section of the 'Standard' RPg Battery. It is compact and yields ample capacity

A masterpiece in battery making!

Standard RPg railway battery

with patented tubular positive plates that effectively prevent shedding of active material . . . ensure longer battery life . . . reduce ratio between capacity and weight

STANDARD RPg train lighting batteries have positive plates made of patented Pg tubes (manufactured under Indian Patent No. 47394.) This construction prevents shedding of the active material (the chief cause of battery failure), provides extra insulation, and thus prolongs battery life to the maximum. Fitted with 'MITEX' latex rubber separators with glass-wool mat reinforcement.



P.V.C. Grid protectors
Spine of hard antimonial lead with fins
Lead oxide blend active material
Internal retainer lining of spun glass fibre
Perforated P.V.C. sleeving



STANDARD BATTERIES LIMITED
Santa Cruz (East), Bombay 25

QUALITY CONTROL AT F. H. LLOYDS

By An Engineering Correspondent

FOUNDING like many other commercial manufacturing methods first started as a means of expressing art form. Since it has become commercialised it has developed into a highly intricate and complex practice. It is a practice where there is a fusion of science and craftsmanship. In modern steel founding practice this has meant that as the potential market for steel castings, and the complexity of casting design is increasing, the customer is also expecting closer tolerances, high standard of quality, and finish to his castings.

This inevitably means that the standards in the steel foundries must keep abreast of these developments. It means that men and equipment must be of the highest order to ensure that the castings produced are the very best that modern science and the finest craftsmanship can make them. Both founder and customer are becoming quality conscious.

It is on this accent of quality in its widest aspect that has earned F. H. Lloyd and Company Limited, with its associated foundries of Lloyds (Burton) Limited, Burton-on-Trent and Parker Foundry Limited at Derby, a universal reputation. They have earned this reputation by employing the best craftsmen and technicians, modern machinery and equipment, modern methods, the latest scientific techniques, modern welfare facilities and training facilities that are acknowledged to be the finest in Europe.

It is only in this way by having and utilising the best, that the steel foundry can produce the type of castings that are called for today. Steel castings—that are sound, efficient, and have good surface quality. For today a steel casting must look good as well as being integrally sound.

F. H. Lloyd—are as keen to produce these castings as the customer is keen to receive them. For it is in this high reputation of good steel castings that their reputation depends.

This Quality Control is implemented in every department in the foundry.

The Metallurgical Division, with its staff of metallurgists, chemists, sand technicians, and radiographers, provides a comprehensive control system at

all stages of manufacture; from receipt of raw materials to final inspection.

At the heart of Metallurgical Division is the Main Laboratory and Test House, staffed and equipped to handle all analyses and physical properties of steel, including research into specific problems, such as nitrogen/hydrogen content, and Low Temperature Impact Testing.

Research, however, is but one aspect of Quality Control. It is in the normal day to day routines, the use of available facilities, and the skill of supervisors and staff, that Quality Control is established. In addition to the Main Laboratory other laboratories carry out the routine work of checking raw materials, analysis during melt etc :

RAW MATERIALS

A separate laboratory is used for the preliminary analysis of steel scrap, prior to purchase. No scrap is unloaded without analysis. A supervisor examines all incoming loads; rejecting any which may contain free-cutting, alloy, coated, or other deleterious materials. All raw materials—sands, fluorspar, iron ore, pig-iron, ferro alloys, refractory materials etc: are subjected to stringent tests before use. Sands are tested in a separate laboratory, and sand technicians are always on duty checking sand mixes.

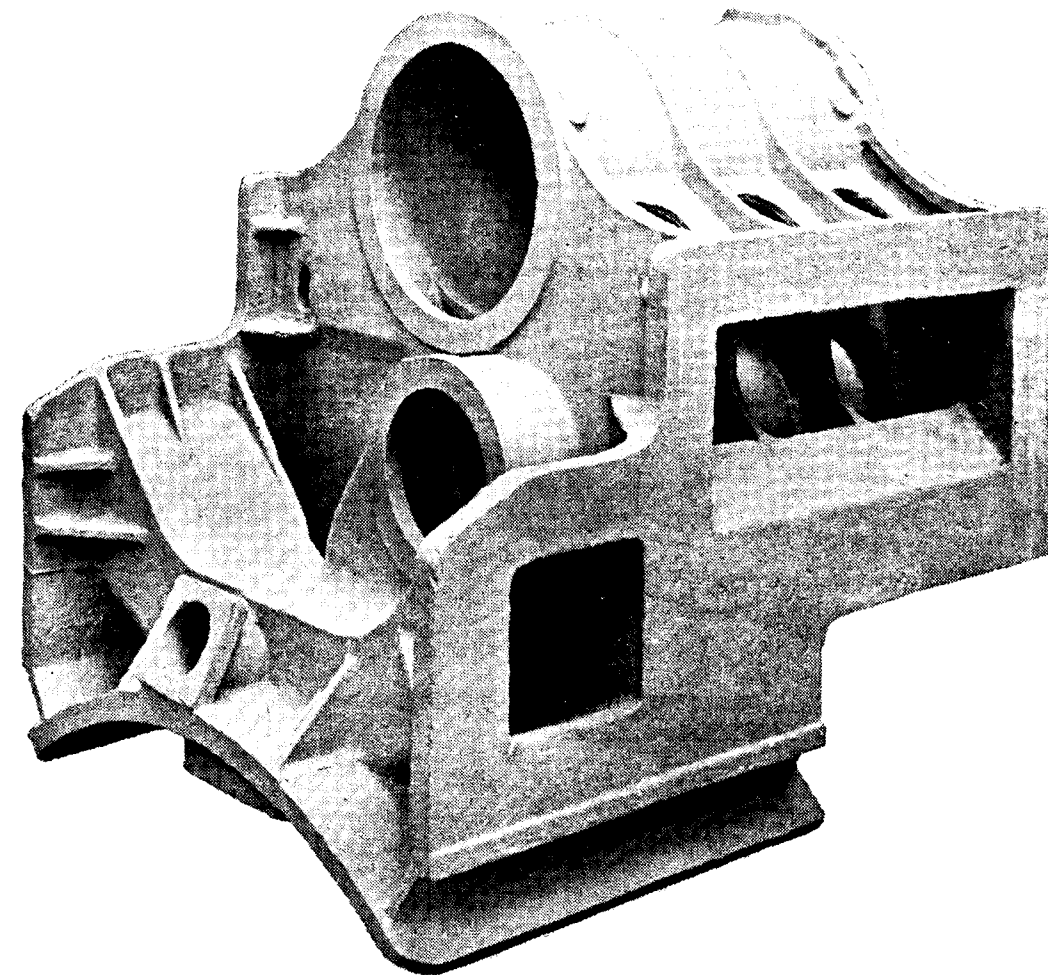
MELTING

Each battery of furnaces is served by a fully equipped laboratory, staffed by trained chemists. Samples of metal taken from the furnace at various stages during the melt, are subjected to rapid tests, the results of which enable the furnace supervisor to follow the chemical changes that are continually taking place within the furnace.

Test pieces cast either separately or integral with a casting, provide a final check on the metal at the time of teeming—its chemical and physical properties being determined in the main laboratory and test house.

TEMPERATURE CONTROL

Different castings, owing to size, complexity, or



*Cast in Steel
for Strength*

by

F. H. LLOYD & CO., LTD.

This complex casting is a combined internal cylinder and smoke box saddle. It provides important structural strength at the front end of a steam locomotive chassis as a rigid spacing member between the frames and a seat for the smoke box. This casting also houses the inside cylinder and valve chest and the external cylinder exhausts. The designer knew that all these requirements could best be met by producing this component as a steel casting—and that the casting could best be produced at James Bridge Steel Works.

STEEL FOUNDERS AND ENGINEERS - P.O. BOX 5 - JAMES BRIDGE STEEL WORKS - JAMES BRIDGE
WEDNESBURY - STAFFORDSHIRE - ENGLAND - TELEPHONE JAMES BRIDGE 2401 - TELEX 33-338

grade of steel, demand different optimum teeming temperatures, and strict control is required to obtain good results. Each furnace is supplied with a number of immersion pyrometers (Pt—PtRh—thermocouple and interchangeable silica end plugs) manufactured in the metallurgical division, which are used in conjunction with an electronic recording device. Temperature is indicated by a moving pointer, and at the same time permanently recorded on a chart. After tapping to a pre-determined temperature, additional measurements can be made during teeming, by means of optical pyrometers.

FLAW DETECTION

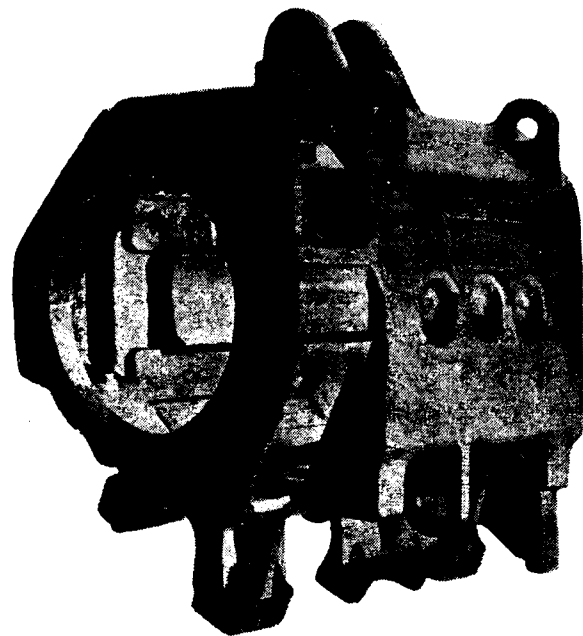
In addition to the routine visual examination to which all castings are subjected, such modern aids as the 20 Curie Cobalt 60 Radiography Unit, and Ultrasonic flaw detector, can be brought to bear in the search for hidden defects. Today, radiography is the guarantee against failure in service of apparently defect-free castings; the final proof of not only the soundness, but also the quality control which made possible its production.

METHODS STUDY

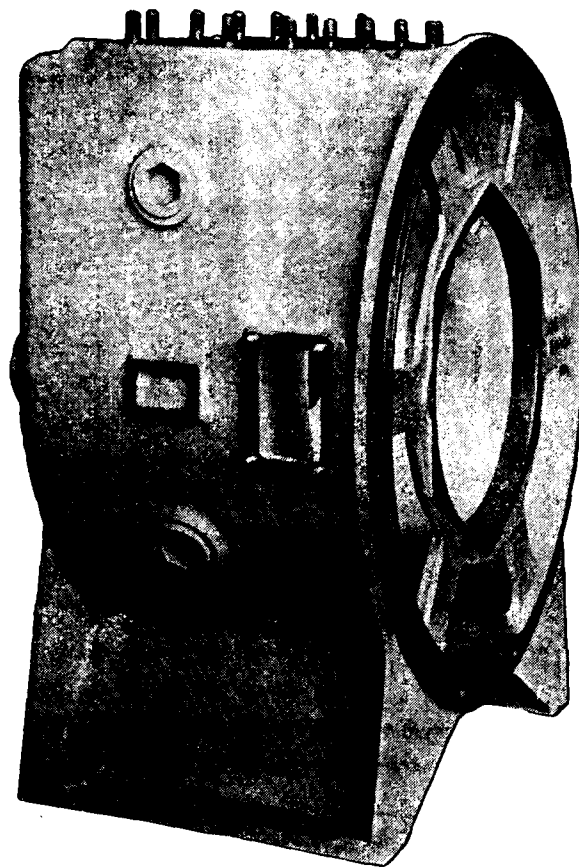
Efficient and economical production is only achieved when there is perfect co-ordination between all departments. While the Metallurgical Division concentrates on producing steel precisely to specification, the Methods Department ensures that the metal is transformed into a sound casting, efficiently and economically. Methods Engineers, each a specialist in particular aspects of foundry practice, carry out intensive pre-planning on all problems associated with the production of a casting; decide on the moulding, feeding, and other techniques; and ensure that every department concerned is in possession of all relevant information. This close liaison between all departments; the skill of technicians and craftsmen in close co-operation, backed by all the resources of a modern foundry, results in quality control of the highest order.

This ability to produce steel castings in such a degree of complexity and quality is very acceptable to modern design engineers, who appreciate the obvious advantages of having a Foundry available to produce engineering components in cast steel.

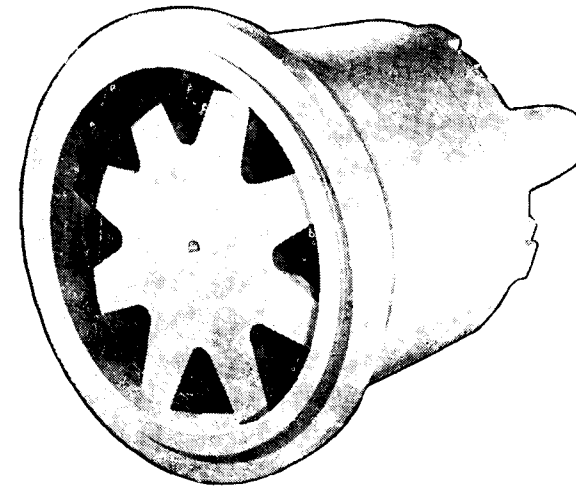
To take one particular example, steel castings are widely used in the manufacture of railway equipment,



Traction Motor Casting.



Turbine Casing.



Armature Hub.

in locomotives, railway stock and track crossings in manganese steels.

Castings such as those illustrated are a traction motor yoke casting, length 3' 6" and weighing 1,810 lbs., and an armature hub 5' long, weighing 1,110 lbs. These are produced for the Brush Electric Company's type 2, 1,365 h. p. locomotives supplied to the British Railways. Also illustrated is a turbine casing supplied to Messrs De-Havilland Engine Company. This is part of a pressure charger for Sulzer Engines used for British Railways diesel electric locomotives. The weight of this casting is 450 lbs. These are merely examples of the castings that F. H. Lloyd and Company Limited have had to produce for this railway development programme.

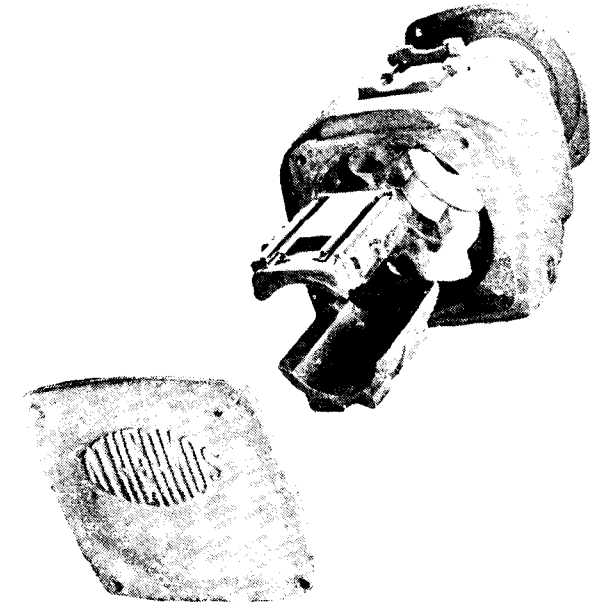
AXLE BOXES

Axleboxes have developed rapidly along with the current railway development. Isothermos Axleboxes for example have a universal reputation for long trouble-free performance. They are extensively used in Europe and were fitted to the world record breaking stock of the French Railways. By arrangement with Isothermos, the housings for these axleboxes are made by F. H. Lloyd and Company Limited.

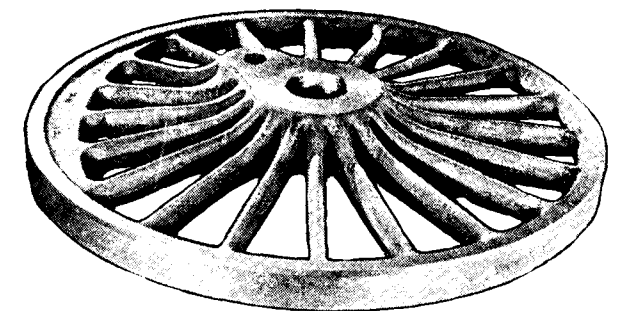
In this connection F. H. Lloyd and Co. Limited also make cast steel axleboxes for the F'AG roller bearing axlebox.

RAILWAY WHEEL CENTRES

Railway wheel centres have long been produced as



Athermos Axlebox.



Wheel Centre.

cast steel. Today although they are still produced by this means with modern manufacturing methods however they are now produced with good surface finish, sound in quality and to close tolerances, thus minimising subsequent expensive and time consuming machining operations.

With the development of new engineering projects calling for a higher degree of technical know-how, it is inevitable that the progressive foundry will be able to keep pace with the future demand for steel castings demanding the more intricate design and higher quality. It is, however, necessary to prepare for the future by ensuring that there is an adequate force of fully competent young men being trained in all aspects of the foundry trades. F. H. Lloyd and Company Limited have a fully comprehensive training scheme to ensure that this is so. There is a large force of youths who are being taught all aspects of foundrywork

based on practical craft training, and leading from there to technical engineering studies. In addition to this there are young men of technician and supervisory possibilities who are given further training, so that they may keep pace with modern developments in all fields of engineering. Furthermore a series of lectures are held for the staff, so that they may be informed of the future trends in a wide field.

The facilities available for full time training are too numerous to mention in detail, but include a foundry training school, fitted out with all modern equipment. There is also a fully equipped engineering training school, for the primary training of young engineers, and a training headquarters which has a lecture and study room, library, and comprehensive administrating and training records for all trainees. It is interesting to note that the Foundry School was the venue of the European Foundry Apprentice Competition in 1960.

It is the first time that this competition has been held in a production foundry.

In addition to receiving practical training at the works the youths receive lectures from a full time specialised staff, and also attend the local technical colleges for further study, so that they may obtain the higher qualifications of national educational institutions.

The future of industry in general, and the foundry industry in particular with its ever increasing challenging competition, makes even greater demands upon the knowledge, skill and enterprise of the young and the old. It is for the older generation to set the younger generation an example of hard work, initiative and enterprise, and for the younger generation to grasp the challenge and with the youthful spirit of purpose and endeavour to carry it to even greater success.

METAL CLAD SWITCHES

The purpose of IS: 1567—1960 Specification for Metal Clad Switches prepared recently by ISI is to meet the need of the industry and domestic users. The standard specifies the requirements and tests for metal clad switches suitable for a maximum voltage of 650 V between poles, and current rating not exceeding 100 A. These switches may consist of any series combination air-break switches and fuses forming a composite unit, having not more than three fused poles with or without neutral, within metallic enclosure (or enclosures), and are intended for use on DC systems, and AC systems whose frequency, unless otherwise specified, is 50

cycles per second. Splitter units and isolators are excluded from the scope of this standard.

The majority of the switches being manufactured in this country at present are metal clad switches, though switches with insulated enclosures may become available in large quantities in future. However, with a view to ensuring safety, only metallic enclosure has been recognized in this standard. Extension of the scope of this standard to include switches with insulated enclosures may be considered later, if necessary.

CADMIUM PLATING

The Indian Standard Specification for Cadmium Plating (IS: 1572—1960) published recently by ISI covers electroplated coatings of cadmium for protective purposes on fabricated articles of iron and steel. Three grades depending on thickness of coating and three types, namely, without any further treatment and with either chromate or phosphate treatment have been included in this standard. The specific grade and type required should, therefore, be specifically indicated in the enquiry or order by the intending purchaser of the cadmium-coated article.

The grades have been designated as A, B and C. The recommended application for the three grades are as follows:

Grade A—For exposure to marine atmosphere and tropical conditions with high humidity.

Grade B—For conditions falling in between A and C.

Grade C—For dry interior conditions.

SIGNALLING, INTERLOCKING & TELECOMMUNICATIONS SUPPLEMENT

A NEW KIND OF RAILWAY SIGNAL

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

THE title of this article is the one used for a column published in a London morning paper more than 33 years ago. It reads:—

“That common object of the British railway landscape, the signal ‘semaphore,’ or arm, has been declared a back number and is being replaced by an appliance which does not to the lay mind appear to be a signal at all. This new device, which is being used both on steam and electric lines, is known as the day colour light signal, and its indications are merely by colour. The familiar signal-post, with its ladder and counter-weights, is no longer required, and in its place is a stumpy metallic case containing one or more electrically lighted discs of coloured glass. In one type a separate glass is used for each colour to be displayed, (of which there may be three, including the caution indication), but there is also in use a most ingenious form in which all the required colours are indicated by a single glass disc.

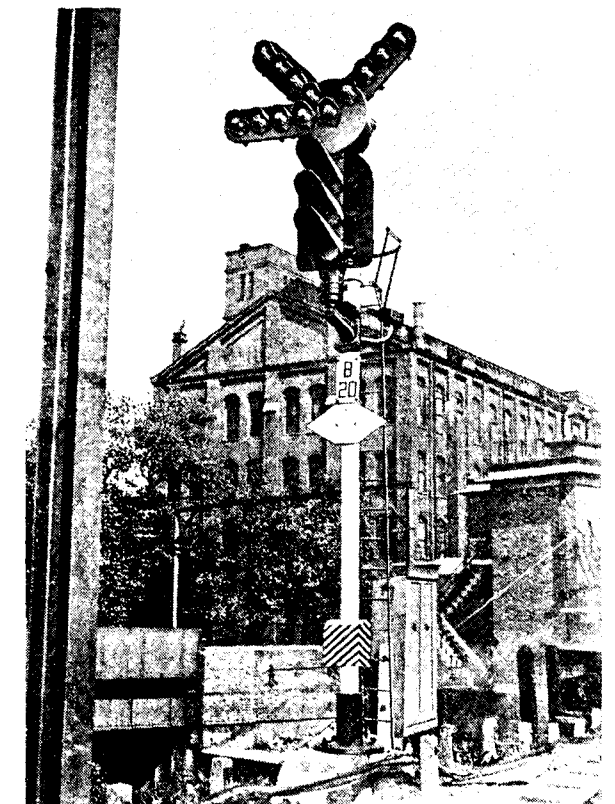
“It might be thought that the elimination of the semaphore was a disadvantage to drivers, but in fact this is not the case. Under normal conditions both light and semaphore are not visible at the same time, as the semaphore is invisible by night and the lamps are not lit in the daytime.

“Moreover, it has been proved that only a fifth of the reported cases of running past danger-signals takes place at night, which would seem to show that colour is a more certain indication to the driver than the angle of the signal arm. In point of fact, tests have shown that these day colour light signals are visible at a distance of over half a mile in the strongest summer sunshine, while they are far more easily picked out in foggy weather than a semaphore.

“The early railway signals, in which England led the world, as it did in the railway and the locomotive, were square or round disc, such as are still used on some Continental lines, but the type with which every railway traveller is familiar soon replaced these primitive forms.

“Signalling, as we understand it, really dates from the day when a lazy porter, who detested the job of continually walking up to the signal in order to set it, hitched a piece of string round it so that he could operate it at his leisure without bestirring himself.”

At the time, that article stated that the semaphore signal had been declared “a back number” but in the three decades that have passed the installation of colour light signalling has been remarkably slow and mainly confined to stations where remodelling has occasioned alterations in signalling. In 1938 there were 3,000 colour light signals in use on British railways, 5,000 in 1948 and 9,320 in 1957 or



Three aspect colour light signal with junction direction indicator.

approximately 3 per cent of the total signalling installation.

From these figures it will be seen that semaphore signals are by no means obsolete though in suburban areas they have been superseded by the light signal. The semaphore signal has to use lights at night. The light signal is sufficiently powerful to be observed in daylight and has the advantage of showing the same type of aspect by day and night.

Experiments with colour light signals were made as long ago as 1913 but they were not too successful. The London Underground introduced a type of light signal for use in daylight about that period. It was an ordinary lamp signal as used in the tunnels, fixed on a post and surrounded by a deep hood to produce artificial shade to emphasise the aspects. Although used in daylight, it was mainly found in cuttings or sheltered places, not in direct sunlight.

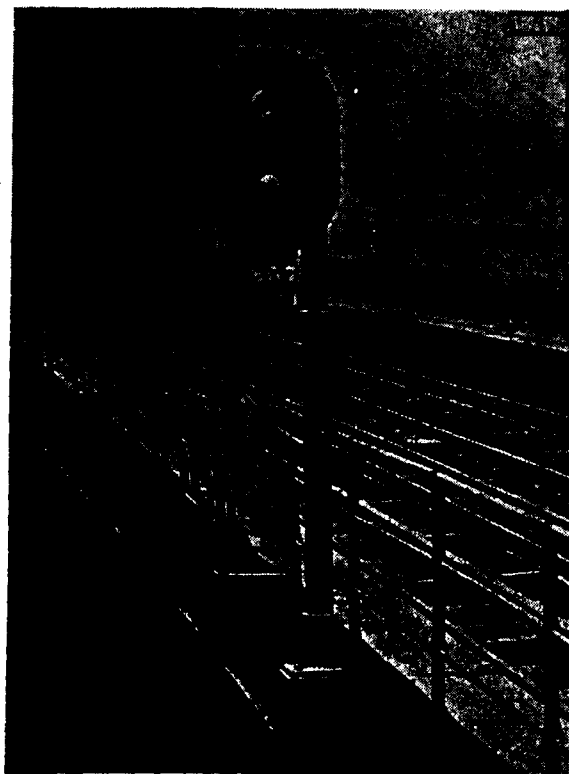
The Liverpool Overhead Railway was the first in the Commonwealth to introduce colour light signalling and these were brought into use on July

27, 1921. The railway (now closed) ran from Dingle to Seaforth Sands, along the west bank of the River Mersey, and for most of the way the tracks were elevated above street level. The signals were therefore displaying their aspects against a predominantly sky background and their success was never disputed.



Searchlight Signal.

All the signals were of the two-aspect type, the lamp case having three compartments. The top compartment held the equipment for the red indication and the middle for the green. The bottom compartment held the lamp transformers and terminal cases. The inner lens for the upper lamp was red and that for the lower lamp green, the outer lens being clear glass. All the lenses were manufactured to a specification that ensured a true colour. The inner lens was $5\frac{1}{2}$ in. dia and collected the greater portion of the light which was projected on to the outer lens reducing the rays to a nearly parallel beam. There were two bulbs in each lamp. The smaller was the focal lamp and having a special filament which was normally under-run at 11 V. A larger lamp was behind the focal lamp and was rated at 110 V and obtained current through a relay direct from the a.c. supply. This was used as a stand-by source in case the local lamp burnt out.



First colour light signals installed in United Kingdom. A two aspect signal on the Liverpool Overhead Railway.

TYER & COMPANY LIMITED

(Incorporating PERRAM LIMITED)

ESTABLISHED 1851

(1878 to 1958 at Ashwin Street, Dalston, London)

SPECIALISING IN THE MANUFACTURE OF
RAILWAY SIGNALLING and TELEGRAPH.
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and TELEVISION (closed circuit) EQUIPMENT

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Arm and Light Signal Repeaters, for upper or lower quadrant semaphore signals, in metal, wood or plastic cases.

Thermal Expanders for all types of oil burning signal lamps.

Circuit Breakers for upper or lower quadrant signals with drive arms and connecting links.

Combined Lever Lock & Circuit Controllers with economiser contacts.

Electric Lever Locks, gravity or forced drop type, with proving and economiser contacts (width $3\frac{1}{4}$ ins.).

Morse Telegraph Apparatus, signalling keys, sounders, relays, resistances.

Relays, arm detection, thermal, polarised, interlocking, lamp proving and general 'block' types in wood or plastic cases for wall or shelf mounting.

Relays, track or line units, to BSS. 1659, shelf type. Can be fitted with plug coupler detachable tops. A similar unit also available for general block instrument purposes.

Circuit Controllers, 'Microjust', with 'oilite' bearings, two, four or six-way types with long or short segments, OBA terminals. All types of drive arms available.

Colour Light Signals, two, three or four aspect units for post or gantry mounting, with or without transformers, lamp proving relays. Provision for fitting door and side lights to left or right hand side.

Theatre Type Route Indicators for gantry, top of post or top of signal fitting. Provision for 49 lamp units for 16", 18" or 20" figures.

Junction indicators for gantry or top of signal fitting.

Indicator Lamp Units for multiple fitting on shelf or wall, with flat or bulbous coloured roundels, or with stencilled characters.

Diagram Panel Units with clear or coloured indications.

Terminal Units, plastic or ceramic with OBA terminals, two to twelve posts, with or without connecting links.

Fuse Units with ceramic bases and OBA terminals.

Point Detection Units.—Transformers 250v, 500v and 750v.—Battery charging equipment.

Automatic Train Control Equipment, including Tyer's Strength of Polarity Meter for track inductors.

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The Company's design policy
standardisation of parts

—Unit construction

—interchangeability

A MEMBER OF SOUTHERN AREAS ELECTRIC CORPORATION GROUP

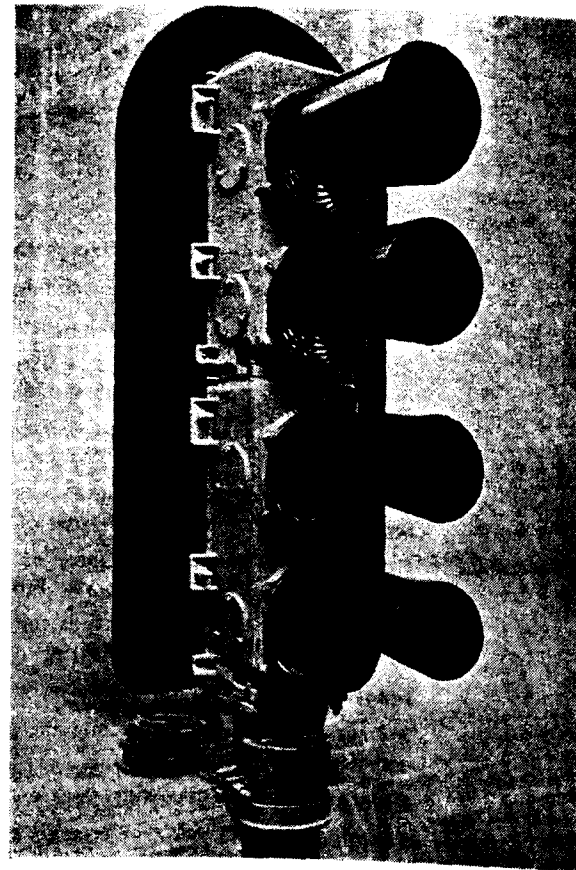
In 1923 the London Underground adopted two-aspect colour light signals for their extensions from Golders Green to Hendon and Edgware. At that time this type of signal was often referred to as a daylight signal. This installation was followed by others on the main line railways. Since its first appearance, the shape and form of the colour light signal has not changed but there has been constant development in lamps and lenses. Other types of light signals have since emerged and today there is the multi-aspect colour light signal, the searchlight signal, the position light shunt signal and the junction direction indicator.

Multi-aspect colour light signal lamp cases are generally of cast iron though some have been made of aluminium. A peep-sight device is usually placed at the top which enables the light beams to be focussed on to any desired point. They have a hinged, gasketed door at the back and a socket at the base to mount on a $4\frac{1}{2}$ in. or $5\frac{1}{2}$ in. dia pole. The lenses are usually of the doublet type with a stepped clear outer lens and a smaller coloured inner lens also stepped. This combination of lenses gives a highly concentrated beam. In order that drivers halted at signals can still observe their indication, a sector of the lens is so arranged that a strip of light is projected downwards.

Some railways use a side lamp for each indication. These comprise a small lamp case and lens fixed outside the main lamp case, one for each aspect. A transformer is mounted in the lamp compartment of each aspect the usual operating voltage being 110 V which goes to the primaries of the lamp transformer. The secondaries deliver 12 V which illuminates the signal lamp which can be either single or double filament but generally the latter is standard. This type of signal can be used for any number of aspects but in this country one to four aspects is normal practice.

The searchlight signal has only one lens, the actual colour of the light beam projected through the lens being changed by the mechanism inside the signal. This enables the signal lens to be positioned immediately adjacent to the driver's eye. Another advantage is that they can be operated by battery power enabling light signals to be used on installations where a power supply is not available. The upper portion of the case is provided with a peep-sight device as in the case of the multi-aspect signal. The signal consists of a lamp the concentrated filament of which is located at one of the focal points of an

ellipsoidal reflector which collects about 80 per cent of the light flux given off from the lamp and concentrates it at the second focal point of the ellipse. Near this point, which is coincident with the focal point of a clear, optical lens, the light passes through a coloured roundel, enters the lens and emerges as a beam of great power. Signals situated on curves can be provided with a half toric lens which produces a spread beam. A relay mechanism is placed inside the signal which operates a miniature spectacle bearing red, yellow and green glasses. The relay may be of



Four aspect colour light signal.

either the a. c. or d. c. type. The signal control circuit is arranged to give a polarised feed to the relay. When the control circuit is de-energised the red lens is in front of the lamp. When the control circuit is energised by one polarity the red lens is removed and the yellow lens takes its place. When energised by the opposite polarity the green lens appears before the lamp. Proper gravity bias on the spectacle ensures that beam flashes do not take place. The relay mechanism is provided with proving contacts which are used for lighting repeating lamps in the signal box.

Where no power supply is available searchlight signals can be operated from primary or secondary cells. This is arranged by the use of a special compound lens in the signal, and a low power bulb. Light beams up to 1,500 ft. can be obtained. It is usual to arrange for such signals to be approach lit, that is by the occupation of the track circuit immediately in front of the signal.

The junction direction indicator signal was introduced some 13 years or more ago. Before this signal, a separate signal had to be used at junctions for each route. Besides being expensive and taking up a lot of room there was also difficulty in observing a green aspect with red aspects each side, these red aspects always appeared to be stronger than the green so that it could not be satisfactorily observed from a distance. The principle of the junction indicator signal is a row of white lights, which point to the right or to the left according to the direction of the divergence. The indicator is not used for movements along the straight line the driver being guided by the yellow or

green aspect of the signal. The advantages of the junction direction indicator are that it is cheaper than a number of signals one of which would be required for each route, it occupies less space and, as only one signal is used in conjunction with it, drivers are not required to pass a red aspect as would be the case when a separate signal is used for each route.

Compared with the total number of signals in use of British Railways, the use of the colour light signal has not been so extensive as envisaged when they were first introduced. What is certain, however, is that on the completion of the 15 years modernisation programme on British Railways, all main lines will be equipped with this type of signal.

India was not slow in adopting the colour light signal. Only six years after their appearance on the Liverpool Overhead they were introduced on the former B. B. & C. I. & G. I. P. Railways on the Bombay suburban section. These signals are now used extensively on the Indian Railways.

RAILWAYS NOT FOUND ON ANY MAP

Bright with new paint, a narrow-gauge train is seen standing ready for the "all aboard" signal at the platform of the Pioneerskaya Station, near Moscow. The engine driver, quite a boy, looks out of the locomotive. Another one, wearing the uniformed cap of a man on duty, gives the signal, and the train leaves the station and gradually disappears in the distance.

This is a usual picture on the Malaya Moskovskaya Railway, which will not be found on any map despite its almost 25 years of existence. It was laid specially for children in 1937, two years after the country's first children's railway was built in the Georgian capital, Tbilisi.

Since that time the network of children's railways has been constantly expanding. Today they can be found in Dnepropetrovsk, Yerevan, Krasnoyarsk, Irkutsk, Tashkent, Leningrad, Stalingrad, Kiev, Riga, Chelyabinsk, etc.—34 altogether. Another one, in Sverdlovsk, will be put into operation very soon.

The young railwaymen are in charge of a great deal of rolling stock and, just as on normal railways, all the rules and technical forms are strictly observed.

Normally, the railways are up to 10 km. long. Some have complex engineering constructions. For example, the railway in Yerevan is in the mountains

and the trains have to pass through a tunnel and two bridges on its route.

Today diesel locomotives have taken the place of steam engines on 17 of these roads; 70 per cent are equipped with all-metal cars and 14 have automatic blocking.

* * * * *

HUGE CEMENT PLANT UNDER CONSTRUCTION IN UZBEKISTAN

A huge cement plant is now under construction in Uzbekistan. Four giant rotating furnaces 175 metres long and 4.5 metres in diameter each will be installed. Powerful belt conveyors 6.3 kilometres long and nearly 1.5 metre wide will be used for the delivery of raw materials for the first time in the Soviet Union.

The *Uzbekistan's National Economy* journal reports that the first technological section of the plant will be commissioned in the middle of 1961, six months ahead of schedule.

Subsequently this plant will develop into Central Asia's largest building materials combine. It will consist of a slate factory with a capacity of 130 million conventional units and a factory of asbestos-cement materials which will annually produce 500,000 square metres of "asobement" slabs for housing and industrial construction.

Primary Batteries for Signalling Applications

By D. Krishnamurty

Asst. Development Engineer, Consumer Products Sales Division,
Union Carbide India Limited, Calcutta.

IN the early days of railways when only one or two trains were running on a track each day, the primary concern was just to move the trains. There were no signals and no movement controls because there were hardly two trains simultaneously moving on the same track. With the increase in the number of trains, signalling systems were introduced to regulate the movement of trains so that any two trains are kept at a reasonable distance from each other when they are running on the same track. Today, the number of trains and their speed have increased tremendously and the job of present-day signalling systems, therefore, does not stop at making the railways safe, but at maintaining this safety at maximum speed.

For this purpose modern signalling systems have two definite functions. Firstly to set tracks and signals to direct the train movement, and secondly to control or supervise the setting. Or, in other words, to make the signalling system fool-proof and failure-proof. Setting the signals is mostly a manual job and has been in operation for a long time. The supervisory and controlling function of the signal systems is the key note for the safe and speedy working of modern railways. This is made possible by the imposition of an automatic control on the operation of signals by electric and electronic instrument which sense the presence of trains on the lines, the setting of the track and the signal indications given to train drivers.

This supervisory operation in signalling — distinguished from the manual or power driven track setting, lowering of signal arms, etc.—consists of the modern block system, track circuits, train indicators, slot circuits etc. The mode of power chosen for this operation is electricity, because of its amenability to instantaneous communication and remote control. Three sources of electric power can be used for the control of signals—electric mains, secondary batteries and primary batteries. Electric mains power is not desirable for “supervisory” signalling circuits due to its restricted availability, unpredictable failure and consequent unreliability. Secondary batteries are generally used only where mains power is available to recharge the batteries either continuously (trickle-

chargers) or at pre-determined intervals. The ideal power source for the control equipment of signals is the primary battery. This article aims to discuss the various types of primary batteries and standardisation of the primary battery requirements of Indian Railways.

Analysing the electric energy required for operation of the signal control equipment, three broad categories of batteries are essential for the railways—small batteries for portable equipment such as the emergency field telephone sets carried on trunk route trains; medium size batteries for signal supervision; and heavy duty batteries for track circuit and physical management of signals and points. In the ultimate analysis, the total battery requirement of the Indian railways thus consists of three types of primary batteries.

However, for various reasons, largely historical, the Indian railways at present are using more than a dozen types of primary batteries. In the initial stages the railways imported all their battery requirements. Prior to the amalgamation, the railways in India were run by independent companies using different types of equipment. Each of the railways imported batteries from different countries and consequently more than one type of battery was being used for the same kind of operation. Thus the total number of types of batteries used by all the railways increased considerably.

The uncertainty of imports resulted in the need to maintain large stocks of batteries in railway stores. Due to the semi-perishable nature of regular batteries the railways preferred the more expensive “inert” type of cells which can be stored for long periods and need be activated only when required. The present Indian Railways, which combined the entire railway system of India, generally had to continue the same systems as were in use before nationalisation.

For efficient operation of battery power supplies four conditions should be fulfilled—(1) the battery should give maximum performance per unit first cost, (2) the battery should not require any maintenance (3)

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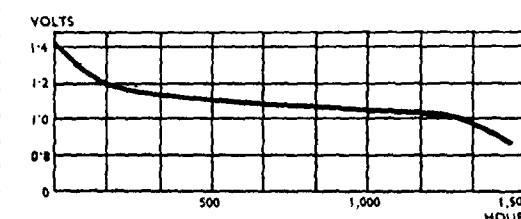
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the stores inventory cost of the battery should be minimum and (4) the battery should be readily available. To fulfil the first requirement, different types of batteries with different capacities have to be designed so that in each application the performance per unit cost is maximum. However, the number of types of batteries should be restricted to reduce the stores inventory. For example if 10 types of batteries are used and the stores has to keep a minimum inventory of 2 units of each type, the total stores to be maintained will be 20 units. If, however, the types of batteries are reduced to three sizes by using them on more than one circuit, the minimum stores inventory will reduce to six or a little more. Reducing the number of types of types of batteries automatically increases their availability because each battery can be used on more than one application. The battery should be manufactured for ready use in order to eliminate maintenance.

Efficiency of operation can therefore be greatly facilitated by standardisation of stores items. The Indian railways have realised this and established the Central Standards Organization to reduce the number of stores to an optimum level. The Indian dry battery Industry has also realised the advantages of standardization and has been working on the development of efficient batteries for the Indian railways.

The Indian dry battery Industry has been developing more and more dry batteries for the Railways to make India self-sufficient in this respect. The import of batteries was practically stopped during wartime and Indian dry battery industry supplied most of the many types of batteries required by the then separate Indian railways. At present all types of dry batteries, inerts and sac type cells are manufactured in India and the industry is approaching the stage of self-sufficiency with respect to materials and processes.

The Indian dry battery industry does not stop at merely manufacturing all the types of batteries used by the Railways. It also works closely with the Railways in the standardisation of primary battery requirements for efficient operation. Investigation of

the relative economies offered by inert and sac type cells and the dry cells has shown that the performance obtainable from inert type of cells per unit cost is comparatively very low. This is because the cost of manufacture of inert cells is more than regular round cells. The sac type of cells are also expensive overall, because they require regular maintenance. On the whole, it is now generally accepted that economy can be realised from using regular day cells only.

The industry has now succeeded in developing two types of dry cells each with a wide range of application in its field. A small type of dry cell is developed for portable instruments like the portable emergency telephone sets used in the mail trains. The second type of dry cell, the Railroad and Industrial Cell (Indian Standard Institution Specification IS 586 : 1959 type R 401) can be used in all supervisory circuits of the signal equipment; This dry cell, which is designed to give long service in applications involving either heavy discharge for short periods or light discharge for long periods, has already been tried successfully by the Indian Railways and is rapidly becoming established as the standard battery in these applications.

These two types of dry batteries give efficient service in all signal applications except for the signal and point movement and in track circuits. These two circuits require very heavy current and can be handled efficiently only by the Air Depolarised cell. These cells, which are imported at present, are not easy to manufacture indigenously, and offer the dry cell Industry its greatest challenge at present.

The Indian Industry by virtue of its past performance will certainly manufacture the Air Depolarised cells and will complete the range of primary batteries required by railways. The co-operative spirit existing between the Indian railways and the dry battery industry will surely result in the standardisation and efficient use of primary batteries in the Indian railways.

FERRO ALLOYS

The following three Indian Standard Specifications published recently by ISI are the latest additions to the series of Indian Standard Specifications for Ferro Alloys:

(1) IS:1467-1960 Ferro Tungsten (2) IS:1468-1960 Ferro Titanium (3) IS:1469-1960 Ferro Molybdenum.

These standards cover requirements regarding the size, chemical composition, sampling and supply of their respective materials.

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Keyset-operated Centralised Traffic Control System

(I BOBERG, L M ERICSSONS SIGNALAKTIEBOLAG, STOCKHOLM)

By An Engineering Correspondent

The first C.T.C. installation in the world was put in service some 30 years ago. Since then many new C.T.C. systems have been developed in different countries, each of which has brought some improvement in rapidity of operation or general reliability. But the systems of operation, and the design of the control and indication apparatus, appear to have been neglected and still look roughly the same as they did 30 years ago. This article describes an entirely new system of C.T.C. operation by means of a keyset. In the last few years LM Ericsson has introduced C.T.C. in Sweden, Denmark, Norway, Poland, Yugoslavia and India.

CENTRALIZED Traffic Control—or C. T. C.—has proved an admirable means of improving railway operation. The introduction of C. T. C. on a line will both increase its capacity and reduce the station staff requirements. C. T. C. means that the train despatcher directs all train movements within his section by direct operation of the entire signalling system in that section from a central point, which may be located wherever desired but is usually placed somewhere along the line.

The degree to which C. T. C. can contribute to rationalized railway operation is admittedly little affected by the design of the controlling and indicating equipment at the C. T. C. office. This equipment does, however, appear to have been grossly neglected over a long period. It was not until a few years ago that it began to be realized that C. T. C. could, in fact, be put to very much more effective use if the controlling and indicating equipment were improved. This need has been accentuated by the tendency to place larger and larger sections of track under the control of one office. A more efficient system of control and indication will then lead to direct savings in staff at the C. T. C. office. (This will obviously not apply to small offices which can be managed by one man). The most important benefit to be derived from greater efficiency in the organization of C. T. C. offices—although not always easy to demonstrate in terms of money—is perhaps the possibility afforded of further improvement in the directing of train movements.

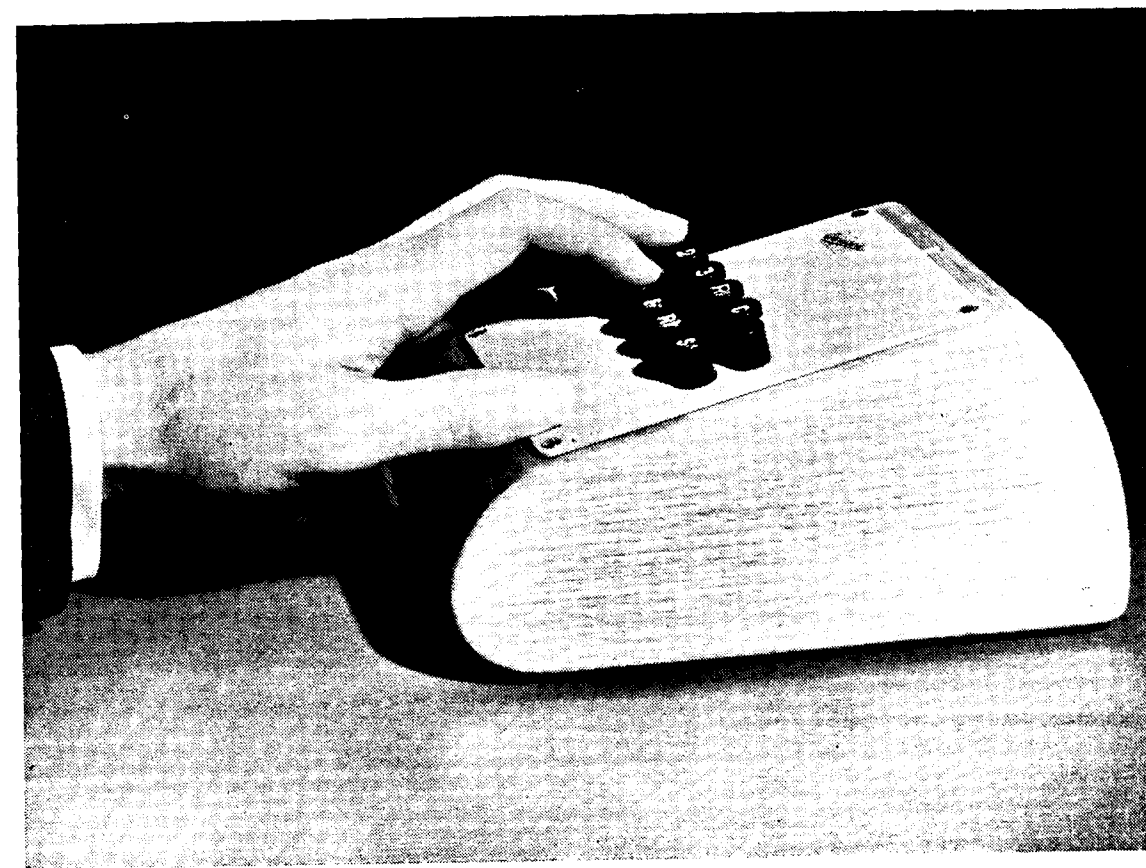
DEVELOPMENT OF CONTROLLING AND INDICATING EQUIPMENT FOR INTERLOCKING PLANTS

In studying the design of various controlling and

indicating apparatus for C. T. C., it may be of interest to consider the development of corresponding equipment for interlocking plants. Interlocking machines came before C. T. C. machines, and there is reason to believe that they influenced the design of the latter. Recently, however, a certain influence in the reverse direction has been noticeable.

It is obvious that the design of the controlling and indicating equipment of interlocking plants has been, and still is, greatly dependent on the devices to be controlled by and indicated to the signalman. When mechanical interlocking plants were usual, and both points and signals (semaphores) were mechanically controlled, the system could operate only over very short distances. Indications to the signalman were not considered necessary, nor did resources for transmitting them exist. The work was physically heavy. Later, when points and signals could be controlled electrically, the control machines were reduced in size. Control could be effected over greater distances, and the control equipment for a large area could be combined in one interlocking plant. This brought the necessity of indications; they were of a simple character, and the indicating lamps were usually placed on the control machines. When indications became more and more complete, and track circuit control was introduced, the indicating equipment had to be placed on a special track diagram behind the control panel so as to be visible to the controllers from their operating positions.

The interlockings required between the various controls for points and signals, to ensure that faulty operation did not imperil traffic safety, were initially set up by mechanical means in the control panels. Electrical interlockings were introduced in the thirties and in due course led to all-relay interlocking plants.



FIRST IN THE WORLD WITH **C. T. C.** CONTROLS

concentrated in a small keyset panel

The concentration of the C.T.C. control equipment to a keyset implies numerous advantages. Chief among these are that the train despatcher

- has a good visual control of the entire track diagram
- remains seated in one position throughout
- has all control equipment and other aids immediately to hand.

The first keyset-operated C.T.C. equipment in India was delivered in 1958 to the Railway Staff College, Baroda which works a model railway system.

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The size of control panels could now be greatly reduced. Once again the indicating equipment could be placed on the control panel, and the methods of control could be simplified. The usual procedure was that signals and points along an entire train route were controlled by a single manual operation (possibly using both hands simultaneously). There are several designs of such equipment. The only method mentioned here is LM Ericsson's LTL (Line-To-Line) method with keys on the miniature track diagram on the control machine. The simultaneous operation of two keys controls the signals and points of the route on which the keys are placed (fig. 1).

With the advent of relay interlocking plants, larger and larger territories could be controlled from one office. The question now arose whether the control panel and track diagram should still be combined or whether they should again be separated. Different methods were adopted by different railways, but the most practical

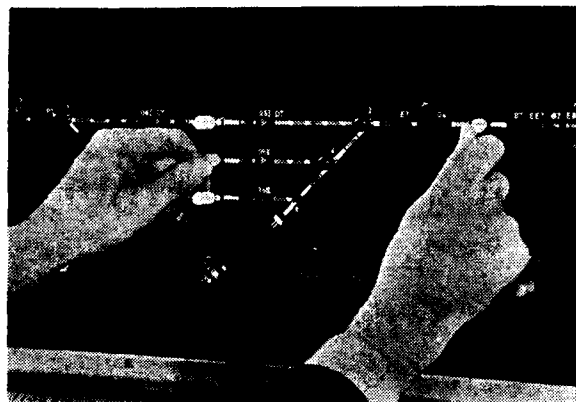


Fig. 1. Close-up of control machine of modern design for relay interlocking plants.

Line-To-Line control of an entire route is effected by throwing two keys simultaneously in the same direction. The keys are placed on the miniature track on the control machine as shown in the photograph.

procedure now appears to be to use a single panel provided that it is not larger than that the operator can reach all controls from his chair. If the panel is too large for this to be possible, it should be split into control panel and track diagram. If the control machine can have the controls placed on a sub-miniature diagram, this alternative would seem to be preferable.

It will be apparent that the initial goal of the designers of interlocking apparatus was to eliminate

the need of physical strength in the operator. Later efforts were aimed at the design of controlling and indicating equipment of a kind that permitted every operator comfortably and efficiently to control as large a territory as possible from his position at the machine.

THE DEVELOPMENT OF C. T. C. OFFICES UP TO THE 1950-IES

The first C. T. C. system in the world was installed in the U. S. A. in 1927. The line controlled was a very short one, and the little control machine was designed for individual control of points and signals, roughly as illustrated in fig. 2. It probably fulfilled all reasonable requirements at that time. But it is remarkable that the C. T. C. machines produced during the following thirty years closely followed the design of the original model. Most machines delivered even up to 1957 were probably almost identical in appearance and in operating principles to the machine produced 30 years back. In large C. T. C. offices the control machines have admittedly

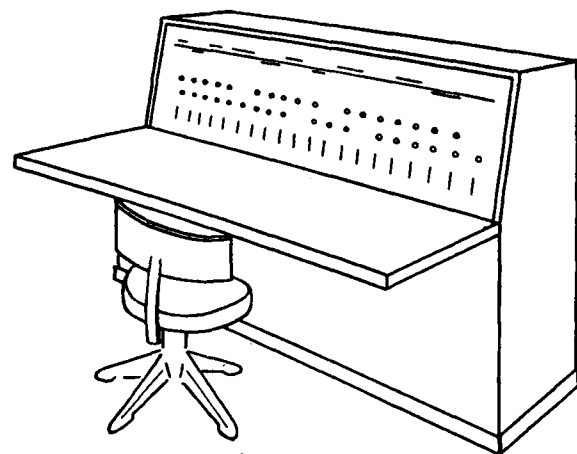


Fig. 2. Control machine in C.T.C. office, 1927 model.

assumed a horseshoe shape and the operator's chair now has runners, but the advance has not been rapid (fig. 3).

It would seem an important point that the C. T. C. operator should have a constant view of the entire track diagram of the territory for which he is responsible. This is quite clearly impossible with the "conventional" design of control machine and operating system. Moreover, according to the notions of our time, it is considered an advantage if the operator can sit still—even if a certain amount of

motion has points in its favour. The drawbacks of the conventional design are likely to become more serious in future owing to the tendency to enlarge C. T. C. areas. Quite soon a single C. T. C. office may control an entire railway district covering thousands of miles of track. The track diagram will then have to be divided into sections, as admittedly is done now, but the sections will have to be much larger. It should be possible to cover at least 300 miles and 50 stations from a single control machine of suitable design.

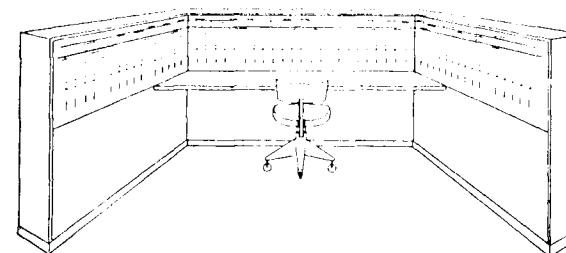


Fig. 3. Control machine of conventional type, model 1927—1958.

Most C.T.C. offices in the world are still of the design illustrated, and as a rule every point and every signal is still individually controlled. The operator cannot reasonably be expected to have the entire track diagram constantly under his eye while moving about. His chair is normally fitted with runners.

Individual control of points and signals is admittedly fully acceptable for a short length of track. But for large C. T. C. offices the method does not appear satisfactory. In the latter the control must cover entire routes, and should perhaps to some extent be automatic. The larger the C. T. C. office, the more important do these factors become. The introduction of route control on the LTL principle, as described for interlocking plants above, is a case in point. Systems of this kind have been installed by LM Ericsson in Denmark, Norway and Poland.

KEYSET OPERATION

LM Ericsson's first C. T. C. system was delivered in 1938. The control machine was of conventional design, although with equipment for control of complete routes. The equipment is still in service and operating efficiently.

When LM Ericsson started to redesign its C. T. C. system around 1950, primarily in order to step up the rapidity of operation, it was considered advisable at

the same time to modernize the control and indication equipment and the method of operation. After careful deliberation and study the following criteria for a C. T. C. office were set up.

1. The operator should be able to actuate all controls from one position.
2. The operator should have a good view of the entire track diagram from his desk.
3. The operator should be able to actuate all controls with one hand (preferably the left hand).
4. The control panel must be capable of standardization for all C. T. C. offices; and several control panels should be capable of operation in parallel, temporarily or permanently.
5. The normal procedure should be control of an entire route. But individual control of signals and points should also be possible.
6. If indication of category of train on the track diagram is desired, the same control panel should be used for this purpose as for other C. T. C. operations.
7. The track diagram should be semi-circular.
8. The operator should be able to transmit from the control panel information which permits automatic control of the C. T. C. system to a varying extent. The track diagram should possess the necessary indicating lamps for this purpose.

Requirements 1 and 2 meant that, at least in large C. T. C. offices, the track diagram must be separate from the control panel. Since it was also required that the control panel should be standardized, it followed that this separation must apply to small offices as well. An example of the placing of the controller and his control panel in relation to the track diagram is shown in fig. 4.

The control panel would meet the requirements of universal applicability (standardization) and be operatable with one hand (requirements 3 and 4) if it was designed as a keyset of the type used on calculating machines. The keyboard could be large or small, with one or more sets of keys for each digit.

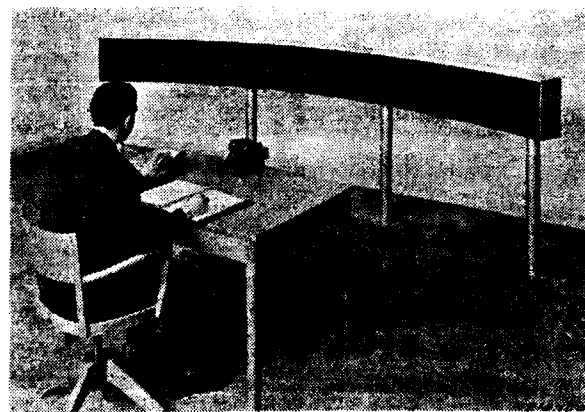


Fig. 4. Keyset and track diagram for C.T.C. office as supplied by LM Ericsson.

All controls are effected by keying a multidigit number on the keyset. The operator has a full view of the entire track diagram in all situations. (This track diagram was delivered to the Swedish State Railways).

The small keyboard would require a rather more complicated intermediate relay set than the large one, but the advantages from the control aspect appeared so great that the small keyboard was adopted (fig. 5). Requirement 4, that several control panels could be used in parallel, was thereby easily met.

Since control was to be exercised through the keying of numbers on a keyboard, the numbers would have to be simple enough for the C. T. C. operator to remember at least those in common use. This did not prove difficult, particularly since, for reasons of rapid operation, an entire route would normally be controlled by keying a single code (requirement 5). An example of a logical numbering system for all routes on a single-track line is shown below. This is only one way of arranging the numbering. Many other systems would be equally logical and equally easy to remember. Easily memorable numbering systems can likewise be made up for double-track lines.

Keyset control nos.	Route
11	Approach from south (northward) main track
13	" " " " first siding
15	" " " " second siding
	etc.

21	Exit northward from main track
23	" " " " first siding
25	" " " " second siding
	etc.
12	Approach from north (southward) main track
14	" " " " first siding
16	" " " " second siding
	etc.
22	Exit southward from main track
24	" " " " first siding
26	" " " " second siding
	etc.

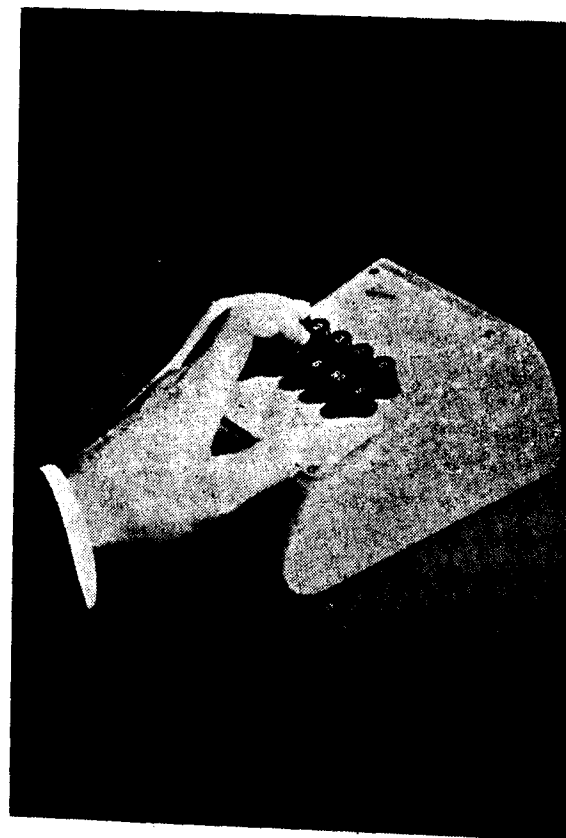


Fig. 5. Keyset for C.T.C. operation.

The operator keys a four-digit number to control an entire route. When desired, however, he can control points and switches individually by keying other numbers. With other numbering schemes the operator can indicate the category or destination of each train on the track diagram, after which the indication moves with the train from track section to track section. A trained C.T.C. operator, of course, need not look at the keyset when manipulating the keys.

Odd numbers are used for all controls of trains in one direction, and even numbers for all controls of trains in the other direction. The first digit of all controls is odd for approaching trains and even for departing trains.

Each control, however, must consist of four digits, of which the first two represent the station number. The station number can be indicated on the track diagram so as to be easily visible to the controller from his working position. The control of a route for a train entering the main track at station 34 from the south will be effected by keying number 3411 (fig. 6).

Train categories (goods, express etc.) or train numbers (requirement 6) are indicated on the track diagram by the track circuit lamps or by lamps placed beside them. When a new train enters the C. T. C. section, the category of train must be indicated on the track diagram by operation of the keyset. This can be done for instance in the following manner. The controller first keys the number of the station and of the track on which the inbound train has entered the C. T. C. section. He then keys a letter, signifying the category, or numerals, signifying the number, of the train. The combination 0112G would provide the following information.

0 signifies that the subsequent digits and letter refer to the category of train. (The

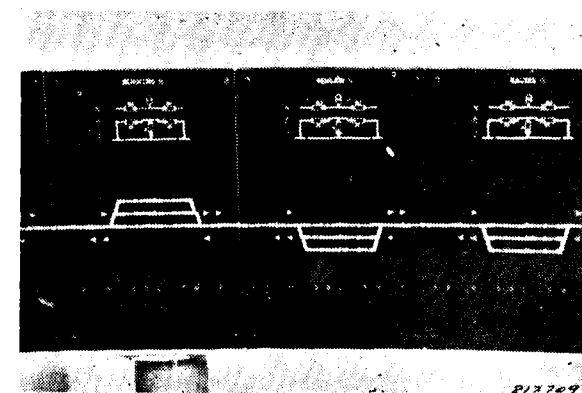


Fig. 6. Part of C.T.C. track diagram

Every station has its number, which the C.T.C. operator keys when transmitting a control. This track diagram also shows the positions of circuit-breakers and disconnecting switches in the rail-road overhead line and auxiliary transmission line. The control of circuit-breakers and disconnecting switches is effected with the keyset in the same way as control of routes etc.

information is not to be transmitted to the C. T. C. control register.)

11 signifies indication of the category of train at station 11.

2 signifies indication of the category of train on track 2 (at station 11).

G signifies goods train.

When using a train number system, the combination 0112324 would permit the entry of train number 324 to track 2 at station 11. The indication of train category or number moves along the track diagram automatically from track section to track section as the train advances.

Requirement 7 needs no special comment. The track diagram is semi-circular as shown in fig. 4.

Requirement 8 stipulated that the control system should permit automatic operation to varying degrees, and that whatever automatic methods were employed should be adequately indicated on the track diagram. This requirement is dealt with in the following section.

AUTOMATIC OPERATION

The execution of a C. T. C. control takes very little time. It amounts to a few seconds, and in a small office the actual operating time is a relatively insignificant factor. But it must be remembered that the main job of a C. T. C. operator is to plan train movements, not to execute the actual controls. In a large C. T. C. office, therefore, it may be necessary either to use several C. T. C. operators or to have a single operator and give him additional technical aids. We may take as example a single-track section comprising 25 stations and carrying 60 trains a day. During the period of heaviest traffic the operator would have to execute controls about twice a minute. (In assessing the amount of work to be performed by a C. T. C. operator, the number of occasions on which he has to execute controls would appear to be a better gauge than the number of controls to be executed.) Even if every action by the C. T. C. operator controls an entire route, he should hardly be made responsible for so great a number of operations if he is at the same time to do his main job of planning train movements.

But the capacity of a train despatcher can be increased by giving him additional technical equip-

ment. This can be arranged in several different ways without needing to add unduly to the expense of the C.T.C. equipment. The Swedish State Railways, for example, have introduced local equipment at the stations for storage of routing orders from the C.T.C. office. The C.T.C. operator can then give advance orders for control of several train movements, and the number of occasions on which he has to execute controls can be easily reduced to less than half. If considered preferable, the storage equipment can naturally be installed equally well in the C.T.C. office. It can also be combined with a certain measure of automatic operation by having station signals and points automatically set for a meet if two trains approach from opposite directions.

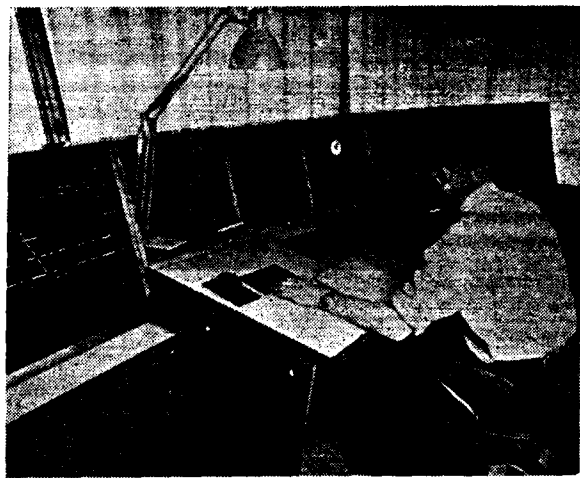


Fig. 7. C.T.C. machine and track diagram with Line-To-Line system

In the centre of the machine, beside the traingraph, are certain keys with which the controller can perform all normal operations. For special operations, however, he must move over to the track diagram. (This equipment was delivered to the Danish State Railways).

The Danish State Railways have chosen another method of reducing the work of the C.T.C. operator. It has been called the "destination indication system"; the destination of every train entering the C.T.C. area is marked on the track diagram by means of the track circuit lamps, or by lamps placed beside them, in the same way as the category of trains. When the train arrives at its destination, the destination lamp on the track diagram darkens and the C.T.C. operator keys a new destination. All signals and points are operated automatically by the destination marking equipment.

Keyset operation of the destination indication system could be carried out for instance in the following manner: When the C.T.C. operator wishes a train on track 2 at station 12 to move to track 2 at station 34, he keys 0122342:

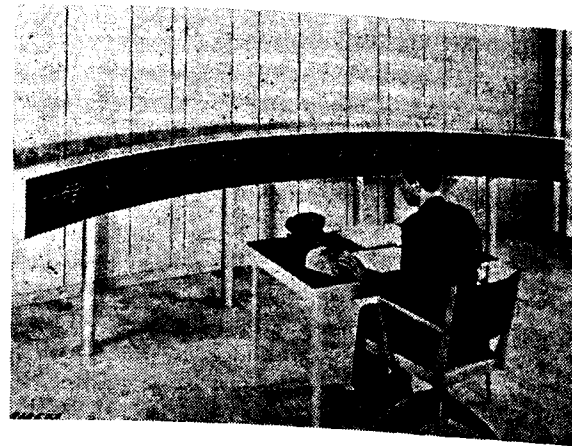


Fig. 8. C.T.C. equipment delivered to Yugoslavian Railways

This office, situated in Doboj, controls the roughly 100 kilometres of single-track line between Doboj and Zenica. The main part of the installation will be completed this year and the remainder during 1959.

- 0 signifies that the subsequent digits refer to destination marking. (The information is not to be transmitted to the C.T.C. control register.)
- 12 signifies indication of the destination of a train at station 12.
- 2 signifies indication of the destination of a train on track 2 (at station 12).
- 34 signifies that the train will proceed to station 34.
- 2 signifies that the train will proceed to track 2 (at station 34).

If for any reason the destination of a train requires to be cancelled, this is done by keying the track number and station number of the present position of the train, followed by 0. Number 01120 would mean cancellation of the destination of a train on track 2 at station 11.

Like the storage system employed by the Swedish State Railways, the destination marking system can be

combined with automatic equipment which sets signals and points at a station for a meet if two trains approach the station from opposite directions.

OTHER DESIGNS

Even if L M Ericsson has found that C.T.C. operation can best be effected by means of a keyset, it is obvious that other methods may be preferable in special instances. The aforementioned principles of indication of train category and of automatic control by means of storage or indication of destination can be applied to other methods as well.

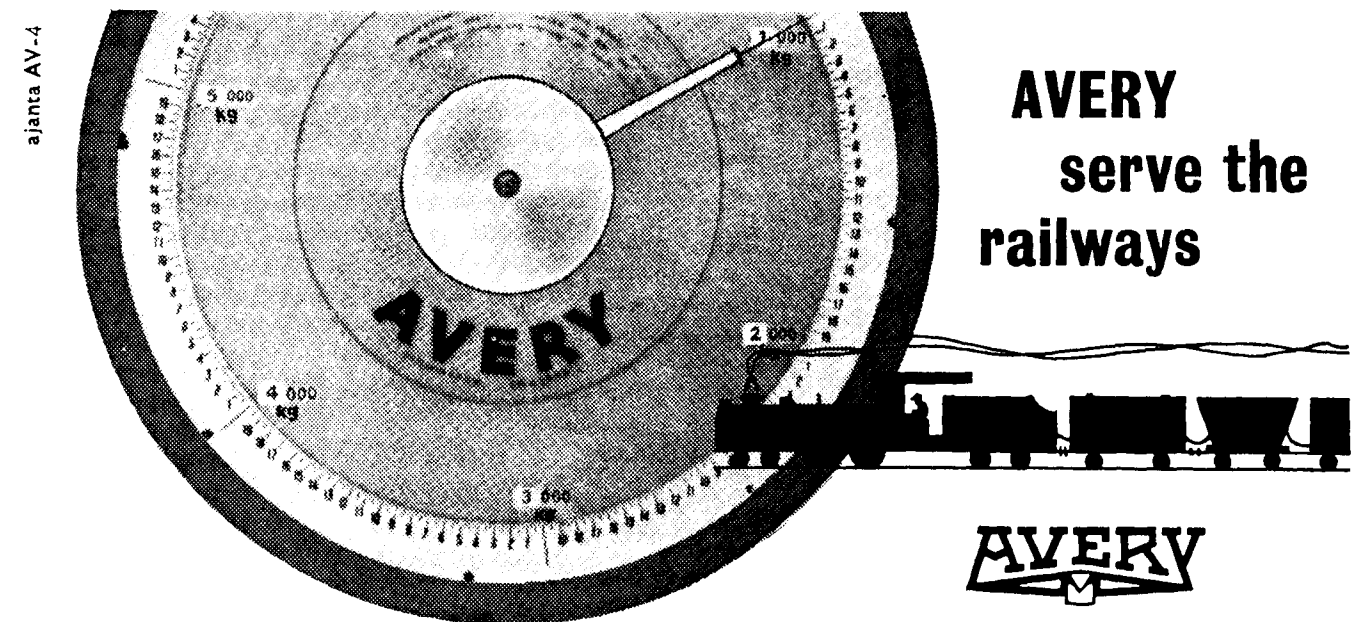
Particular mention may be made of a method employed by the Danish State Railways, involving the control of entire routes by means of a Line-To-Line system on the combined control panel and track diagram. In parallel with the Line-To-Line controls, however, are keys which are placed in the centre of the control machine beside the traingraph (fig. 7). These keys can only be used for normal

control operations, but preclude the necessity of the C.T.C. operator moving from one part of the control machine and track diagram to another, apart from exceptional cases. The use of the destination indication system, with the controls placed beside the traingraph, means that the C.T.C. operator should in practice never need to leave his normal working position.

EXPERIENCE OF KEYSSET OPERATION

L M Ericsson's first keyset-operated C.T.C. system was installed on the Swedish State Railways in 1955. The overall experience during these three years has been very satisfactory. The personnel have had no difficulty whatsoever in learning the numbering system, and it has found to be a manifest advantage that the C.T.C. operator should have the entire track diagram constantly under his eye and be able to perform all operations while sitting at his desk.

(Reprint 1163 from ERICSSON REVIEW)



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Supervisory Controls in Power Supply System

By G. N. Upadhyay

Chief Power Engineer, Bhilai Steel Works

IN a Steel Industry, failure of supply causes not only loss of production, but also damage to equipments in Plants like Coke Ovens, Blast Furnace, Open Hearth etc. For example, in case there is failure of supply in pump house since the circulating water system for the cooling of the furnaces in the Plant will be affected, the refractories of the furnace will be damaged. Therefore, great stress is laid on having a very reliable power supply system while building a Steel Plant. For this, the necessity to have a centrally controlled despatcher system in order to have quick restoration of supply has long been felt. This resulted in the remote control of all distribution systems from a centrally controlled despatcher point.

In old designs, the control is limited to the control of equipment in an out-door yard from the control room, as the direct wire method is adopted. In this, the main draw-back is the use of an expensively large number of cable connections radiating from the control point and also the necessarily large size of control equipment. Now a days, these draw-backs have been overcome by the use of telephone type of relays and selectors. Here several objects are grouped together and individual relay from group is controlled by one controlled point. This facilitates group selection and then individual selection due to which the number of cables radiating from the centrally controlled despatcher point are very much less and the power consumption is negligible.

DESPATCHER CONTROL

In Bhilai, all the Plant sub-stations fed from the buses of main step-down sub-station and Plant Power House are subject to Despatcher control i. e. tele-control, tele-signalling and tele-metering.

a) Tele-controlled sections and apparatus :—

1. 6.6 KV circuit breaker of the plant power house outgoing feeders.
2. Circuit breaker one the 6.6 KV incoming feeders to sub-stations.

3. Circuit breakers on cables connecting main step-down sub-station to Plant Power House.
4. Circuit breakers on outgoing feeders of non-attended sub-stations.
5. In some instances, circuit breakers of feeders inter-connecting other sub-stations in attended sub-station, and
6. 6.6 V bus section circuit breakers.

All these apparatus have also got local control for periods of repair, adjustment and supervision.

(b) Tele-signalling is provided for :—

1. Signalling of positions occupied by all tele-controlled circuit breakers.
2. General signals informing of emergency tripping of circuit breakers for both tele-controlled and non-tele-controlled apparatus.
3. Signals indicating voltage on 6.6 KV bus.
4. General alarm signalling dis-orders in transformers.
5. General alarm signalling faults at sub-stations (installation control, switch over of tele-control systems from regular power supply to emergency power etc.)
6. Signalling switch over of a sub-station to manual control.

(c) Tele-metering is being applied for in the following cases :—

1. Tele-metering of voltage of plant power house buses.
2. Tele-metering of currents flowing between

plant power house & distribution sub-stations :

The dispatchers' office is housed in the main step-down sub-station and this allows the dispatcher to control the circuit breakers of the feeders from main step-down sub-station with the aid of remote control. The dispatchers' control devices are arranged in a mimic bus switch board and control desk, representing buses of all sub-stations and sections controlled by tele-controlling.

As can be seen from the Tele-control diagram, since the distance between the main step-down sub-station (controlling point) and the shop sub-station (the controlled point) is not more than 4 kms. the coded impulse type of supervisory system has been adopted. The principle of operation of the device is as follows :

The controlling point is connected to the controlled point by a double core single channel wires of the telephone type through which normally a current of 30 mA flows. Equipment suitable for the generation of coded signals are situated at both the points. The pre-selection of a particular controlled point is done by radial selection with the help of telephone type of line relays. Each controlling point can control upto a maximum of four controlled points. Pre-selection is done in the order in which the impulse series is transmitted from the four controlled points or if the impulse series come all at the same time, the pre-selection is done in the order in which the blocks controlling the controlled points are placed in the controlling point panel. After this, the selection of a group and then the individual object from the group at the controlled point is done as in an automatic telephone exchange, where the signals are transmitted and received in the form of impulses of current in the channel. These signals are sent from the controlling point when a certain command has to be given and from a controlled point when a certain double position object changes its position.

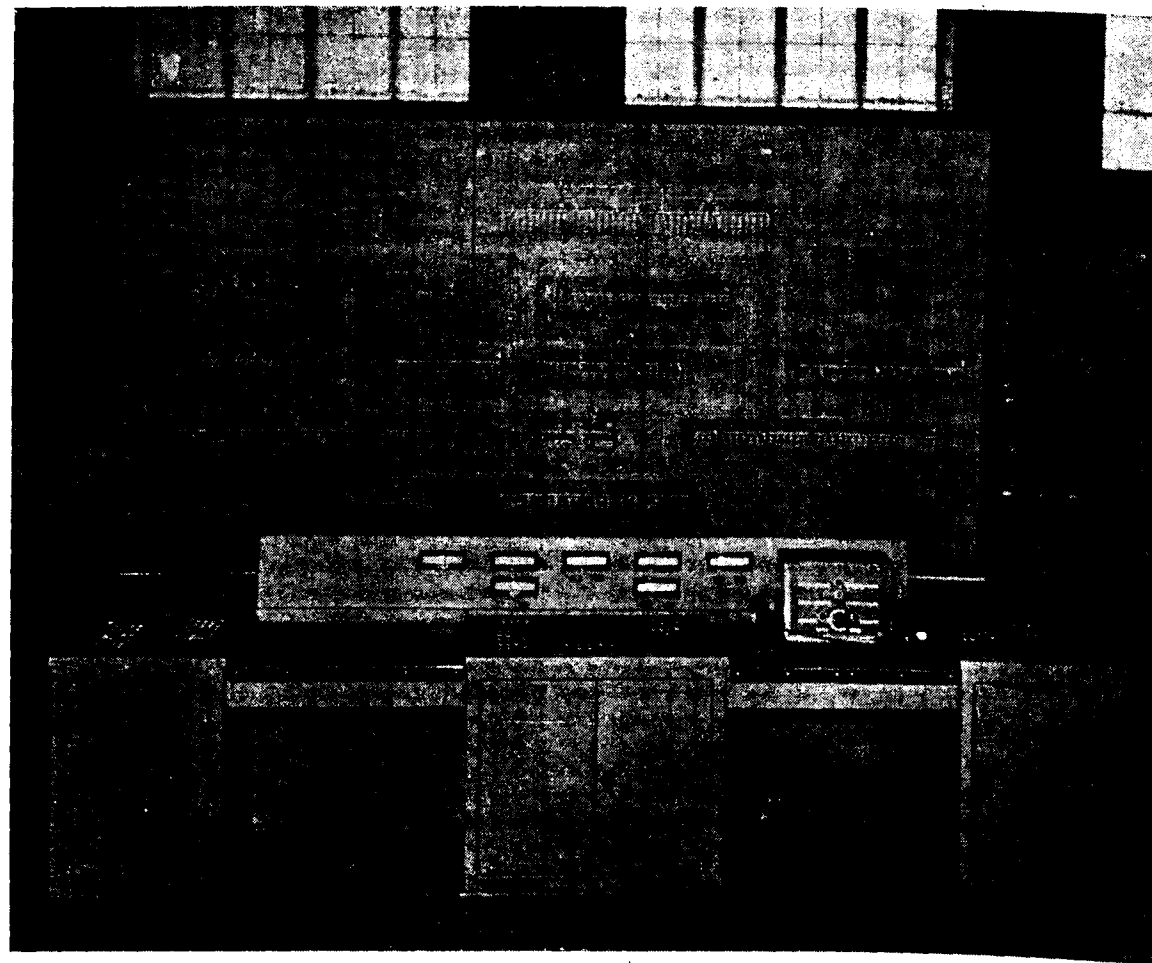
To close a circuit breaker, the despatcher puts the relevant control key, on the control desk at the main step-down sub-station to "ON" position. The line relays operate and select the channel and the correct controlled point, the correctness of selection is checked by the burning of the lamp on the relevant control key and of the lamp on the circuit breaker symbol on the mimic diagram. Then he pushes

the button "Start" which actuates the code sender which transmits the coded series along the selected channel. The code receiver at the controlled point receives the coded series and selects the correct object and switches on the circuit breaker. After the circuit breaker switches on, a normally open auxiliary contact of the circuit breaker actuates a code sender at the controlled point. Notification (coded) impulses are transmitted back along the channel. The reception of this coded series at the controlling point is indicated by the flickering of the lamps on the mimic circuit breaker symbol and a lamp common non 'correspondence'. When the despatcher switches on the mimic circuit breaker symbol, the lamps go out and the operation is complete.

The tripping of a circuit breaker is done in a similar manner except that the control key is put to "Off" instead of "ON" position. In case a circuit breaker changes its position by the operation of an operator at the controlled point, the same sequence of operations, as stated above for notification series, take place and the despatcher at the controlling point has to change the position of the mimic C. B. symbol and also that of the relevant control key on the control desk. In case a circuit breaker trips due to a fault, then in addition to the above sequence of operation, an additional red lamp "Emergency" flickers. Any sub-station can be put under supervisory control or manual control by switching on or switching off a switch on the control desk. In case it is "ON" a lamp "Ready" will be lighted.

To ensure the accuracy, safety selection and quicker rectification of defects in the device, several special safety & protective devices are incorporated in the system which are as under :—

- (a) A red lamp "channel" which burns when there is a fault in the line.
- (b) A duplicating starting relay which operates and sends impulses in case the starting element of a particular object on a controlled point does not work.
- (c) Interlock are provided against :
 - (i) wrong group selection.
 - (ii) wrong individual selection.
 - (iii) a synchronous motion of selectors.
 - (iv) bad coding of impulses.
 - (v) continuously repeated operation of devices.



- (d) Indicating lamp for wrong signalling on the mimic board. When this lamp burns the despatcher has to send an impulse series to the particular controlled point by pressing the button "Call". If the lamp goes out, then the device is working alright.

The centrally controlled despatcher point is at main step-down sub-station, with six controlling point panels, a mimic board showing the position of all the 6.9 KV circuit breaker in the system and a control desk, controlling 14 controlled points (the thirteen shop sub-stations and one Power House). Most of the equipment in the sub-stations for shops like Coke Ovens, Sintering Plant, Foundry and Oxygen Plant, where there is no operating personnel, are completely tele-controlled. But, in the Power House, tele-control of only the outgoing feeders to shop sub-stations such as 1, 2, 3, 4 & 5 has been provided. In addition to this, tele-metering of the load current in the above out-going feeders and of the voltages of the two bus sections has been provided. Selection of a tele-metering channel is similar to that

of tele-control except that a button "Meter" for the particular tele-metered quantity has to be pressed. Since the length of the channel is not more than 4 Kms, tele-metering by rectified devices transmission has been adopted. The kenetrons trans-impedance being very high, the error of measurement due to resistance, variation and also power loss are reduced. Since the Kinetron is in the secondary circuit of a high turns ratio current transformer, the reflected impedance in the primary is very low. Also since the tele-metered impulse is a direct current a highly sensitive magnet electric meter can be made use of. In all other sub-stations tele-control of only the incoming and sectionalizing circuit breaker has been provided.

The supply for these supervisory control devices is by means of selenium rectifier with voltage stabilization by a saturated choke. The ripple on the 60 V d.c. side should not be more than 5% and the maximum consumptions of a device is not more than 4 A.

The time taken for sending a command and receive

an indication signal is 3.5 secs. A single controlling point can telemeter 18 quantity, telecontrol 36 objects and telesignal the position of 80 objects.

The cabinets a vermix proof ones are made of steel and aluminium with rubber packing for the steel doors in order to prevent dust and moisture. To facilitate easy maintenance and quick rectification of faults, the relay panels are of the swinging type and the blocks of line relays and selectors are removable.

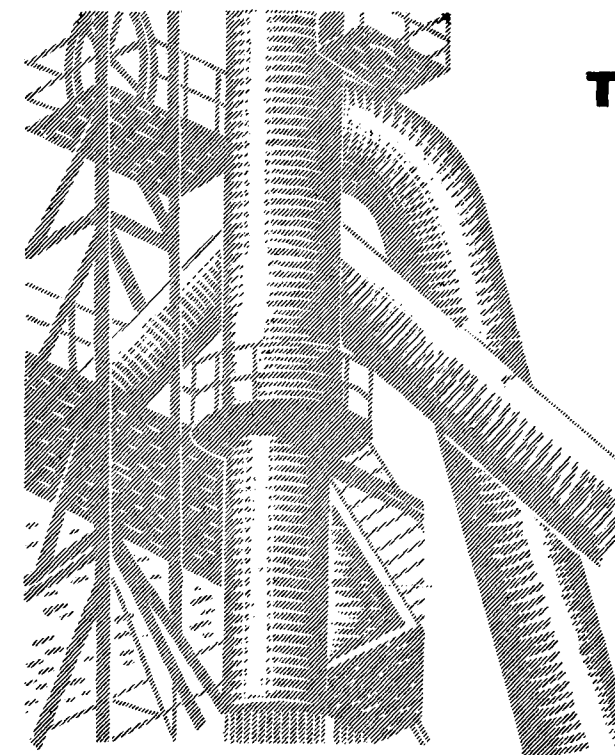
In order to maintain and test these devices a special group has been organised in the electro-technical laboratory, to test completely the equipment once a year and check the devices once in 3 months, and effect rectification of defects, if any. Since the devices are of the exchange type and operation pertains to power system, this group have been given a thorough knowledge of both power as well as communication engineering.

The use of these devices in Bhilai has resulted in quicker restoration of supply because :

- Correct information is given as to the position of objects to the despatcher.
- Direct control of all necessary objects and thus avoids delay in communication to personnel.

The system has resulted in the reduction of operation personnel, since sub-stations are tele-controlled completely. Maintenance gang for sub-stations are separately provided for (a) Normal maintenance (b) Preventive maintenance.

With the effective facilities, quick operation and hundred per cent control and decorative effect, supervisory control is becoming increasingly popular in modern Industries, particularly in Steel Plants, where production means everything.



The Steel Plants Railway

The South Eastern Railway has earmarked the lion's share of its total Second Plan outlay for construction work for the steel plants. The construction programme includes doubling of 566 miles of existing track, laying 348 miles of new lines and electrification of 406 miles of track on Asansol-Sini, Tatanagar-Rourkela, Rajkharwan-Dangoaposi, Tatanagar-Khargpur and Howrah-Khargpur Sections.

SOUTH EASTERN RAILWAY

A Swiss Contribution to Modern Signalling

By An Engineering Correspondent

TOKENLESS BLOCK AND SIMPLIFIED AUTOMATIC TRAIN CONTROL

RAILWAY Signalling in Switzerland has, in general, developed along Continental lines because railway operation is in some ways similar to that in the neighbouring countries. There are, however, several special features of Swiss railway signalling which are of particular interest and which are not yet widely known overseas. The following article is concerned with the Swiss inventions in railway signalling which have raised the greatest interest with overseas visitors.

TOKENLESS BLOCK

Unlike other highly industrialised countries a considerable portion of the Swiss network is still operated with single lines. Although a great deal of important civil engineering work has been done to double lines in the most difficult areas, there remain and will remain many important single lines with a high density of traffic. Because of these conditions, both modern and economic designs of signalling equipment for single lines have been developed. When one compares the standard of

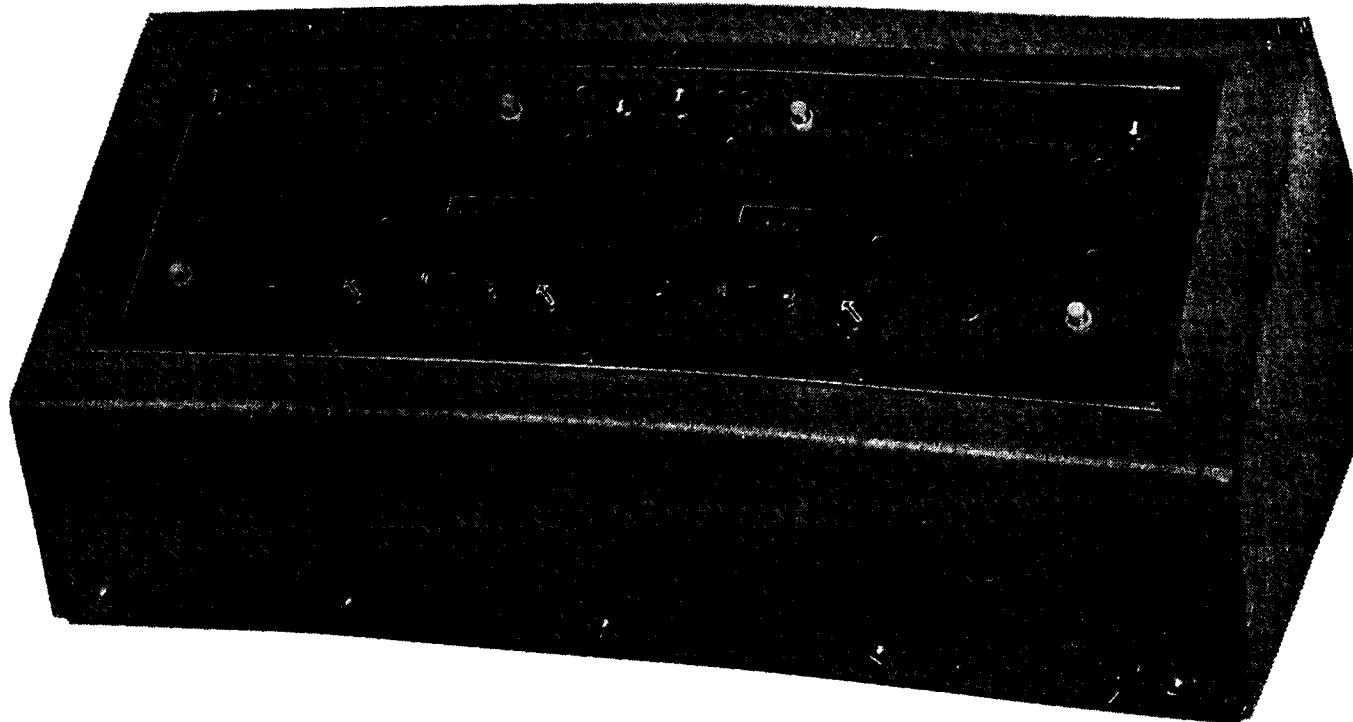
single line signalling reached in Switzerland with that of other countries, one can clearly see that, except for the very specialised field of C.T.C., more has been done to modernise single line operation than anywhere else.

The backbone of any signalling system is, of course, the lock and block and it may be of interest to note that token systems have never been used in Switzerland. Lock and block systems are therefore traditional but new developments were not biased by the operating methods of any token system.

The lock and block which has found large scale application is known as R. A. B. (Relay Auto Block). It is based upon developments which were made some fifteen years ago and which led, after several years of severe testing, to the basic system from which all later R. A. B. versions have grown.

The fundamental objectives of this system were to obtain:—

- (a) The highest possible safety of operation with equipment that would not, now and in the future, give any danger side failure



DOMINO-type R.A.B. Panel (incorporates also the control elements for home and starting signals)

R.A.B. (Relay Auto Block)

THE INTERLOCKING BETWEEN STATIONS

A tokenless block system featuring:

- top level of **safety** and immunity
- marked **simplicity** of operation
- **interchangeable units** with plug-in connections
- adaptation to any kind of **existing signalling**
- **variety** of versions (through-switching, permissive block, shut-in sidings, double line block with commutation to single line operation)
- **basic system** with facility for gradual adaptation to future traffic requirements

**R.A.B. is the most up-to-date
tokenless block system**

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A.W.D. (Approach Warning Device)

THE LINK BETWEEN TRACK AND TRAIN

A simplified Automatic Train Control featuring:

- economic system to increase **level of safety** on a whole network at once
- **warning** to driver and **checking alertness** at the approach to signals or other selected points
- unbiased **recording** of drivers vigilance
- increase of **average running speed** as driver cannot miss a signal
- **no interference** with actual or any future signalling system
- **basic system** which may be converted into multi-aspect A.T.C. without loss of first installed equipment

**A.W.D., a new approach
to A.T.C. problems**

Indian Associates: Messrs. GUEST, KEEN, WILLIAMS LTD., Calcutta-16

from extraneous influence (i. e., stray currents) and exclude wrong or malevolent operation.

- (b) Versatility of the apparatus to permit its application with any kind of signalling at stations, whether mechanical, electro-mechanical or all-relay type.
- (c) Simplicity of operation in order to have maximum flexibility, fast reaction to traffic problems and to make its operation so easy that no special skill or training would be required.

The safety problem has been solved by the operation of an absolute interlocking between the block elements of adjacent stations. The system is such that any stray current, even of similar voltage to the interlocking current, cannot affect safety in any way. This is a great advantage over any system in which safety is based upon frequency codes, i. e. on remote control principles, as future developments in telecommunication or diesel-electric traction may cause stray currents which would affect the safety. Switzerland being the country with the oldest tradition in utilising the plug-in feature for whole sets of apparatus, it was quite natural to apply this to tokenless lock and block. R. A. B. is an all-relay equipment and the functional elements are, as far as the apparatus is concerned, separated from the operating elements. R. A. B. relay sets can therefore, function in any scheme.

The operating elements, which are pushbuttons, are arranged separately either in a block panel or incorporated in the panel of the station. The push-

buttons are, of course, easier to operate than any form of lever and once pushed no further action is required between adjacent stations. Despatching of a train into a section may be done without the co-operation of the attendant at the station in advance. The reception of a train and clearing of the section does not require the co-operation of the attendant of the station in the rear.

The following is a brief description of the most universal version of R. A. B. single line lock and block which has been designed with a view to replacing token systems and for use in tropical climates.

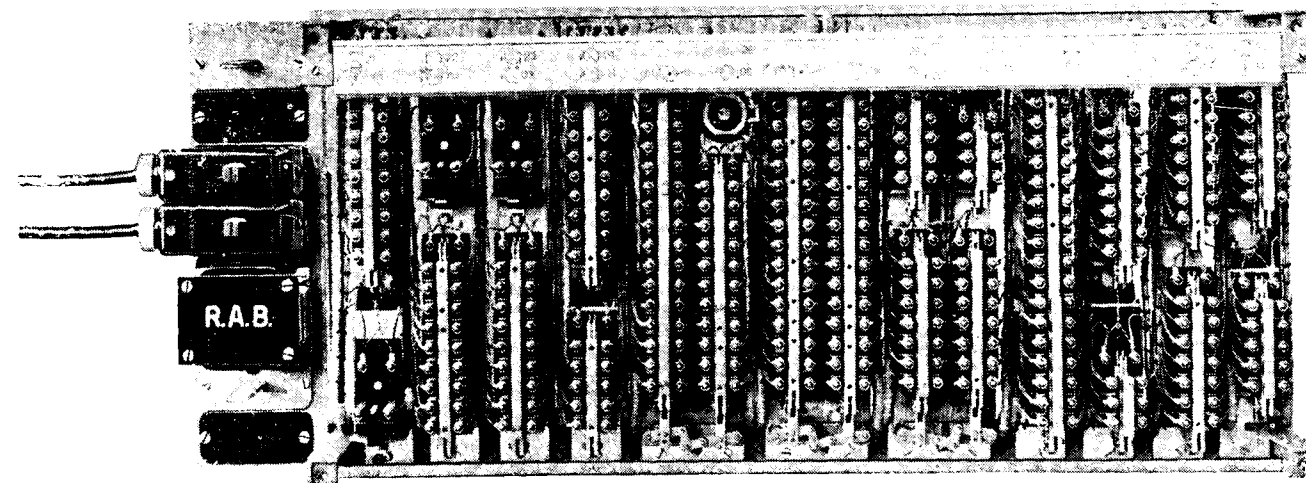
DESCRIPTION OF R. A. B. APPARATUS

With R. A. B. one no longer thinks in terms of "block instruments" but of block schemes for either wayside stations or terminus stations. All functional elements relating to one side of a station are assembled and wired in the factory in a R. A. B. Relay Set, with plug-couplers for ease of changing sets. This means that the sets may be replaced by unskilled staff. Two such R. A. B. relay sets are required at a wayside station and one set at a terminus.

For stations with traditional interlocking systems (mechanical or electro-mechanical) it would be necessary to provide a R. A. B. operating panel whereas with modern all-relay installations it would of course be more convenient to include the block operating elements in the interlocking panel. The R. A. B. panel is a small unit which can be placed on the station master's desk or elsewhere on a console. It is of the 'Domino' type i. e. of the same unit



R. A. B. Relay set with plug-in connections.



R. A. B. Relay set (cover removed).

design as now used in modern signalling technique for interlocking panels. With this panel, additional elements can be included, such as starter signals if these are of the coloured light type. The panels have plug-in connections and can be easily changed. This is a point well worth emphasising because it means that a minimum of maintenance need be done on the spot. Generally speaking, there is a great shortage of highly skilled maintenance men and it is far more economical for the apparatus to be taken to the skilled maintenance staff than for the latter to waste their time travelling to the apparatus.

OPERATION OF R. A. B.

To despatch a train into a block section the station attendant is able to get the "right of way", if not already available, by simply operating a pushbutton. The "right of way" will automatically be obtained without any action on the part of the attendant at the next station except when the latter has already reserved the "right of way" or the block section has not been cleared. The starting signal may now be cleared, after which the despatcher is relieved of any further duty apart from putting back the starting signal lever, if it is of the mechanical type. Indicators on the panels at both stations show "train on line" and the station in advance gets an intermittent acoustic warning until the home signal is cleared and also when the train enters.

When a train has entered and has been checked as being complete, the station attendant has to put the home signal at danger, if it is a mechanical one, and to clear the section by operating a pushbutton. With additional apparatus (e. g. Check-out Device, Axle Counting or full track circuiting of the Line) clearing

is done automatically. No co-operation is required from the station in rear for clearing the section, but the information is given that the section is clear again.

Once a starting signal has been cleared, it can at any time be put back to danger and subsequently cleared again, unless the train has started and put the signal "on". Cancelling of forward blocking requires a distinctive action by means of a special element whose operation is normally recorded on a counter.

Provision is made with R. A. B. for a train to return to the station from which it entered the section and for the clearing of that section after the complete arrival of the train has been checked. The station attendant at the station in advance must not, however, take any action. This provision is of considerable advantage for either shunting movements into the section or for ballast trains.

CONNECTION BETWEEN STATIONS

The operation of R. A. B. interlocking between stations, at best, requires one 2-wire loop although the single wire, earth return loop of an existing token system would do. With the latter, however, the block wire may become earthed by heavy tropical rainfall and it is a particular advantage of R. A. B. that with a short circuit in the block loop, some of the trains can still operate under full block protection; the interlocking operation between stations is stored until the short circuit disappears, when the stored operations take place in the proper sequence.

BLOCK TELEPHONE

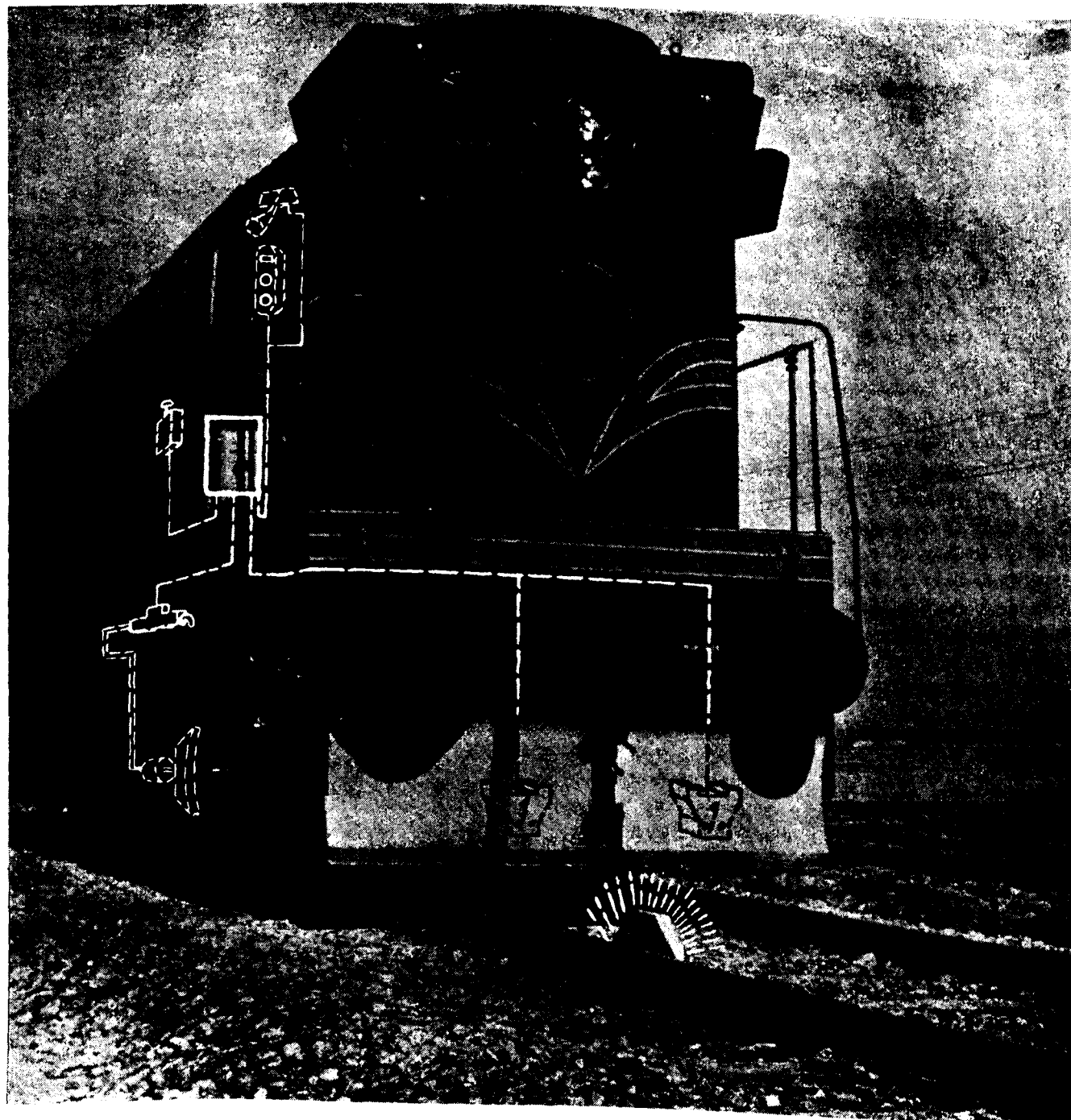
Tele-communications may be worked over the block

loop without interference between the block operations and telephone conversation.

OTHER FEATURES OF R. A. B.

R. A. B. is very often used in a version permitting throughswitching. Any station may be closed and the R. A. B. throughswitched so that the two block sections adjacent to the station form a single block section. It is not essential for a train leaving the

closed station to complete its journey to the next attended station before the closed station can be re-opened and the throughswitching cancelled. No additional line wires are required for throughswitching and it is possible that, when the installation of long section token instruments is considered, the cost of these and the additional line wire may amount to a substantial part of the cost for replacing token working by the throughswitching version of R. A. B.



A.W.D. equipment on a diesel-electric locomotive (also suitable for steam or electric locomotives).

A version of the single line R. A. B. for permissive operation is so designed that a pre-established number of trains, travelling in the same direction, can successively enter the section. The following trains are, of course, under permissive signal aspects and rules. After the maximum number of trains has entered the section, no further train is permitted to follow. When the section is clear again, the opposite direction gets priority.

With another version of R. A. B. sidings in the section grant shut-in facilities and do not require additional line wires.

Double line R. A. B. is also generally used in Switzerland. In most cases it is so designed that when either of the tracks is temporarily closed the other can be operated as a single line. This is of particular advantage for the maintenance of track and catenary.

It has already been mentioned that R. A. B. forms an automatic block if Axle Counting or a Check-out Device is installed. In this case a closed station with throughswitched R. A. B. becomes an automatic block post and there are many instances where this offers, at a fraction of the cost, almost the same advantages as C. T. C. It is also easy to increase the capacity of a line by installing automatic block posts in overlong sections. Another important feature of R.A.B. is that it can be used to control automatic crossing loops.

APPROACH WARNING DEVICE—A SIMPLIFIED A. T. C. SYSTEM

The Swiss Federal Railways were the first and still are the only State owned railway system fully equipped with Automatic Train Control. Other state railways in Europe are either not yet entirely equipped with A. T. C. or are still experimenting with it. It is worth mentioning this because it may be assumed that where there is a market for A. T. C. there also will be found experience and development. In particular, some of the most advance developments in multi-aspect A. T. C. in recent years have originated in Switzerland.

In many countries A. T. C. is the last item on the Signal Engineers' list of requirements. This has been for the simple reason that hitherto, any A.T.C. scheme has had to be considered as a major investment. In fact, A.T.C. developments have generally been undertaken only in cases where dense networks with short intervals between signals are met with, as in Europe.

Little consideration has been given to the entirely different conditions prevailing overseas where station intervals are up to 10 miles or more and climatic conditions might have an adverse influence on the locomotive drivers. The problem therefore is not primarily to gain a few seconds between signal space and braking distance but, with the long block sections, to give the drivers advance information of the approach to points at which a reduction of speed may be required e. g. at the approach signals. Furthermore, it is important to check the drivers' alertness at the approach to such points to prove his ability to see and obey signals or other indications.

With this main object in view, Approach Warning Device (A. W. D.) was developed for lines on which long sections prevail. As information is to be transmitted from the track to the locomotive irrespective of the signal aspects, permanent magnets may, in principle, be used as wayside equipment. When properly designed these are not only very reliable but also inexpensive. Hitherto, the cost of an A. T. C. scheme was governed by the cost of the signal controller wayside equipment. However, A. W. D. is a very economical solution and can easily fit into the budget of a progressive railway system.

For the capital investment involved with the installation of A. W. D. there are considerable improvements to be expected both from the economic and safety aspects of running a single line, namely:—

- (a) Because A. W. D. checks the drivers' alertness and records lack of attention, a marked increase of vigilance is obtained throughout the A. W. D. controlled network.
- (b) The fact that the driver is given plenty of warning when approaching a signal (e. g. an outer home) it enables him to run his train at full admissible speed right up to the approach to the signal. On long sections this may lead to a considerable increase of average speed and consequently to an increase in the capacity of the line. Time-tables can be scheduled to these higher average speeds as the driver can have no possible excuse for saying that he had to reduce speed in order not to miss the signals.
- (c) The above, as a matter of fact, is of particular importance where no distant

signals are provided. In any case, distant signals may or may not be noticed after a long run under tiring conditions.

- (d) With diesel or electric traction one can easily dispense with an additional man on the footplate as he is not required to help in looking out for signals and in the case where the driver is incapacitated, the train will be brought to a stop before passing a signal. This is the outstanding advantage of A. W. D. over vigilance systems with time or distance control. In the latter systems, the train with an incapacitated driver may still pass a signal at danger at full speed whereas A. W. D. performs a check and eventually an intervention at the right point.

A. W. D. is undoubtedly a big step forward towards increased safety and increased capacity of a line. It is however a basic A. T. C. system and should, at a later stage, a signal control A. T. C. be required, the original A. W. D. system is not wasted. It merely requires the addition of equipment to obtain a 3 or 4-aspect A. T. C. This outstanding fact about A. W. D. is emphasised because its installation as a basic A. T. C. system in no way jeopardises future development. A. W. D. like any kind of A. T. C. is of as much interest to the locomotive people as to the

signalling people. The close collaboration of both is the basic condition for any development in A. T. C. The reason the Swiss Federal Railways became the leading state railway in this field was the common interest of the signalling and the locomotive departments in the pioneer work achieved by Swiss industry.

Although R. A. B. and A. W. D. are different in purpose and conception, they both show a typical aspect of Swiss mentality, namely, to keep progress always within the limits of funds and means available and thus to favour step by step development. This mentality is one of the reasons why Switzerland has achieved the highest standard of living in Europe in spite of its natural resources being the lowest in any European country. No doubt, this is also one of the reasons that the Swiss Federal Railways are among the few state railways that do not lose money.

Considering the systems described above from this angle, it may be noted that R. A. B. is a basic system that may be superimposed to any type of existing signalling with the possibility of gradually installing additional equipment later on. This may be done with a view to increasing the capacity of a line and to reducing the staff required at the stations. In a similar way, A. W. D. is a basic investment giving an immediate return without compromising future development.

Welded Rails for Passenger Comfort—India Among World's Leading Countries

India is now one of the world's leading countries in respect of total track mileage of welded rails, which have in recent years been gradually introduced on major railway systems abroad to ensure greater passenger riding comfort.

By reducing jolts during the journey to the minimum, welded rails provide a smoother, jerk-free ride in passenger coaches. They are at the same time known to result in better and more economical track maintenance and less wear of rolling parts of vehicles.

Although experiments on welded rails in India started before the last war, it was only after the

achievement of independence that real progress in this direction has been made, following extensive tests undertaken by the Indian Railways' Research, Designs and Standards Organization. The country had just over 300 miles of welded rails in 1955, but the subsequent five-year period has seen this figure jump more than five times to about 1,500 miles at present.

The rails are welded both in the workshop and in the field, the lengths varying from 210 feet to 420 feet. In the shop the rails are welded by the flash-butt welding process and in the field by the aluminothermic process. Welded rails of half-mile length are also under trial.

TRAIN DESCRIBERS

By An Engineering Correspondent

UNDER modern signalling conditions each Signal Box tends to handle a greatly extended length of line and the provision of comprehensive Train Describer equipment is of paramount importance. An interesting feature is the so called Train Berth type of describer which shows at a glance the position of a Train along with its description and if the Train is routed from one line to another the description moves with it.

When a Train Describer is equipped to display descriptions for every signal berth in a large interlocking, it inevitably follows that a considerable amount of

space would be required for indicators of the older type, where a separate space is needed for each available character in the description. To overcome this difficulty new indicators have been introduced by means of which any selected number or letter can be displayed in a single space. This may be achieved by means of an optical projection indicator which combines 12 miniature projectors in one moulded unit. When one of the 12 projection lamps is selected by the train describer relays then the number or letter associated with that lamp is projected to fill the front screen. Standard units are available displaying 1 in. or $\frac{5}{8}$ in. characters, the choice depending of course on

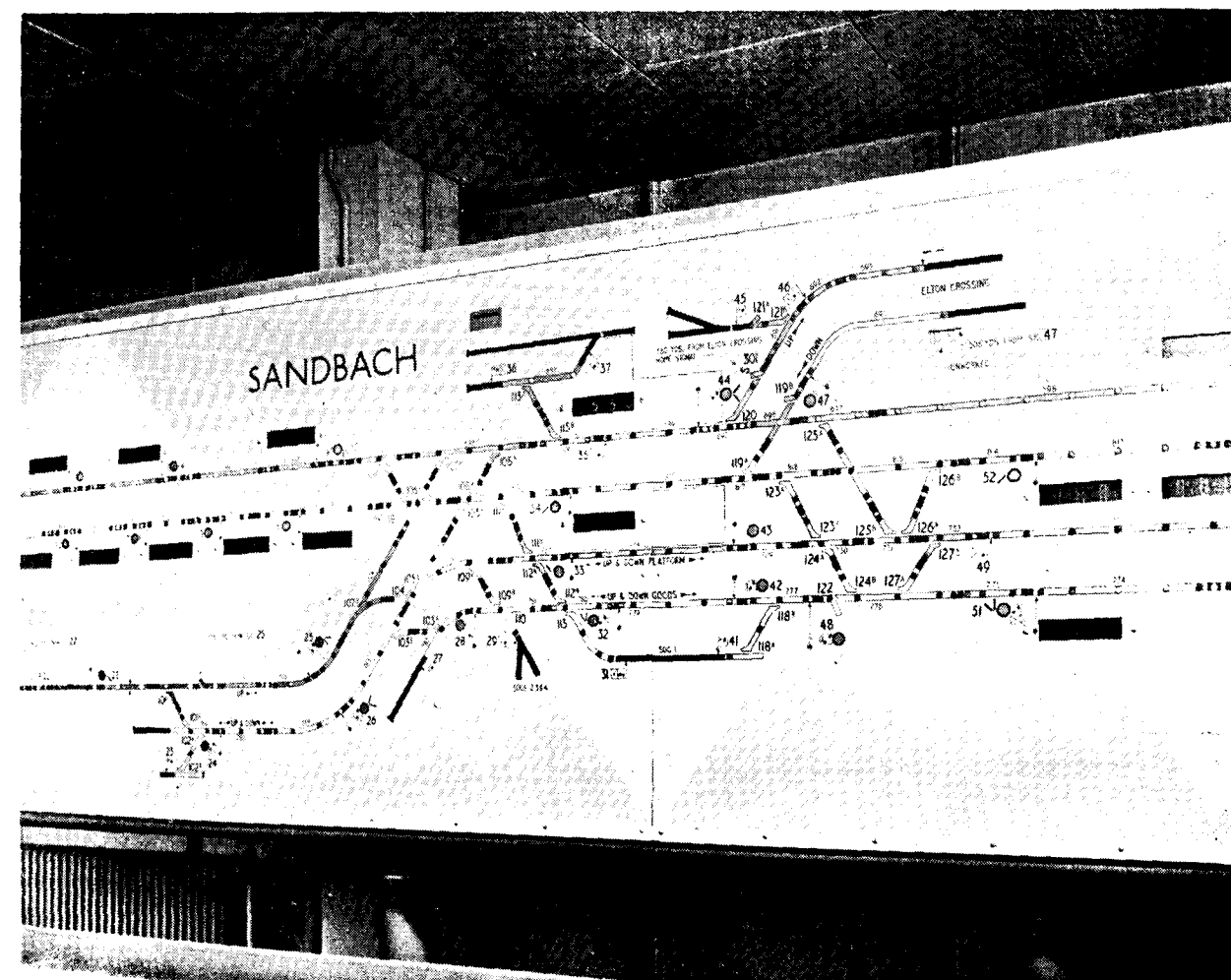


Fig. 1. Close up of Sandbach Signal Box illuminated diagram showing train description 2665 at Signal 44 and 1528 at Signal 15.

the space available and on the distance from which the description must be readable.

Four such units can be mounted together to display a 4 digit train number with no waste of space or alternatively letters representing the description or destination of the train can be projected.

To meet the latest requirements of British Railways an indicator has been produced in which one of the four digits can display any one of twenty letters.

Where even smaller characters, or a wider choice of characters is required, then an electronic device which 'writes' the desired description on a miniature Cathode Ray Tube is recommended. Either the optical or the CRT display unit can be equipped in cabinets to show the train descriptions in columns associated with the appropriate signals, or they can be built into a track diagram to show the position and description of the train at the same time.

The CRT method of display which can show the full multi-digit description in an aperture about 1 in.

long and $\frac{3}{8}$ in. high, is particularly suitable if it is proposed to include the train description in a signal control panel of the 'Entrance-Exit' type where the whole diagram must be within reach to the signalman.

Of course there is still plenty of scope for a Train Descriptor covering the automatic or block sections where no transfer from line to line is possible and where it is more economic to provide sequential indication of the first three trains together with 'Blind' storage of descriptions to cover the full capacity of the section. In many cases the best operating advantage is achieved by providing Train Berth Describers for the interlocking areas linked together by Sequential Describers for the automatic sections.

In most modern describers the control equipment is of an all relay type using standard telephone type relays because of their long life and reliability. The use of relays in limited combinations is economic in comparison with any other type of switch gear and permits of a very complete checking of the code transmission and the display so that it becomes

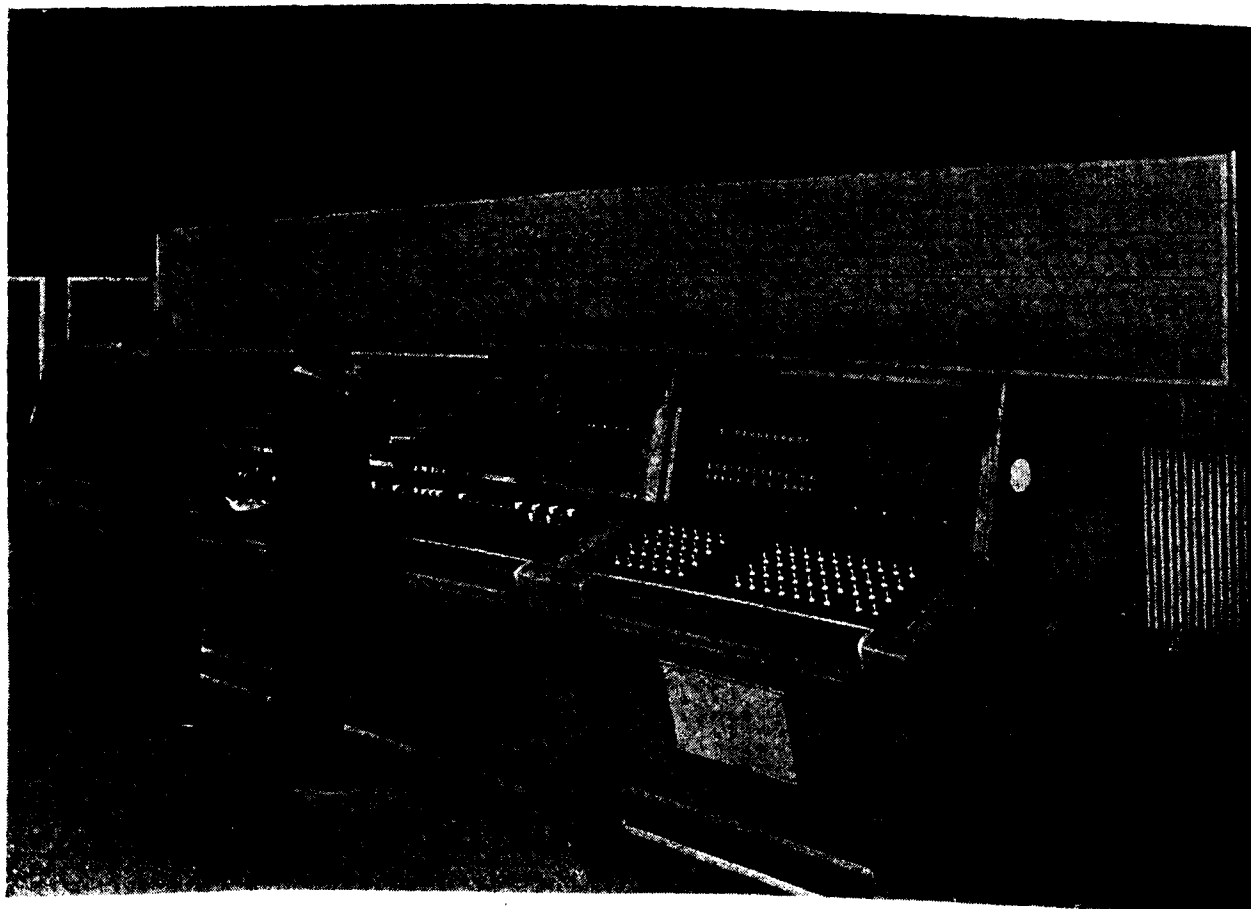


Fig. 2. Latest type STC train describers display train descriptions on the actual track diagrams. Train descriptions move across the track diagram in step with the train movements. The installation illustrated is at Sandbach on the London Midland Region of British Railways.

TRAIN DESCRIBERS
TRAFFIC CONTROL SYSTEMS
TRANSMISSION EQUIPMENT
LOUDSPEAKER SYSTEMS
REMOTE CONTROL SYSTEMS
TELEPHONE SYSTEMS
TELEGRAPH SWITCHING SYSTEMS
COMPUTERS FOR RESEARCH,
DESIGN AND ACCOUNTING
RECTIFIER EQUIPMENT
COMMUNICATION CABLES

systems
and equipment
for railways

STC



Standard Telephones and Cables Limited

(Incorporated in England with Limited Liability)

TELECOMMUNICATION ENGINEERS

P. O. BOX 348

NEW DELHI - INDIA

TELEPHONE : 43961

virtually impossible for any technical fault or line disturbance to display a wrong description.

The illustrations show the describers recently installed by Standard Telephones and Cables Limited on the London/Midland Region of British Railways from Crewe to Manchester and Crewe to Liverpool.

On this job the four figure Train Number appears in the rectangular space on the diagram panel which corresponds with the position of the train on the track. As an example, the close-up picture of the Sandbach Track Diagram on Fig. 1 shows train number 2665 approaching Signal No. 44.

As the train advances from signal to signal the description is stepped along the diagram.

All the characters displayed on this diagram must be large enough to be read by the Regulator who sits well back from the control desk.

The picture in Fig. 2 shows the control panel, mounted on the signalling console, by means of which the signalman can interpose descriptions of trains which originate there. This control panel also carries push keys for manual stepping of descriptions in the event of any failure of the Track Circuit Controls.

If a train appears on a track without any corresponding description having been received, then an Asterisk (meaning NOT CLASSIFIED) will be displayed in the appropriate position and stepped forward with the train until it is replaced manually by the correct train number.

Carbon Batteries for Railway Signalling

Carbon batteries are being successfully used in the signalling and safety installations of the Western Pacific Railroad. A 2.5 volt, 1000 amp-hour capacity battery lights a 2-2.9 V, 0.15 amp lamp which is extinguished on the approach of a train. Similar batteries are installed to drive code transmitters for applying coded d. c. to the track in highway crossing protection. For bridge fire detectors, two batteries in series energise a 40-ohm relay, which is connected in series with a zinc wire affixed to the top of the bridge. Excess heat melts the zinc wire, thus cutting off the flow of about 0.12 amps from the battery through the relay coils. The use of these batteries for line circuits is being tested to extend the life of straight primary batteries on approach-lighted search light signals.

* * * * *

BOMBAY—LONDON "TELEX" SERVICE INTRODUCED

A "fast, modern and efficient" telecommunications service between Bombay and London was inaugurated with an exchange of messages between the Indian Minister for Transport and Communications, Dr. P. Subbarayan, and the British Post-Master General, Mr. Reginald Bevins.

This is the first time that such an international

"Telex" service has been introduced in India by the Overseas Communications Service of the Government of India, in collaboration with the Posts and Telegraphs Department.

Elaborate equipment has been installed in the Cental Telegraph office of the Overseas Communications Service to facilitate teleprinter "calls" between Bombay and London.

The service can be availed of by subscribers either on the printogram system in Bombay as well as in Ahmedabad. Initially, the International Telex (INTELEX) is available to and from the United Kingdom.

* * * * *

RADIO TELEPHONY IN MARSHALLING YARD

The first radio telephony system in a marshalling yard in the London Midland Region of British Railways was put into operation at Totan yard on January 11, 1960. There is a 2-way radio communication between the hump room, the control tower and the two diesel engines engaged in shunting trains over the hump. Instructions on the radio can be heard at all locations. The equipment on the engines is readily interchangeable, two sets being provided for daily use and are held as spare.

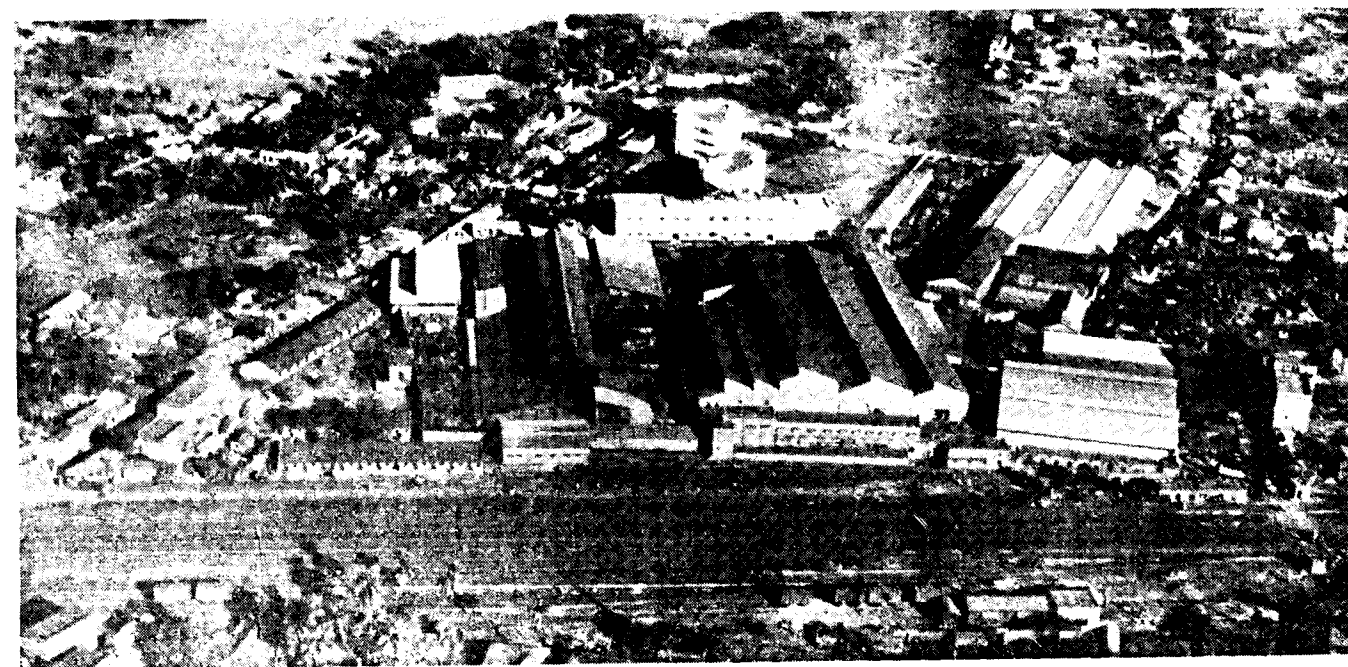
The Britannia Engineering Company Limited

FORTY YEARS OF PRECISION ENGINEERING

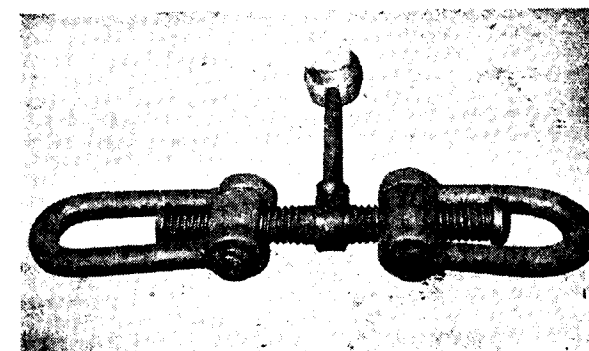
IN the industrial development of India, the Britannia Engineering Company Ltd., have been playing quite a significant part. Established in 1917 mainly for the purpose of manufacturing Jute Machinery spare parts, which it was then difficult to obtain from the U. K. because of the First World War, the unit at Titagarh (West Bengal) has grown from a humble 'jobbing shop' to a well-equipped and sizable Engineering Works having specialised, among other things, in the manufacture of Railway equipment.

Schemes for other large scale expansions are well in hand, and when shortly Britannia go into production of Printing Machinery, Coach Underframes and Wagons at Mokameh (Bihar), the entire unit will have assumed a size very much bigger than what it promised to be 40 years ago.

The year 1923 is a very significant one in the history of Britannia, as it was then, when for the first time they undertook the manufacture of Screw Couplings for Railways, the present productive capacity alone of



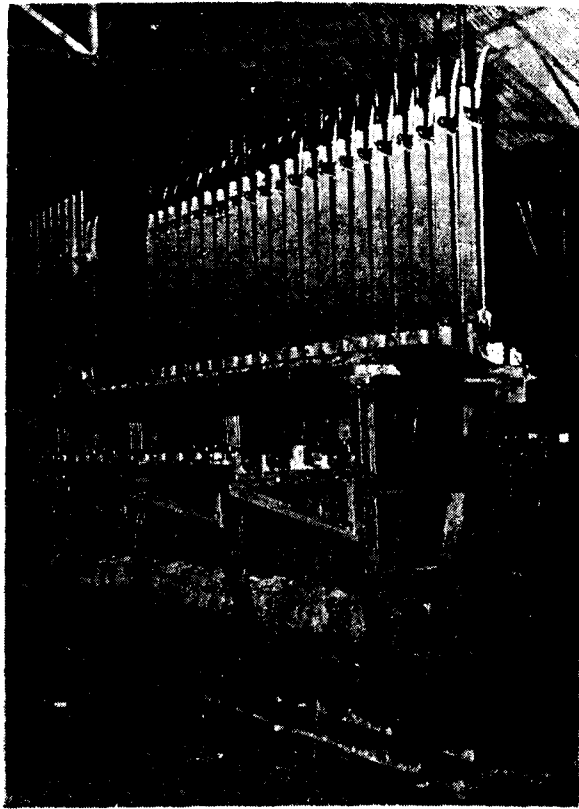
Aerial view of Britannia Works



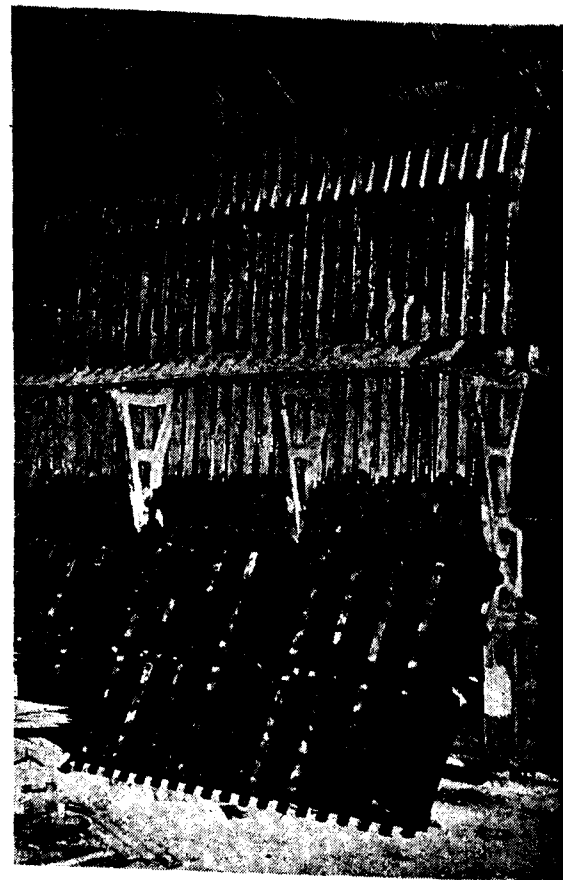
Screw Coupling

which is in the region of 3000 Nos. per month : f. o. r. (Titagarh) price is Rs. 106.25 each.

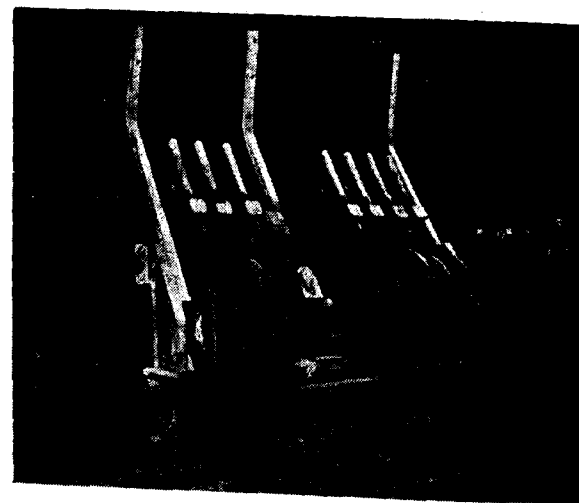
In 1935 a still further new line of production was introduced for the manufacture of Railway Signal Lever Frames; firstly, what was originally termed the 1935 type, now called the Direct Locking type frame, and later a modern double wire continental type. Of the latter type made at Britannia, the one at Andal on the Eastern Railway, is perhaps the largest in India, having 155 levers in one frame. To this list, numerous other items of manufacture have



Direct Locking Type Lever Frames



Catch Handle Type Lever Frames



Double Wire Type Lever Frame

in the meantime been added, and given below are brief descriptive notes on some of the important items which Britannia are manufacturing for the Railways according to the various standard specifications and I. R. S. Drawings.

DIRECT LOCKING TYPE LEVER FRAME

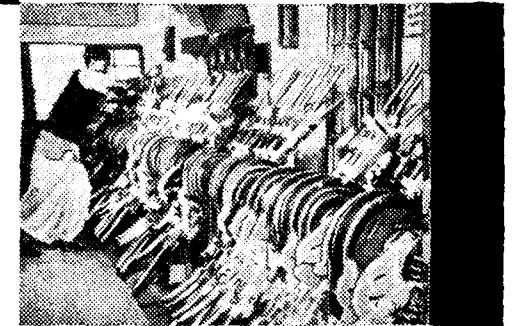
A combination of mechanical type levers fitted with a system of inter-locking, by means of which points and signals, which govern the safe movement of trains within defined limits, are operated. The points and signals are operated by independent levers, and locking between them is set in motion immediately one is moved, release being impossible until the lever determining it has been moved through its entire stroke. The rate of production is 450 levers per month and the f. o. r. (Titaghur) price is Rs. 288.00 upwards, per Lever.

CATCH HANDLE TYPE LEVER FRAMES

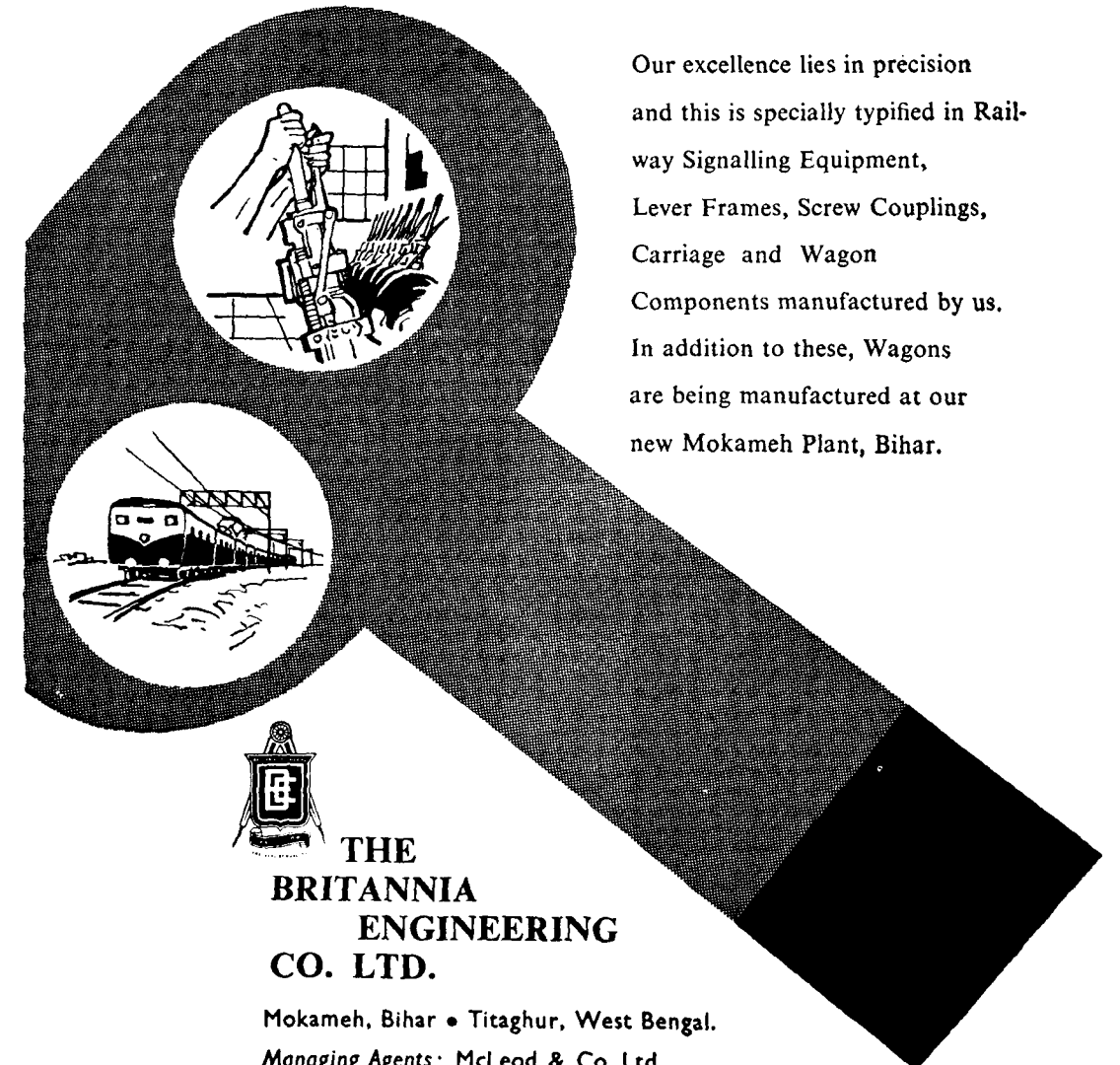
Here the principle is that the lifting of catch handle moves the locking mechanism through a certain travel, after which the latter remains practic-

ally immovable while the lever itself is being moved. These frames are generally used for longer stations where the amount of locking involved is great and which cannot be accommodated by D. L. type frame described above. Approximately 200 levers of this

THE VITAL POINT



Britannia's Lever Frame at Ondal



Our excellence lies in precision and this is specially typified in Railway Signalling Equipment, Lever Frames, Screw Couplings, Carriage and Wagon Components manufactured by us. In addition to these, Wagons are being manufactured at our new Mokameh Plant, Bihar.

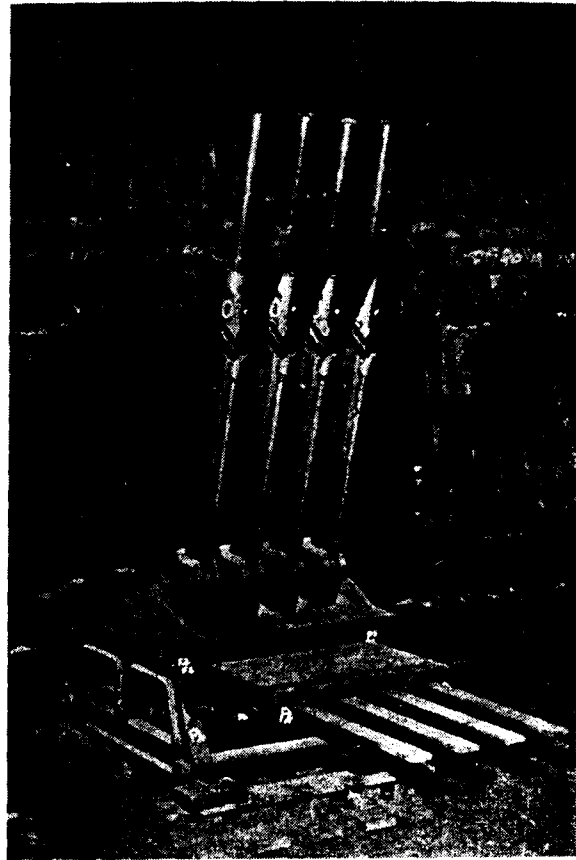


**THE
BRITANNIA
ENGINEERING
CO. LTD.**

Mokameh, Bihar • Titaghur, West Bengal.

Managing Agents: McLeod & Co. Ltd.

3 Netaji Subhas Road, Calcutta.



Ground Type Lever Frames



D. W. Compensator



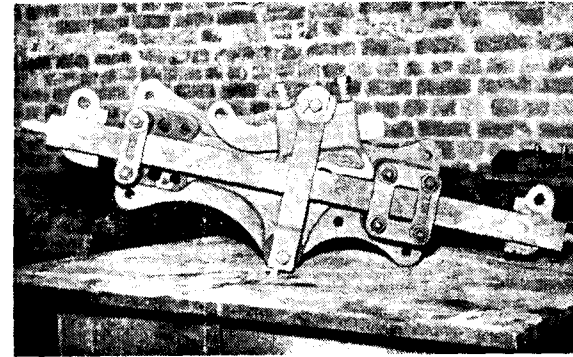
Signal Crank

type are produced per month and the f. o. r. (Titaghur) price is Rs. 306.00 upwards per lever.

DOUBLE-WIRE LEVER FRAME

In single wire working, we require rodding for points and wires for signals. In double wire, we can have both points and signals by wire. Only one cabin

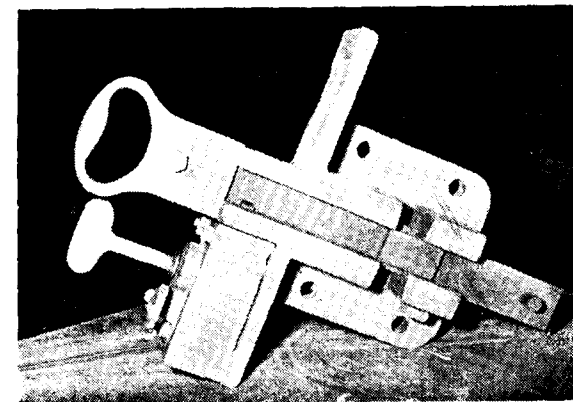
← Rotary Detector



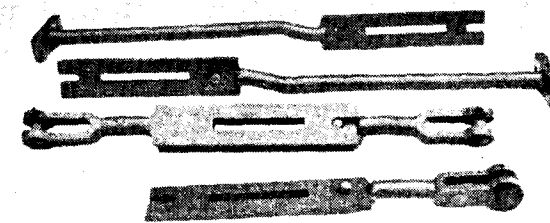
Switch and Lock Movement



Wire Pulleys



Key Lock Facing Point



Split Stretcher Bar

is necessary for a reasonable length of loop line. With double wire lever frame, we can legislate at what angle we want the signal arms in the lowered position which it is impossible to have with a single wire. f. o. r. (Titaghur) Price is Rs. 420.00 upwards per lever.

GROUND TYPE LEVER FRAMES

These frames are designed to be operated at ground level as distinct from lever frame elevated from the ground. These are used in small sidings. The rate of production is 25 Nos. per month and f. o. r. (Titaghur) price is Rs. 269.50 per lever.

ROTARY DETECTOR

A device used for ensuring the correct setting of a particular road for lowering the signal by detecting the individual switch and the bolting mechanism. Rate of production is 50 per month. f. o. r. (Titaghur) Price is Rs. 139.39 each upwards.

COMPENSATOR— INDOOR AND OUTDOOR TYPE

A device for counter-acting the expansion and contraction caused by changes of temperature in a run of rodding or wire lines, thereby maintaining a constant length of line between units. 50 Nos. per month and f. o. r. (Titaghur) price is Rs. 590.00 each upwards.

CRANK

A lever, the arms of which form an angle at the fulcrum with the vertex of the angle, which is used to transmit motion by changing its direction, i. e. from 'vertical' to 'horizontal' and from 'pull' to 'push' etc.

There are different types of cranks such as straight, arms, right angles, accommodating, etc. which are used at places suiting the requirement of the layout f. o. r. (Titaghur) Price Rs. 42.41 each and production : 600 Nos. per month.

SWITCH AND LOCK MOVEMENT

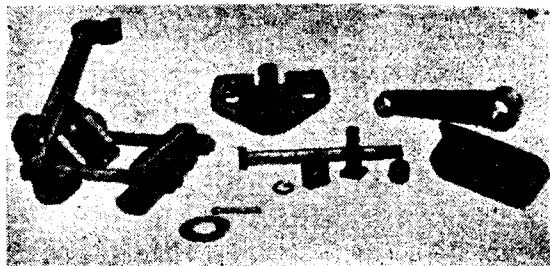
A device, the complete movement of which performs 3 operations, of unlocking, operating and locking the switch or movable points. 75 Nos. per month; Rs. 275.00 each f. o. r. (Titaghur).

WIRE PULLEY

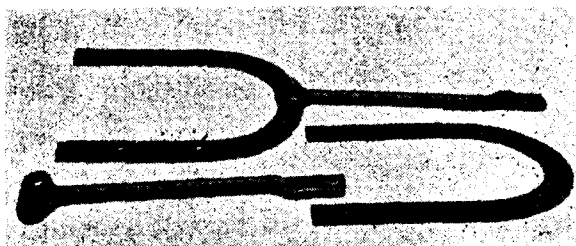
Small pulley for supporting the wires used for operating the mechanical signal and wire operated points. f. o. r. (Titaghur) Price Rs. 4.25 nP Each.

KEY LOCK FACING POINT

A device to lock the track points locally, generally used for sidings, level-crossing gates, etc. f. o. r. (Titaghur) Price is Rs 236.50 each upwards.



Clip Lock Bar



Shoe or Fulcrum

Vsa Tatra Universal Goods Wagon

To secure economic utilization of tractive force the Czechoslovak wagon-building industry has designed the large capacity goods wagon of Vsa type for transport of loose materials, piece goods and vehicles up to a loading weight of 58 tons. It is of all-metal open construction with high side walls, removable front walls and drop doors in the floor. A special design of the emptying of the wagon makes possible very fast and economic operation.

The weight of the wagon is 22,000 kg, which is about double the weight of a normal goods wagon. However, the loading weight of the Vsa wagon is three times the loading weight of a normal one. The economy of utilization of the Vsa wagon for transport of goods is shown by a small example. A train of 40 fully loaded Vsa wagons weighs 3200 tons, of which 880 tons are the weight of the wagons and 2320

SPLIT STRETCHER BAR

This is an equipment fitted on the points and is used to hold the bolting plunger of the facing point lock, or switch and lock movement lock, ensuring the locking of the points. f. o. r. (Titaghur) price Rs. 73.75 each upwards.

CLIP LOCK BAR

It is a part-fitting of Lock Layout imparting a smooth radial movement for working the lock bar. f. o. r. (Titaghur) price Rs. 35.75 each upwards.

SHOE OR FULCRUM

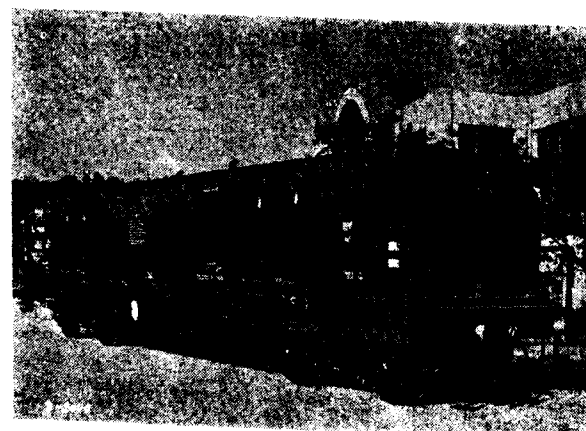
Standard fitting for direct locking type Lever Frame. f. o. r. (Titaghur) price Rs. 24.75 each.

INDICATOR POINT

A mechanical device used to indicate the position of track points both by day and by night. f. o. r. (Titaghur) price Rs. 35.25 each.

COUPLING DEVICE

A device used in double wire Lever Frame for working coupled levers for signals. It economises on the cost of wire runs by reducing the number of wires in transmission. f. o. r. (Titaghur) price Rs. 135.76 each upwards.



tons the weight of the transported goods. It would be necessary to use 116 wagons of normal type, weighing 1270 tons, to transport the same quantity of material. The saving achieved by using Vsa wagons is in this case 390 tons of dead weight needlessly transported.

The Signalling Relays of the French National Railways (S. N. C. F.)

By J. Walter

Chief Engineer, French National Railways
Head of the Department of Signalling, Telecommunication and O.H.E.

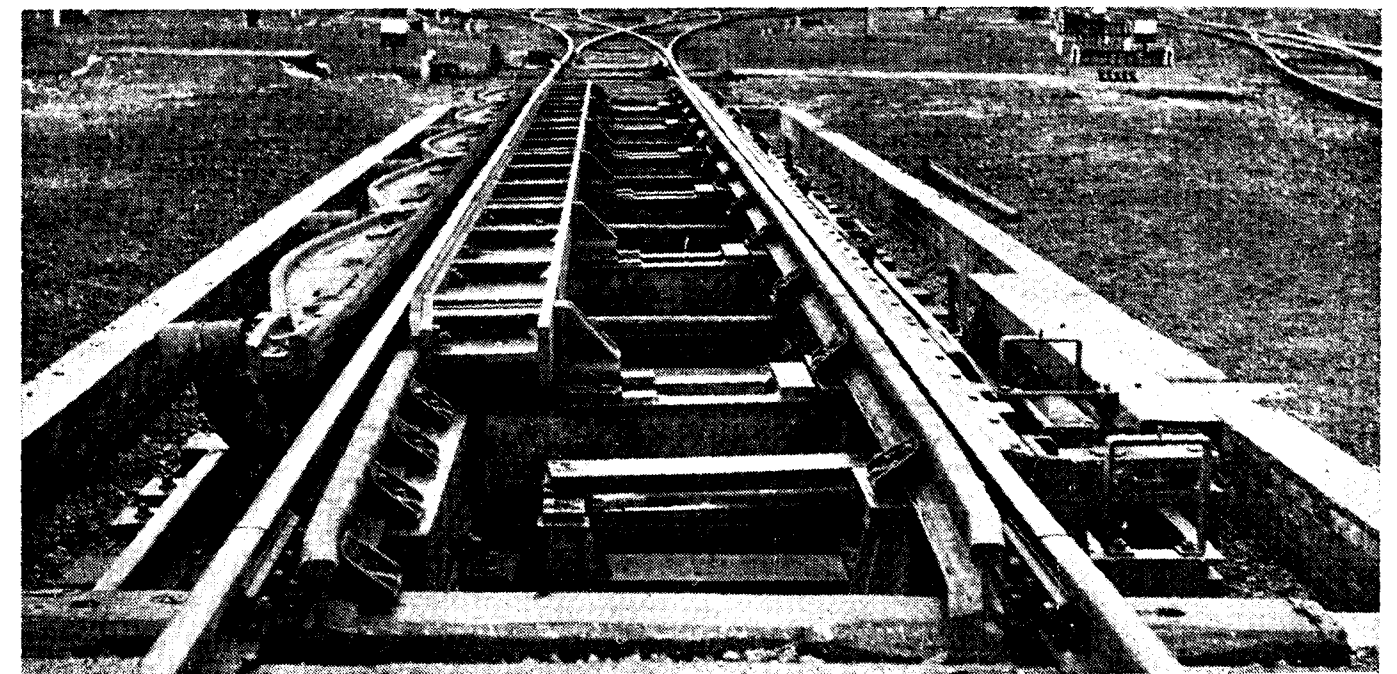
GENERAL

THE Signalling relays offer a large variety according to the conditions under which they are to be used, but, at first, two main classes can be discriminated :

Class "a" : Relays the operation of which cannot be proved and which, therefore, are to work perfectly ;

Class "b" : Relays the operation of which can be proved and which though being of good workmanship, do not meet as complete a program as the former.

To class "a" belong at first the relays reflecting the occupancy of the track, called "track relays", and the operation of which cannot practically be proved. In the countries where track circuits have been installed since many years (it is the case for France



Joint Stock Company capital 183 750 000 Frs
HEAD OFFICE: 40, Rue de l'Orillon, PARIS (XIe)
Telephone: OBE 55-20 Post Box No. 171
Works at CREIL (Oise) Tel.: 153

R-52 TYPE RETARDER, retarding effort proportionate to weight of wagons braked

- SAFETY AND SIGNALLING DEVICES mechanical, electro-mechanical and electrical.
- RETARDERS
- electro-hydraulically controlled HALF-BARRIERS for protection of level crossings.
- handling lift trucks.

where similar layouts exist since the beginning of the century) the manufacturers, at the request of the Railway Companies progressively improved the features and the workmanship of these devices and thus succeeded in obtaining irreproachable apparatuses. As natural consequence, this quality was also applied to the other automatic block relays and to the relays of the various layouts. This comes from the desire to standardise to the largest possible extent the device used for all the layouts, which induced the S.N.C.F. to generalise their adoption. These relays comply of course with the specifications of which the main features are outlined hereafter:

1. It is not allowed that in the absence of current the relay should remain in pick-up position;
2. The front contacts should be un-weldable;
3. The back contacts can be welded but in case of any of them should be welded, it would not be possible to establish any front contact.

As regards the class "b" relays, their operation being proved the conditions outlined under 1 and 2 above are not imperative, but the contacts of the relay should not overlap one another, i. e. should a "front" or a "back" contact be closed, then no contact of the other position should be established.

It can be readily understood that with class "a" relays the diagrams are much more simple, and the maintenance, as well as the detection of disturbances, greatly facilitated. This is the reason why the S. N. C. F. uses extensively these relays, though, in some particular cases, class "b" relays are also used. Besides this, the use of class "b" relays is generalised in remote-control layouts.

DEVELOPMENT

Since 1950, due to the technique of the all-relay route interlockings requiring a large number of relays in each cabin, the S.N.C.F. was led to invite the manufacturers to design new types of relays which, while presenting the essential qualities of the automatic block relays, would be of smaller size and would work more speedily.

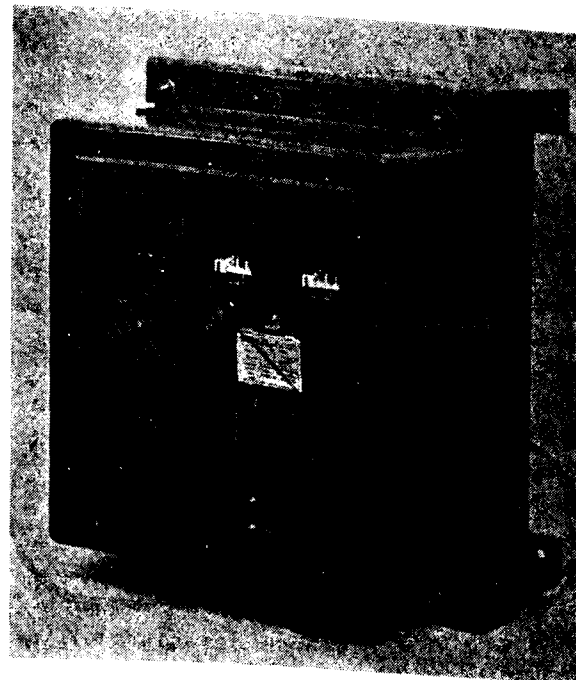
Thus a new range of "non-proved" relays (called S-1 relays) appeared, including particularly relays liable to have a large number of contacts

(8 dependant plus 4 front), changeover relays with 2 positions stabilised by magnet, breaker relays and relays with various time element features both for pick-up and release.

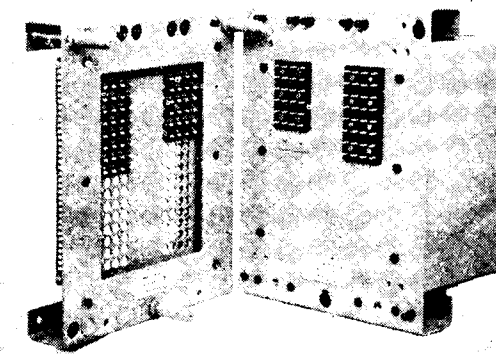
Over and above the various qualities which characterise the signalling relays, these devices should not be liable to be influenced by alternating current, at least for the voltage values which can be met on the conductors in operation on alternating current electrified lines.

On the occasion of such manufacture, the S. N. C. F., has specified plug-in type models, either for one relay or for a group of relays, the latter being called "functional block". In the small cabins which do not include any functional block, all the S-1 relays are mounted in casings with terminals the models of which were also approved by the S. N. C. F.

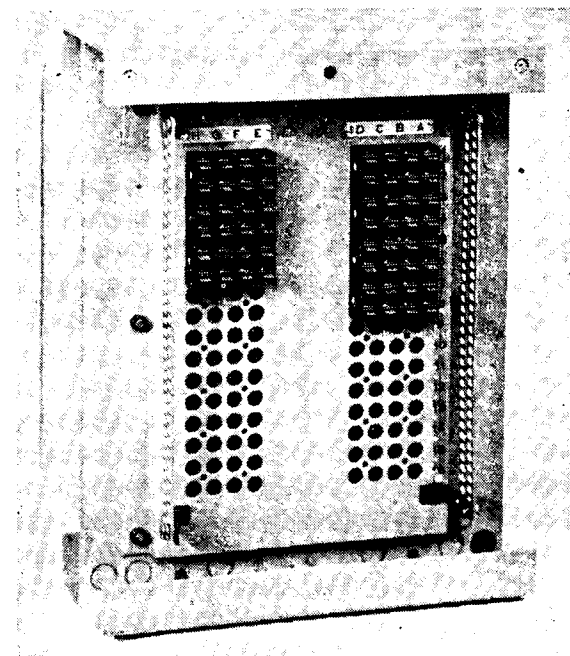
The plug-in type blocks are provided with a coding device whose function is to prevent mounting of a different device than that for which it was intended. Connection of the cabling wires on the fixed part of the plug-in type block is ensured by means of "soldering tails" placed at the rear part of these fixed parts. Assembling of the fixed parts is made on frames so as to give access from the front to the removable boxes containing the relays and from the



"Plug-in" type functional block
front view of the complete unit.



"Plug-in" type functional block
Left: fixed part, Right: removable part.



"Plug-in" type functional block
Rear view of the complete unit

rear to the "soldering tails" on which are connected the wirings. Such frames are provided, at their lower part, with the distribution elements (fuses, lightning-arresters, bus-bars) and, at their upper part, with automatic connectors for connection of the junction cables with the other frames and with the interlocking frame.

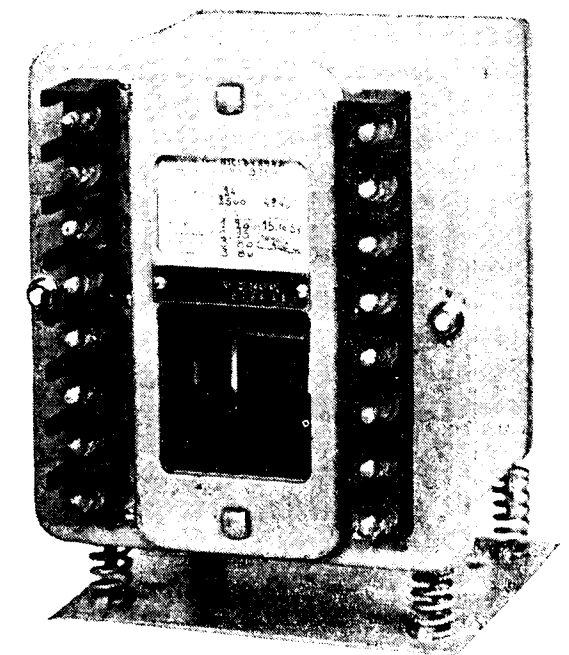
Once sufficient experience had been acquired with these devices, the S. N. C. F. asked the manufacturers to design new lines relays for automatic block which would embody the features adopted and which would be housed in the casings provided with terminals studied for the type "S-1" relays. The new automatic block relays were called "S-2" relays.

Finally, in the Class "a" relays, the S. N. C. F. still uses for D. C. track relays and for A. C. track relays the conventional relays designed prior to 1950. Studies concerning new track relays for D. C. track circuits or for 50 Hz A. C. track circuits do not seem to be of major interest, due to the fact that the new track circuit technique do not make much use of these relays and moreover it must be considered that the final designing of these devices would require a rather lengthy preliminary experience.

As already mentioned, the S. N. C. F. also uses in signal cabins some proved D. C. relays ("C" relays) fitted with silver front and back contacts. These contacts are not "un-weldable" but they are "non-overlapping".

This type of relay is more economical than the "S-1" relay but it can be used for safety duties only in case the welding of a front contact does not hamper the safety or if the electric diagram allows proving of its operation.

The use of such a relay does not seem to be of value for layouts with long lines (block relays, for instance) as the provision of checking circuits would lead to an important increase of the cabling in the field. This increase would prove to be more costly than the use of simple circuits with safety relays.



Safety Relay class "a" model S-2

Type "C" relays can be both slow drop away and slow pick-up relays; they can be provided with coils allowing energising under 8 or 24 volts. They can be fitted with a variable number of contacts and are mounted either in individual casings or in group casings.

The functional blocks housing several relays, in the same casing and also eventually some accessories such as valves, offer the following advantages:

Reduction of space occupied and therefore of the surface which the same devices would take on the relay racks if they were mounted in individual casings.

Reduction of cable lengths due to the fact that the length of the connections inside a block is notably reduced as compared with what it would be if the devices were housed in individual casings.

Reduction of the number of connecting points (terminals) and consequently saving on time required for erection at site.

When a relay or a functional block has to be replaced, for instance in the course of a maintenance

operation, cutting off the wires of the old device and connecting these same wires to the new device takes a certain time which is of course longer if the number of terminals is higher. On the other hand, there is a risk of error when the wires are re-connected.

The use of an automatic plug-in device suppresses this risk as the substitution of the apparatus is executed without touching the wiring and as a coding device prevents replacing a functional block of a given type by another block of a different type. Moreover it affords valuable savings in time since the operations are essentially limited to "undrifting" and "redrifting" which is rapidly performed.

The widespread use of plug-in type material (relays, relays blocks and connections between frames) offers another noticeable advantage; it allows final wiring of the frames at the works which considerably reduces the erection time on site (of technical and economical importance). Moreover this technique facilitates subsequent interventions in the signal cabin.

The S. N. C. F. believes that the maximum safety and dependability is obtained with simple diagrams (without check of the position of the relays) and with relays giving the corresponding performances.

Kilosa—Mikumi Line Opened

The new branch line from Kilosa on the Tanganyika Central Line to Mikumi, East African Railways & Harbours, was opened for traffic on August 15. The line, costing in the region of £715,000, is 44 miles in length and provides a new railhead for the traffic of the southern Highlands of Tanganyika, which was formerly dealt with at Morogoro. It also advances the railhead to within 24 miles of the Kilombero Valley sugar project. There is one intermediate station on the section, Mbamba, 19 miles from Kilosa.—(RG)

RECORD MOVEMENT OF FREIGHT

On two days recently Rhodesia Railways broke the record for the movement of traffic on any section of the line. On August 3, 19,654 gross tons were despatched southwards from Wankie and on August 5, 20,988 tons. Two extra trains were needed on the first occasion and three on the second to handle the additional traffic. In the northward direction the tonnages despatched from Wankie were 11,645 and 12,057 tons,

but these figures are not records. On an average day, southbound traffic from the coalfields area amounts to between 12,000 and 16,000 tons.—(RG)

SECOND BRIDGE ON THE JAMUNA

The Deputy Minister of Railways, Shri Shah Nawaz Khan, said in a written reply to a question by Shri Ram Krishna Gupta and Shri D. C. Sharma in the Lok Sabha that the design of the second bridge on the Jamuna, which incidentally was to be sited near Purana Qila, and not Tughlakabad, was nearing completion. He added that the land acquisition was also in progress. About 291 acres of land had already been acquired from private owners and about 478 acres of nazul land were yet to be taken over in respect of which the Railway Administration was in correspondence with the Land and Development Officer under the Ministry of Works, Housing and Supply. The construction work would be taken in hand as soon as all the land had been made available.

The Design and Development of Resilient Rail Mounting for Jointed and Long Welded Track

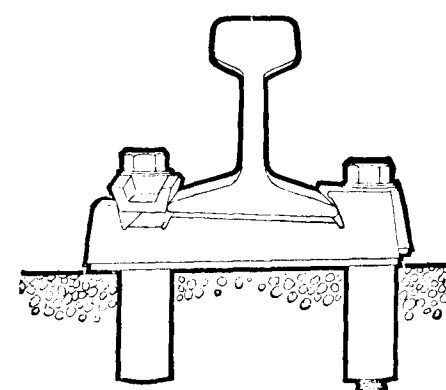
By O. H. Varga, M. Sc., A. M. I. Mech. E.

Great scope of systems employing rubber anchorage in all types of rail sleepers and rail foundations.

THE great success in recent years of resilient grip anchorage methods in concrete and other foundations for light and heavy industrial equipments by means of expanding sleeves of tough rubber and plastic materials, the Seetru Mounting Bolt being a particular example, has led Seetru Ltd., of Bristol, England to undertake an extensive programme of design and development of rail mountings employing the same anchorage principle. The original purpose of this work was to provide a rail fastening for concrete sleepers, which

are being used in ever increasing numbers all over the world, in which the inherent resilience of the fastening was to supply the essential degree of elasticity which is absent in concrete sleepers as compared with timber sleepers, and even steel sleepers. The work has led to the establishment of a rail mounting principle, widely adaptable, and patented in many countries, which far beyond the original objective, is considered to provide a general solution for the many diverse requirements of technical performance and economy of installation and maintenance which a modern rail

SEETRU RESILIENT RAILWAY MOUNTING SYSTEMS



SPECIALIST DESIGNERS AND SUPPLIERS OF RESILIENT RAIL MOUNTINGS FOR EVERY TYPE OF RAIL FOUNDATION

- | | |
|---------------------|-------------------------------------|
| (1) Wooden Sleepers | (2) Concrete Sleepers |
| (3) Steel Sleepers | (4) Continuous Concrete Foundations |

Patented systems provide for complete electrical and mechanical insulation between rail and foundation by means of resilient grip rubber anchorages and rubber pads, together with positive creep-free location of rail. This system is also very suitable for long welded track.

Great economy in use of materials combined with robustness and reliability of components.

Outstanding ease of installation and maintenance. Resilient mounting protects both rail foundation and rolling stock.

In case of temporary lines mountings can be taken up and re-used. Special techniques available for laying track on continuous concrete foundations in tunnels, on harbour jetties, works yards, etc.

Special designs available for locomotive pits giving maximum operating width.

Designs undertaken for every type and size of rail and loading.

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Telegrams: Seetru - Bristol - England

mounting system has to satisfy. The Seetru Rail Mounting principle is in fact applicable to every kind of rail foundation: concrete sleepers, timber sleepers and also steel sleepers, as well as to continuous concrete beds. One particular version of the system, the Wedge Clip Mounting has been designed to meet the very important special requirements of long welded track.

THE SEETRU RAIL MOUNTING PRINCIPLE

The Seetru principle is readily observed in the simple mounting employing steel sleeper type rail clips, illustrated in Fig. 1. This mounting was originally designed for 60 lb/yd. F. B. rail, but is applicable to other rail sections as well. A base plate is employed in one form or another in all rail fastenings according to the system, and is placed on the sleeper or other rail foundation with the interposition of a rubber pad. The base plate here is a simple forged steel slab with a centre portion sloping 1:20 to provide rail inclination when used on a horizontal sleeper surface. Where the sleeper surface is itself inclined, the base plate need only be plane. Two rectangular holes are pierced through the base plate on either side of the rail to allow the rail fixing bolts to pass through and to provide location

and abutment for the tabs of the rail clips. The bolts are the so called Seetru Bolt 'M' type with threads uppermost, and it is to be noted that they perform the double function of tying the rail firmly to the base plate and anchoring the rail mounting assembly as a whole to the sleeper or rail foundation.

The shank of the bolt in the sleeper is surrounded by a tough rubber sleeve which in its uncompressed state can stop short of the bolt head, or may be moulded right over it. In any case, the bolt head is clear of the wall of the sleeper hole, and thus the rubber sleeves and the rubber pad between them effect complete mechanical and electrical insulation between the metal parts on the rail mounting and the sleeper. The bolt shank is seen to be formed with a shoulder which, when tightened, abuts against the bottom of the base plate, and thereby limits the amount of axial compression to which the rubber sleeve is subjected. This is a key feature of the Seetru principle and a number of important advantages flow from it. During the tightening down process, a positive stop is felt to the bolt movement when the abutment is reached, and the bolts is then given a final pull-up of arbitrary substantial force to tie the rail, base plate, bolts and clips firmly together into a comparatively rigid assembly. This assembly as a

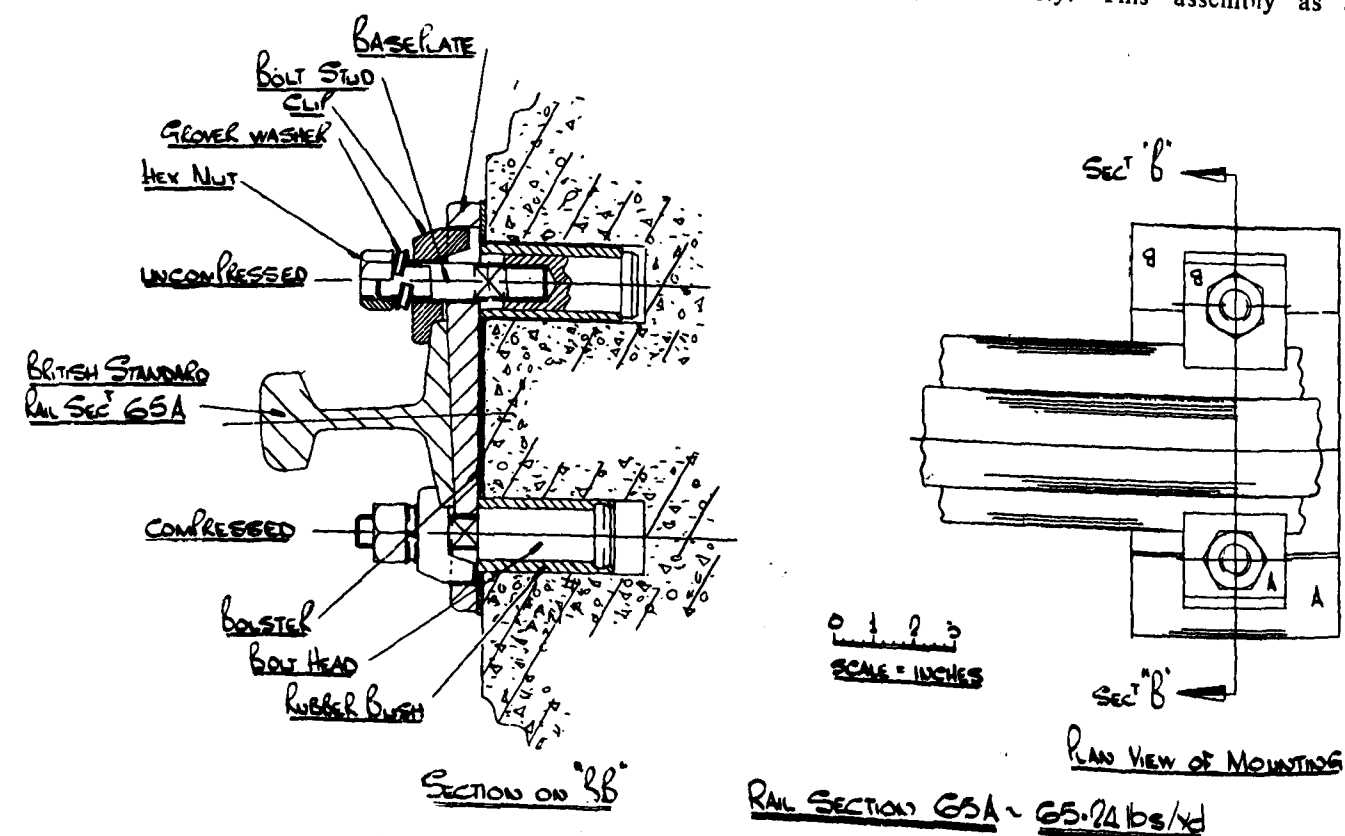


Fig. 1. The Seetru rail mounting designed for 60 lb./yd. F.B. rail.

whole 'floats' in rubber, small vertical oscillations of the rail mounting relative to the sleeper being allowed under impact by deformation of the rubber pad and axial shear deformation of the rubber sleeves.

Above the shoulder the bolt is formed with a square on the shank where it passes through the base plate, and this prevents rotation.

The limitation of the compression of the rubber sleeve ensures that no excessive bursting stresses are set up in the sleeper, while the grip on the rail foot itself is in no way limited. The tightening down process is not subjected to any form of critical control and only requires straightforward robust hand pull-up. This is of obvious importance where there is little opportunity of long term training of large track laying gangs.

For economy of production the bolts are built up of two components, a stout forged shank with a head at the bottom and a female thread on the top, and a stud member with a central square to screw into the forged shank.

The firm "metal-to-metal" grip top and bottom of the rail foot ensures positive rail location, i.e. resistance against both creep and track gauge changes while the resilience of the mounting, as a whole, imparts to the track a great shock resistance. The freedom of the rail to undertake small undulatory movements relative to the sleepers is bound to reduce wear and abrasion of the sleepers, and disturbance of the ballast, and thereby to extend the maintenance free useful life of the track. This point is emphasised by the substantial track movements which are known to exist under moving trains, and which have been measured in the course of research work in Germany [1]. The elastic mounting of the rail reduces the accelerations which are imported to the sleeper, and therefore necessitates a comparatively gentle hold only in the sleeper, involving low stresses, while the location of the rail is assured by the firm, independent grip of the mounting on the rail foot.

The importance of the electrical insulation introduced by the rubber elements is obvious from the signalling point of view.

These results are achieved by the use of economical robust components and notably without the use of any carbon or alloy spring steel members.

DETAIL DEVELOPMENT OF COMPONENTS

The effectiveness of the Seetru Rail Mounting principle from both technical and endurance points of view has been established in the course of the last 6-7 years in extensive laboratory tests in Great Britain, Germany and Austria and on experimental tracks in Great Britain and Austria. It is clear that the principle of the system, i.e. rubber anchorage in the rail foundation and a statically separate 'hard' grip on the rail foot, can be achieved in a variety of ways with different types of components, and the work of the last 2-3 years has been devoted to establishing the best form of the various constructional elements of the system.

'M' TYPE AND 'F' TYPE BOLTS

As distinct from the 'M' type bolts in Fig. 1 with threads uppermost, an 'F' type bolt arrangement is shown in Fig. 2 where the head of the bolt is on the top, and the thread engages a nut member moulded into the bottom of the resilient sleeve. The limitation of the compression of the rubber sleeve is effected by a distance tube integral with, or spigoted into the nut member, and coming to rest against an abutment on the base plate after a predetermined compression travel.

It is the advantage of this arrangement that the thread is protected inside the sleeper, that the external contour of the fittings is very compact, and that standard industrial bolts can be used.

BOLT HEAD OR NUT CONTOUR MOULDED INTO RUBBER

The latest technique consists invariably of moulding (but not bonding) the rubber sleeve on to the metal part which it engages. Experiments carried out at the Civil Engineering Laboratory, Western Region, British Railways, by means of large Perspex models have shown that a special corrugated form of the bolt head or nut engages the rubber sleeve most smoothly, avoids localised high strains, and ensures ready extraction of the rubber sleeves after prolonged service, if so desired.

MOULDED FLANGES ON RUBBER SLEEVES

In the manufacturing cost of concrete sleepers the provisions which have to be made to take the rail fastenings play a very important part, and the plain cored through holes required for the resilient

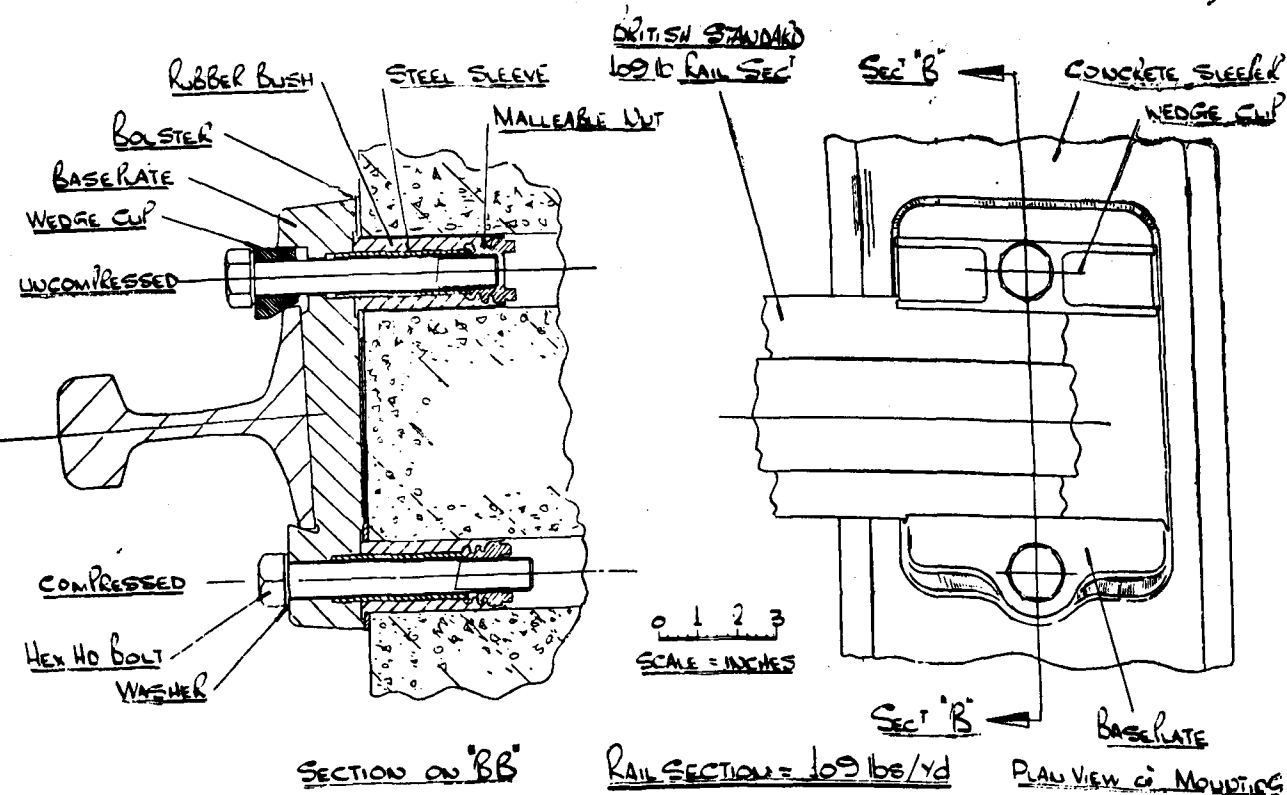


Fig. 2. Seetru rail mounting involving use of 'F' Type Bolts.

anchorages of the Seetru Mountings represent in fact the most economical provision of all the various methods under present consideration. To prevent the rubber sleeves from falling through the sleeper holes on assembly, they are often provided with moulded flanges on top, which can either be accommodated in moulded recesses in the rubber pads, or in shallow counterbores on the base plates.

RUBBER PADS

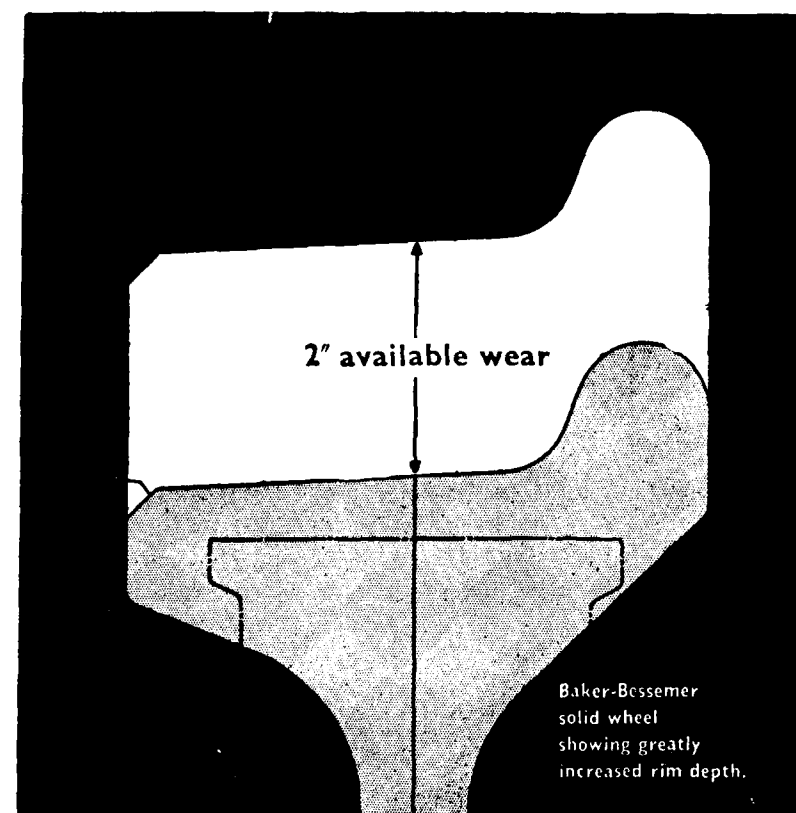
Pads of rubber or other resilient insulating material in one form or another are an essential part of the Seetru Rail Mounting System. Pads of numerous designs are being tried out at present in different parts of the world with the overall result that they are becoming more and more a standard part of the modern track. Again, the Civil Engineering Laboratory, Western Region, have constructed, according to a scheme of the authors, a comparatively simple endurance testing machine for resilient track pads for the rapid evaluation of their long term service performance.

Also, the strides being made at present in rubber and polymer science ensure that satisfactory materials can be compounded for long service track pads in tropical countries.

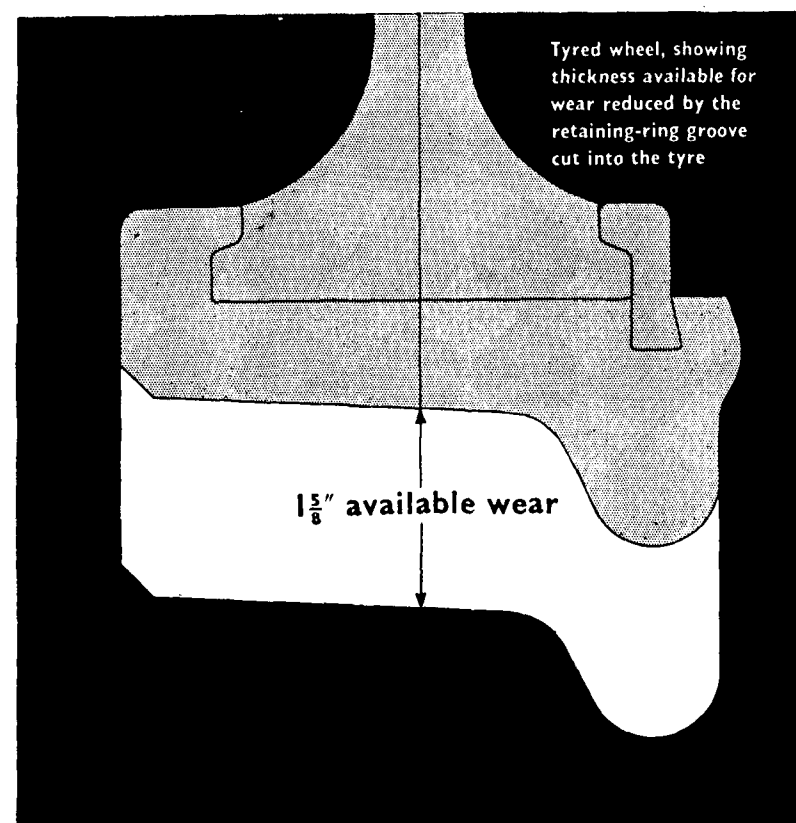
THE WEDGE CLIP RAIL MOUNTING

This important version of the Seetru System is illustrated in Fig. 2. While of general validity, it has been particularly developed for use with long welded track, the introduction of which represents one of the great advances of modern track engineering. Both theoretical analyses [2], as well as comprehensive scientific tests carried out at the Civil Engineering Laboratory, Western Region, have established a high torsional stiffness about a vertical axis to be one of the crucial requirements for a satisfactory rail mounting to be used in such track. The Wedge Clip Mounting possesses this property to a higher degree than any other.

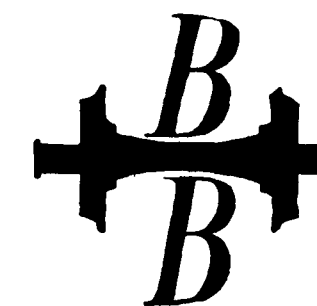
While employing a resilient pad and sleeve as before, the rail foot is held in a powerful wedge grip between the sloping edges of the cast iron base plate and a long malleable cast iron wedge. There are thus no clearances whatever between the rail foot and the lateral faces of the base plate, and any torque about a vertical axis applied to the rail, is at once resisted resiliently by the sleeves in the sleeper, without any rotational rail slip, however minute. Also, for a given bolt load, the grip against creep exerted on the rail foot is more powerful than with any other system.



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The distance tubes inside the rubber sleeves enter and abut in jig drilled counterbores in the base plates.

SEETRU RAIL MOUNTINGS ON CONTINUOUS CONCRETE BASE

The principle of expanding resilient grip anchorage in concrete holes offers a reliable method of laying track direct on a continuous concrete bed. Apart from harbours, jetties, factory yards and bridges etc., this is of particular value in tunnels where the elimination of ballast reduces the headroom requirements. This can result in a very great saving in the cutting of new tunnels, while in existing tunnels it may make possible the introduction of overhead electrification for which there would be insufficient space otherwise.

Rubber pads lying direct on the concrete surface provide the essential resilience of the track, while two resilient anchorage sleeves are placed into drilled holes in the concrete surface. Fig. 3 shows a special mobile drilling jig developed by Seetru Ltd., by means of which the bolt holes are drilled with very great accuracy from a surveyed centre line. Rotary percussion pneumatic rock drills are used for this purpose in conjunction with vacuum disposal of the concrete dust. It has been found that a team of four men can drill 28 holes per hour, which is, of course, equivalent to seven sleeper positions.

A special base plate design is available which allows shimming up the rails by varying amounts to compensate for any irregularity of the concrete surface.

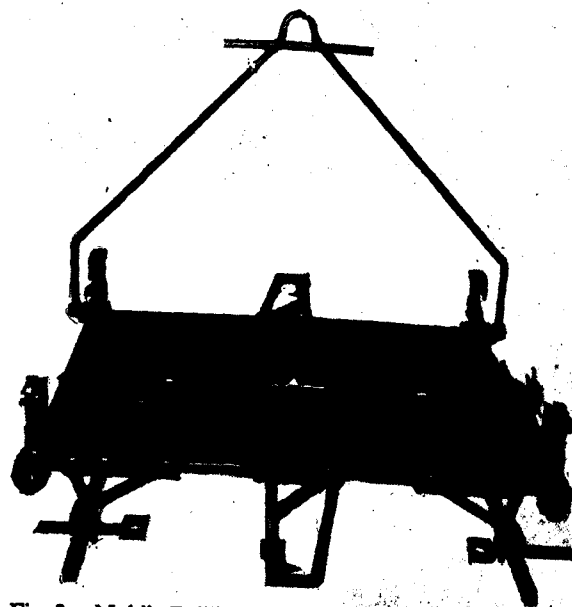


Fig. 3. Mobile Drilling Jig for continuous concrete base.

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Civil Engineering and Public Works Review, No. 639, Volume No. 54, October, 1959.

YOUR ATTENTION PLEASE

We sincerely regret for the delay in publication of our ANNUAL owing to circumstances beyond our control. The recent All-India Postal strike is one of the contributory causes for the delay besides the latest restrictions imposed upon Postal authorities in transmission of journals to foreign countries, without the permit from the Reserve Bank of India. For want of space we could not publish all the technical articles and advertisements received for this ANNUAL but we assure our readers, contributors and advertisers that they would be published in our next quarterly edition.

Rumania's Growing Possibilities of Producing and Exporting Rolling Stock

By Engineer V. Actarian
Deputy Minister of Heavy Industry, Rumania

RAILWAY car manufacture started in Rumania as far back as 70 years ago.

The talent and skill of Rumanian workers and technicians in the manufacture of railway cars were recognized and appreciated by many foreign buyers in Serbia, Bosnia and Herzegovina, Turkey and later by the International Sleeping Car Company, etc.

After the Second World War and especially after 1948 the Rumanian railway car industry assumed a powerful development owing to a wide programme of capital investments, to the systematization and modernization of production processes, to the endowment of factories with highly technical equipment and to the gradual introduction in the production plans of modern railway cars of ever higher technical-economic indices.

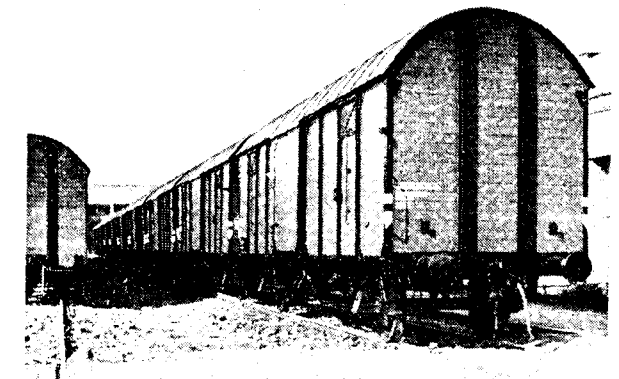
In order to illustrate the great improvements made in the Rumanian railway car industry in post-war years we need only mention some characteristic facts about the "Gh-Dimitrov" Works at Arad, the chief railway car producer. After 1948, the works was radically rebuilt and modernized, and its production capacity considerably augmented.

With its modern equipment and increased production capacity the Rumanian railway car industry has been turning out a wide range of cars of many types.

From among the main varieties of railway cars made by the Arad works after 1948, the following are well-known: covered freight cars on 2 and 4 axles (8 different types); open freight cars on 2 and 4 axles (8 different types); self-discharging cars (in about 5 models); dumping cars; modern iron and steel carrying cars (10-12 types); passenger cars; saloon cars and special cars (approx. 7-8 types) etc.

Concurrently, the Bucharest "23 August" works have turned out new types of 50 cu.m. tank cars on 4

axles in 4 models and, in the last 2 years, new types of Diesel electric railcar trains of 4-6 coaches, 2 of them power cars, with a variable number of trailers, according to traffic requirements.



A consignment of covered freight cars made in the Rumanian People's Republic bound for the German Democratic Republic.

Here are a few types of rolling stock designed for export :

28 Ton Open Freight Car on 2 Axles, UIC Type

This is a car with side walls used for the transport of goods such as: beet-root, potatoes, timber, etc., though it may also serve as a platform car, as the side walls are removable.

The box is made of metal panels with stanchions mounted on the brackets provided for that purpose. The panels are covered with deal boards 40 mm thick, except the lower ones which are of oakwood. The floor is made of 45 mm thick deal.

The underframe of welded and riveted construction rests on 2 axles through the intermediary of 4 leaf

springs. The axle box, one solid piece of cast steel, follows the movements of the underframe, sliding between 2 axle box guides. Traction is continuous and elastic. The buffers are fitted with 16 t volute springs.

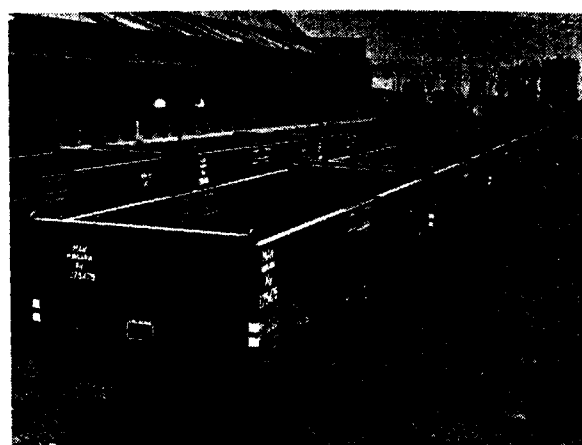
The car is provided with an automatic compressed air brake Hikp type, which acts on the 4 wheels through 8 brake shoes.

The brakesman's platform is secured by means of brackets to the underframe where the hand brake is also located. The handle of the alarm signal is likewise fitted on the platform.

Characteristics of the car :

* gauge	1435 mm
* wheel base	8000 mm
* serviceable floor surface	35 m ²
* serviceable volume of car	28 m ³
* real load : evenly distributed	28 tons
on 8 m	15 tons
on 2 m	10 tons
* tare weight	approx. 12 tons

The clearance gauge complies with RIV standards and the construction of the car is in accordance with UIC prescriptions. The car is approved for a service



A consignment of Rumanian-made open freight cars bound for the Hungarian People's Republic.

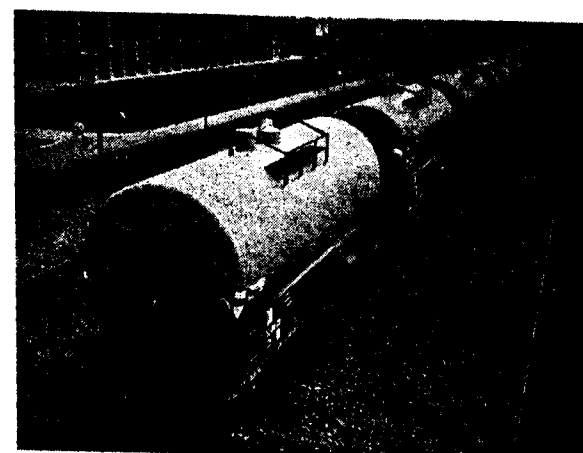
speed of up to 100 km/h and may negotiate curves of 150 m radius on traffic lines and of 100 m on shunting lines.

28 Ton Covered Freight Car on 2 Axles, UIC Type

A freight car of recent designs which may be used for the transport of grain or of animals. The car is

fitted either with mobile shutters or with rings for the straps and sliding racks, according to requirements.

The box is made of a metal frame whose side walls are covered with deal boards 25 mm thick, while the lining of the end walls is 40 mm thick up to 1486 mm from the floor and 22 mm thick higher up. The side walls are provided with 2 sliding doors and 9 ventilation shutters.



50 ton tank cars manufactured by the "23 August" works in Bucharest, ready to be supplied to the German Democratic Republic.

The metal frame of the roof is likewise covered with deal boards 18 mm thick over which comes sheet metal 0.65 mm thick.

The underframe of welded and riveted construction, rests on 2 axles through the intermediary of 4 leaf springs. The axle box is one solid piece of cast steel sliding between 2 axle-box guides and thus following the movements of the underframe. Traction is continuous and elastic. The buffers are fitted with 16 ton volute springs.

The freight car is provided with an automatic compressed brake, Hikp type, acting on the 4 wheels through 8 brake shoes.

The car is manufactured in 2 models viz. with or without hand brake; the latter is operated from the brakesman's cabin. The hand brake model is also provided with an emergency brake.

* gauge	1435 mm
* wheel base	5700 mm
* serviceable floor surface, approx.	25 m ²
* serviceable volume of car	60 m ³

In 1960 "Industrialexport" Rumania offers :

NEW PRODUCTS FOR EXPORT

Multiple-Unit Railcar Train

The mechanical equipment of a railcar consists of :

— A 600 HP Diesel engine driving a 400 kW direct current generator. Traction is achieved by means of two 186 kW electric motors actuating the two end axles of the driving bogies.

— An auxiliary 120 HP Diesel engine which actuates the auxiliary services (ventilators, compressors, amplidyne, etc.)

The welded, rolled steel body of the railcars and trailers is of partially self-supported design. The front of the railcar is streamlined to reduce air resistance; internal and external folding heads are provided between the cars. Thermic and noise-proof insulation is provided: cork for the floor, and aluminium sheets and mineral wool for the side walls and roof. The inside walls of the compartments and corridors are made of blockboards lined with walnut veneer on the lower part and plastics on the upper part.

The train is divided up as follows: one of the railcars has a luggage compartment and a kitchen while the other has a 2nd class compartment seating 40 people; of the four trailers, one has nine first class compartments of six seats each, while the other three will seat 80 second class passengers each in two compartments of 24 seats and one of 32 seats. Altogether the train will seat 54 first class and 280 second class passengers. The multiple-unit railcar train is provided with a modern and varied car heating and ventilation system and with normal and fluorescent lighting.

On request, the internal arrangement may be modified to suit the clients' requirements.

INDUSTRIALEXPORT

2, Gabriel Peri Street

- Bucharest-RUMANIA

* real load, evenly distributed	28 tons
on 1.5 m	14 tons
on 3 m	16 tons
* tare weight	12 tons

The clearance gauge complies with RIV standards and the design with UIC prescriptions. The car is approved for a service speed of up to 100 km/h and may negotiate curves of 150 m radius on traffic lines and of 100 on shunting lines.

40 m3 (80 ton real load) Dumping Car on 4 axles

This car, designed for the transport of earth, rubble mine deads, etc. is of welded all-metal construction.

The box is a carcass made of U-rolled steel sections and stanchions welded together, with interior sheet metal lining 8 and 5 mm thick.

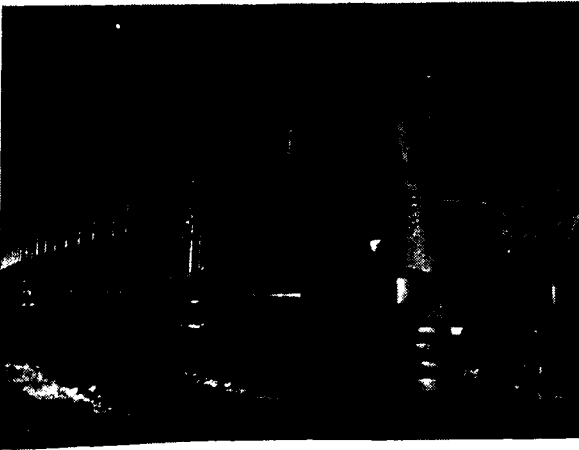
The side flap is a carcass made of U-rolled and pressed steel sections, covered on the inside with 5 mm thick sheet metal and on the outside with 3 mm thick sheet metal.

The box-shaped all-welded underframe is made of sheet plates 20 and 17 mm thick.

The 4 axles are mounted on 2 bogies through the intermediary of 4 leaf springs for each bogie.

The axle box is a single block of cast steel with roller bearings.

The bogies are made of cast steel.



Multiple-unit Diesel railcar made in the Rumanian People's Republic.

The car is fitted with discontinuous central buffer coupling with braking and tipping mechanism, through electric line, and acoustic and optic-electric signalling installation.

The tipping power is supplied by a tipping cylinder fed with compressed air from two 400 litre tanks. The box is tipped by means of a hand-operated cock. The tanks are fed with 5 atm. compressed air from the locomotive. Against a possible unintentional tipping, a top cock and a safety hook are provided. If necessary, the box may be tipped also by means of a special hand-operated device.

The dumping car is designed for a service speed of upto 40 km/h and negotiates curves of minimum 80 m radius.

* gauge	1435 mm
* capacity of box	40 m3
* tare weight	34 tons
* loading capacity	80 tons

50 m3 Tank Car With Pressed Sheet Steel Bogie

A car complying with UIC clearance prescriptions and also meeting clearance conditions for negotiating curves of 250 m radius.

The car readily negotiates curves of 120 m radius.

The assembled wheel set made of material complying with UIC standards is built according to a Rumanian design.

The pressed bogie is provided with brakes on both sides of the wheels.

The assembled wheel set rests on roller bearings.

The underframe is made of two reinforced side sills and two box supports for seating the tank. The two end sills are reinforced at the place where the buffers are fitted up.

The tank is made of 3 shells 9 mm thick on the upper part and 11 mm thick on the lower part. The shells provided with 2 breakwater devices are electrically welded.

The tank car may be provided with a removable heating installation.

Traction is continuous and elastic. The buffers are fitted with 16 ton volute springs.

The car fitted with automatic brakes, with a 14" Hildebrand-Knorr device, and with a hand brake, is moreover provided with a brakesman's cabin and an emergency brake valve.

Leading particulars are as follows :

* gauge	1435 mm
* length of car between buffer faces	12450 mm
* width of car	3080 mm
* height of car	4265 mm
* distance between bogie pivots	6400 mm
* total volume including heating coils	48 m3
* total volume without heating coils	50 m3
* real load	40 tons
* tare weight—with coils	24 tons
—without coils	23 tons

Second Class Passenger Car (72 seats)

This light passenger car on 4 axles and with 72 seats is a second class car with 9 compartments of 8 seats each.

The 2 "Goerlitz" type bogies are fitted with axles on oscillating bearings. The suspension is by 4 systems of leaf and coil springs, with 1 cm per ton flexibility for each bogie, ensuring a smooth, joltless run. The bogie is of all-welded design.

The car is fitted with a 14" Hildebrand-Knorr Hikap type brake, with freight train-passenger train service cut out cock, enabling it to reach a speed of 100 km/h. Traction is continuous.

The metal frame together with the underframe form a thin-walled tubular construction—the mainstay of the car.

The passenger car is divided into 9 compartments with 2 lavatory compartments located at both ends. The inside of the car is built with a view to the passenger's comfort; the semi-upholstered benches with arm and head rests seat 4 people each. The walls are made of plywood, the outer veneer being of semi-polished oakwood, thermically insulated by means of cork or alph. The interior panelling may likewise be of plywood covered with vinylin of various shades and patterns.

Heating by means of low pressure steam radiators placed under the benches and along the corridors. A 24 V Dick system provides direct electric lighting.

The car is provided with a radio-relay station.

Two flaps above the windows ensure ventilation

* gauge	1435 mm
* tare weight	approx. 34 tons

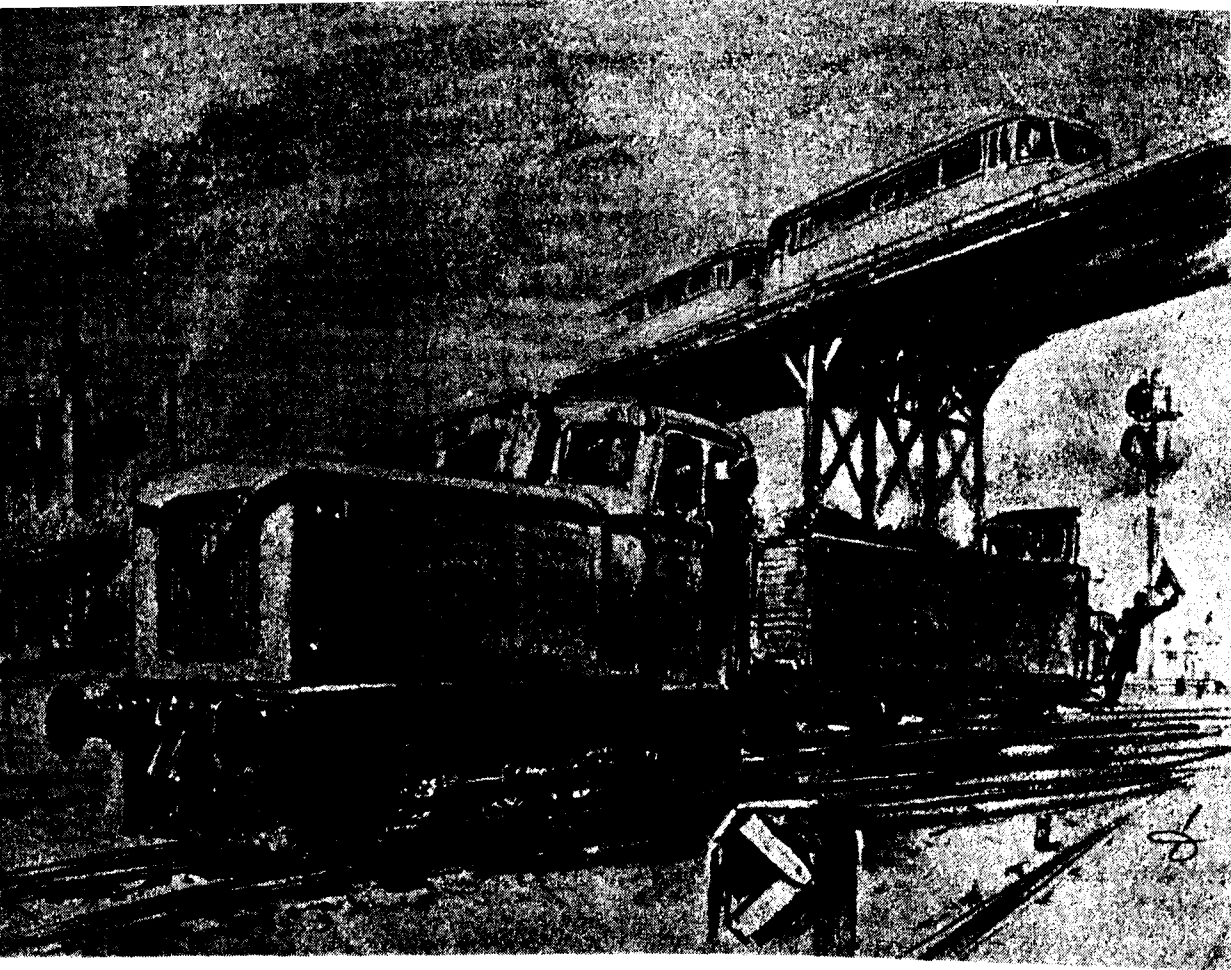
The car complies with RIV clearance gauge.

At present Rumania ships railway cars to over 12 countries including the U. S. S. R., the German D. R., the Czechoslovak Republic, the Chinese P. R., the United Arab Republic and Greece.

Rumanian railway cars are greatly appreciated by foreign clients.

Prompt and high quality manufacture, as well as the co-operation and exchanges of experience between Rumanian and foreign research institutes have enabled the Rumanian rolling stock industry to develop steadily and thus maintain Rumanian products at the level of world technical requirements.

The Rumanian rolling stock industry will as heretofore meet the home and foreign client's most exacting requirements.



Everywhere where shunting is done — in oversea ports and ports of transshipping, on stations and in the internal traffic of industrial works — Diesel locomotives assert themselves.

For what reason? Quick readiness for use, unconditional reliability of service and low operating expenses speak for this modern type of traction without fail.

The respective kind of application determines the performance of the Diesel locomotives. Our engineers and designers are aware of this. As experienced specialists they developed two types of Diesel locomotives for different wheel gages with 100 and 180 metric horsepower capacity respectively which are above all suitable for shunting.

Special importance was attached to the best conditions for seeing, silent run, low consumption and high tractive power.

Apart from all these technical requirements which mark our two types the reliability of service, the utilisation factor — and, thereby, the economy rank foremost.

Please, communicate with us!

We shall be glad to give you information on all technical questions, as well as on export of our modern Diesel locomotives which we supply to many countries.

Exporter :

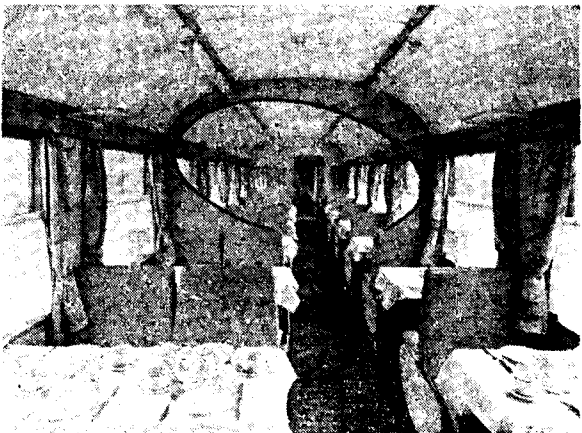


TRANSPORTMASCHINEN EXPORT-IMPORT
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GERMAN DEMOCRATIC REPUBLIC

Sleeping and Dining Cars for International Railway Traffic

WHEN reconstruction of our economy was begun after the war in the German Democratic Republic, also the coach building enterprises expanded their greatest efforts in order to reach once more international standards in railway coach engineering. They had to start from almost nothing and succeeded by hard and arduous work to advance step by step till the goal was attained. One of the most important facts was the help offered by our basic industries and by the enterprises who manufacture parts and accessories for these coaches. Our enterprises were specialized and the latest technologic methods were used. This resulted in a considerable increase in production capacity, so that it was possible not only to construct the coaches needed by our railway system, but also to export them into many countries.

without any reduction in the security offered to the passenger. Some examples are the "Twin storey articulated trains which will solve traffic problems"



(they are described in a different article), and the "Sleeping and Dining Cars for International Railway Traffic". Main characteristics of these two latter types are :

length over buffers	24 900 mm
length of body	24 540 mm
length of undercarriage	23 600 mm
width over frame	2 833 mm
height over rails :	
sleeping car	about 4 200 mm
dining car	about 4 100 mm
distance between centre pins	17 000 mm
wheel base of the no axle box bogies	2 500 mm
wheel set diameter	940 mm
clearance between rails and	
coupling centre	1 060 mm
ground clearance above rails	1 276 mm
weight of cars	about 42 t
number of sleeper compartments	
in the sleeping car	11
berths in 1st class cars	22
berths in 2nd class cars	33
berths in mixed 1st and 2nd class cars	27



The trend in modern coach construction has various aims : the increase of travelling comfort, light weight construction, and an increase in operational economy

Dimensions of the cars meet with the RIC regulations.

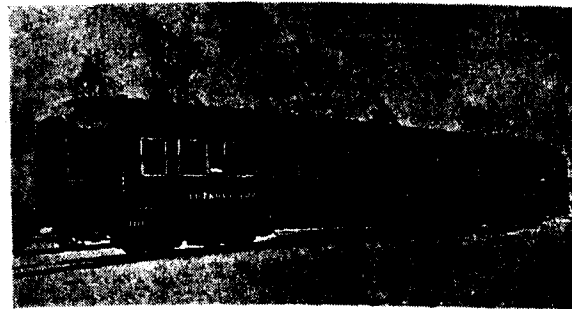
Both sleeping and dining cars have many things in common, such as the all-steel welded light weight construction for a central buffer pressure of 200 t. their streamlined shape and the two axle no-axle-box bogies fitted with twin block brakes and shock absorbers at the cradle supports for the absorption of vertical and horizontal oscillations. Common is also the automatic Dako type two cylinder compressed air brake allowing for maximum speeds of 120 km/h when fitted with normal control valves and of 160 km/h when fitted with rapid brake control valves, as well as the electric power supply system for illumination, pressure controlled de-aering and all other electric appliances. This power plant consists of two axle driven dynamos and alcale storage batteries. Both car types are equipped with through ducts for a possible additional



3000 V electric heating system and steam heating system ducts. There are two hot water tanks, one for individual compartment heating and the other one for the hot water supply. The hot water heating system takes care of temperature differences up to 55 degrees C. That means comfortable temperature even during strong freezing spells. The cars are fitted with wide double pane windows by which draft and outside noises are effectively eliminated. Fresh air is supplied to all compartments by means of a mechanic compressed air system adjustable to either 800, 1800 or 4000 cu.m/h air supply. Fresh air enters the compartments through holes in the ceiling.

The sleeping car carries a total of 27 passengers in 6 first class compartments with two berths each and 5

second class compartments with three berths each. But these sleeping cars are also manufactured and supplied for first class only with 22 berths and for second class only with 33 berths. The seats, respectively beds, are excellently upholstered. The compartments are nicely furnished and appointed with decorative window stores, Perlon carpets and fine wood wainscoatings, table and reading lamps, and washing facilities built into a hidden closet. All this, together with the brilliant light of the fluorescent ceiling lamps, gives the impression of a nicely furnished



room and offer the highest possible comfort to the passengers. The car is also equipped with a small galley fitted with electric appliances where simple meals and hot drinks may be prepared. There is furthermore a public address system operated from the service compartment by means of which messages and wireless programmes may be broadcast to the compartments.

When you visit the *dining car* you will first of all notice the fine decoration and the nice colour scheme of the dining compartment. Seats and tables are arranged to either side of the aisle. To one side there are tables with four seats, to the other one tables for two. In this way maximum comfort is offered to the passengers. In the dining compartment there are 42 seats altogether. Lighting, fresh air supply and heating facilities are the same as in the sleeping cars. The double pane windows are 12 mm. wide. The walls are faced with fine plywood, the ceiling with plastics. The most up-to-date equipment of kitchen and dresser, including a special bar compartment equipped with an electro-automatic beer cooling plant, allow for the supply of well prepared meals to the passengers.

These cars has stood all tests in the railway systems of our clients. They were designed and equipped according to the wishes of our customers and prove the good quality of work of our enterprise who spares no efforts in order to satisfy the demands of our customers for practical and modern rail cars.

Railcoach manufacture at Hindustan Aircraft Ltd., Bangalore

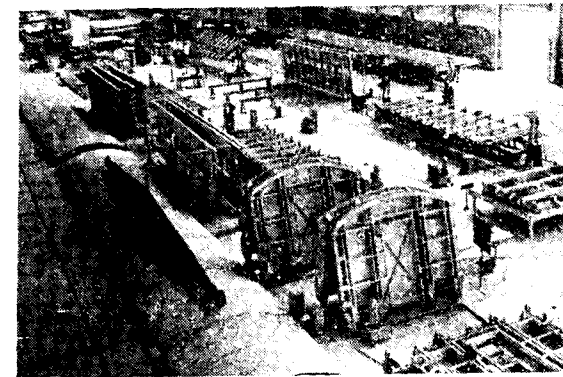
MODERN INTEGRAL COACHES UNDER PRODUCTION

THE year of India's Independence saw the ushering in of the Railcoach Division of Hindustan Aircraft Ltd., at Bangalore. The second world war had ended barely two years earlier; our entire railway system which had stood up so wonderfully to the stresses and wear and tear imposed upon it by the war was in dire need of rehabilitation in many spheres. This was particularly pronounced in the case of passenger coaches. Our coaching stock had dwind-

led to a parlous state. It was at this juncture that the Hindustan Aircraft Ltd., turned its attention to this form of transport. *New conception:* The idea of building Railway coaches at HAL on the same lines as the manufacture of air craft was conceived and soon it took shape. After preliminary development work in the year 1947, a suitable design for an all metal Broadgauge Class III rail coach was evolved. This design was based very largely on the principles governing airframe design—viz., the greatest strength with the lowest possible unit weight. Thus for the first time in the manufacture of rail coaches in India, the older conception of design was superseded by the new HAL technique of railcoach construction. In collaboration with the Railway Board, the HAL design was finalised and this led to the starting in 1947 of a production line at HAL for Railcoaches that have revolutioned Third Class travel in India.

EARLY MODELS

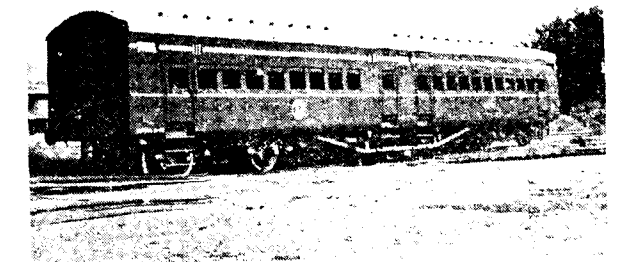
The first HAL designed broadgauge railcoach with an all steel body rolled off the production line on 27-9-1948. It was 100 feet wide, 70 feet long and was built on jigs using cold rivetting and spot welding



A long shop view of a production hanger at the Railcoach Division showing Coaches in various stages of Manufacture.



The Railcoach Division of HAL which pioneered over 12 years ago railcoach construction in India into its all-metal broad gauge railcoaches is now engaged in the production of modern all-steel broad gauge Integral Coaches for the Indian Railways. It now turns out nearly 300 Coaches per annum. A number of Coaches in various stages of production can be seen in the picture.



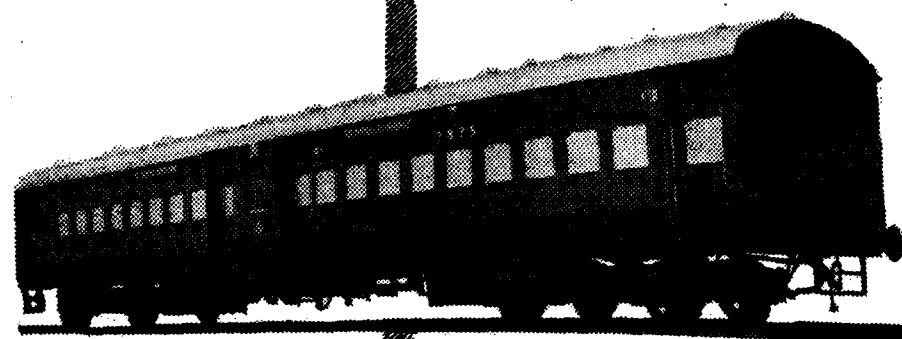
Exterior view of Railcoach Model 404.

and erected on the standard underframe supplied by the Railways. The ends of the Coach were reinforced to minimise damage in accidents. A three tier arrangement of bunks and seats was provided which enabled passengers sleep during nights. This design was known as Model 404. 100 such coaches were built and delivered to the Railways by 1950.

HAL

MADE INTEGRAL COACHES FOR SMOOTH RIDING COMFORT

All-Metal, Integral Coaches
for Luxurious travel of
Class III Passengers,
built in collaboration with
Messrs. M.A.N., West Germany



HINDUSTAN AIRCRAFT LTD.
BANGALORE, INDIA

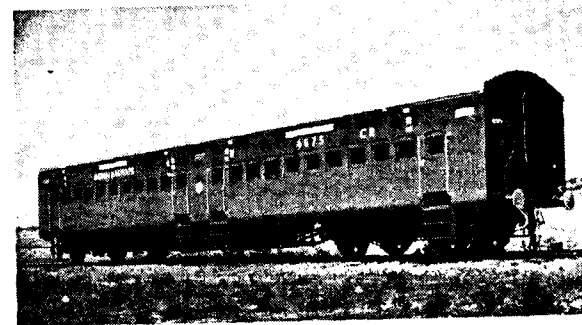
July 1960

THE INDIAN RAILWAY ENGINEER

R.C.11

IMPROVED DESIGN

On completion of 100 coaches to Model 404, an improved design known as Model 407 was evolved. In this model the ends of the coaches were strengthened more than in the previous model with anti-telescopic posts. The interior furnishings were improved to provide more amenities to the passengers like the increased number of fans & lights, better



Exterior view of HAL Conventional Type of Railcoach Model 407.

ventilation, better lavatory fittings, etc., than in the previous model. The three tier arrangement of seats and bunks was also changed to two tiers in the improved model. HAL have turned out upto the end of September 1960 a little over 1500 coaches of this model.

HAL also designed and built 60 military coaches known as Model 408 fitted with foldable bunks for sleeping and provided with stainless steel drinking water tanks etc. These too have been handed over to the railways.

MAN-HAL INTEGRAL COACH

In the year 1956 it was decided to build all steel light weight integral type Class III coaches of welded construction complete with wheels and bogies. Unlike the coaches of previous models built on standard IRS Underframes supplied by the Railways, the underframe in the Integral Coach forms an integral part of the body which bears stresses proportionately and thus permits of light weight design—7 to 8 tons lighter than the coaches of previous models! These coaches provide greater amenities and are designed with the end structure to absorb the forces of collision in case of accidents. Provision has been made at the ends of the coaches to incorporate vestibuling, if desired, at a later date. H. A. L. have embarked on this project in collaboration with Messrs. MASCHINENFABRIK-

AUGSBURG-NURNBERG, a leading railcoach manufacturing firm in Germany. The project is being developed to produce 300 integral type Class III coaches a year in progressive stages using steel available in India. The first Integral Coach manufactured in collaboration with Messrs. MAN was turned out on 26-5-1958.

The body structure of the integral coach is comprised mainly of pressed sheet steel and the underframe portion mainly of rolled steel sections. The steel used is of indigenous manufacture weldable quality, copper bearing to resist corrosion. Further protection against corrosion is provided by special chemical treatment of the structural parts of the pressed sections where applicable and the use of suitable paints and Bituminous emulsion.

NEW TYPE BOGIE

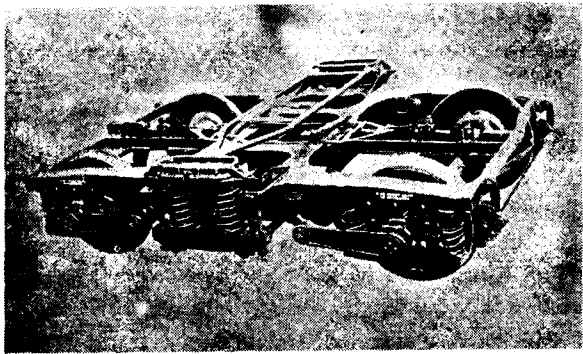
The design of the bogie is a special feature of the H. A. L. Integral coaches. It differs widely from the existing IRS type and other bogies in India. A new type bogie which has not been used in India before and which is, in fact, the most modern type even in the West, has been developed. These bogies are fitted with Hydraulic Shock Absorbers, Helical springs, Roller bearings, Metal bonded rubber fittings and many other innovations. Unlike the conventional axle box guides for longitudinal guidance of the axles, this bogie is fitted with axle holding arms, flexibly



HAL Integral Coach-Model 411 - exterior view.

connected to the axle boxes and to the bogie frame by means of non-wearing silentbloc bushes provided with an arrangement to align the axles easily to a high degree of accuracy. Lateral guidance of the axles is afforded by two rollers fitted to each side of the axle box to roll on rubber-bonded plates fitted to the frame. The inter-position of rubber serves to reduce lateral shocks, and thus improves the riding quality and minimises flange wear. At the same time, the use of

rubber reduces the strain on the guide rollers and their pins while ensuring a roughly uniform transmission of side shocks through the rollers and axle bearings. In



A new type of bogie (seen above) not used in India before is a special feature of the HAL Integral Coach.

order to reduce back lash to a minimum, the rubber-bonded plates against which the rollers bear are pre-loaded by compression. The only wearing parts in this arrangement, viz., the roller pins, are subjected to wear at one side only; they are easily replaceable. Each bearing transmits side forces in both directions through the rubber-bonded plates elastically to the bogie frame. Spring suspension of the body is by means of helical springs on the axle and bolster.

THE SWING BOLSTER

Two hydraulic shock absorbers are connected in parallel with the bolster spring suspension. The swing bolster is of light weight construction and consists of two pairs of spring planks with helical springs and dampers interposed. The entire weight of the body is transmitted to the bolster directly through the side bearers arranged in an oil bath on top of the upper spring planks. The bronze side bearers can be easily renewed. The swing links are hung from the bogie frame on knife edges with spherical washers to enable the buffer level to be adjusted. The swing links are suspended in a manner to permit them to swing freely in order to utilise the lateral deflection of the springs for reducing the natural frequency of the vibrating system. The swing of the bolster is limited by rubber stops. The central pivot does not take any vertical load serving only as the centre of rotation and providing guidance for the coach. It engages the low placed centre bearing with a spherical bush and transmits the longitudinal forces from the body directly to the bogie frame by means of

a system of links fitted in Silentbloc mountings so as to prevent the acceleration and breaking loads from affecting the bolster spring adjusted suspension. The side swing of the pivot is controlled by two leaf springs. This type of bogie gives much better riding qualities and consequently more comfortable travel than ever obtained before for this class of coaches.

INTERIOR FURNISHINGS

The INTERIOR of the coach is divided into two large and equal compartments with an inter-communicating door. Each compartment will comfortably seat 40 passengers making a total of 80 passengers per coach. 23" deep seats with conveniently inclined back rests, luggage bunks and parcel racks above are arranged in transverse direction with 21" leg-room



Interior view showing seats and berths in Integral Coach.

between seats. Single seats on one side of the passage by the windows have a luggage rack above. The ceiling is of non-inflammable 'Limpet' Asbestos sheet and the interior side panels are made of pleasing light coloured panel boards all produced indigenously.

The WINDOW SHUTTERS are of aluminium extrusion frame both for glass and louver windows. They are of light weight and move inside the aluminium runners fitted with velvet lined rubber channels, providing easy & smooth operation. Gravity catches are fitted into runners in three intermediate stages for the glass shutters and two

MAIN FEATURES—HAL INTEGRAL COACH

Structure	..	All Metal	Flooring	..	Oxy-chloride
Construction	..	Welded	Stainless steel wash basins in lavatories	..	4
Design Type	..	Skin	Stainless steel lavatory pans with wall protector & flush head	..	4
		Stressed			
		Integral Type			
Width of the body	..	10'—8" overall	Mirrors with shelves in lavatory	..	4
Length of the body	..	70'—0" overall	Tower rails in lavatory	..	4
Length over buffers	..	73'—1 $\frac{3}{8}$ "	Flushing cocks in lavatory	..	4
No. of compartments	..	2	I. R. S. Type Push Cocks in lavatory	..	4
No. of lavatories	..	4	Water tanks (68 glns. capacity each)	..	2
No. of doors	..	4	Water tank (139 glns. capacity)	..	1
		on each side			
Seating capacity	..	80	Colour scheme—exterior upto Cant rail	..	Gulf red ISC—473
Tare weight (water tanks empty)	..	35.5 tons approx.	Ends	..	Black
No. of fans	..	16	Roof	..	Aluminium
No. of lights in compartments	..	24	All letterings	..	Golden Yellow ISC 356
Total No. of lights in lavatory	..	4	Colour Scheme Interior	..	
Embarkation lights	..	4	Floor to waist rail	..	Light Brown ISC—410
Max. electrical load	..	46.5 amps.	Waist rail to cant rail except places where plastic panels have been used which have not been painted.		Light Buff ISC—358
Equipped with 100 amp. dynamo, 300 amp. hr. lead acid batteries and necessary switch-gear as per I. R. S. 5 wire double-battery, block train lighting system.					
Inside panelling : Aluminium, 'Hylam'			Ceiling : Compartment & Lavatory	..	White
Ceiling : 'Limpet' asbestos.			Lavatory inside	..	Eau-de-nil, colour shade No. 216 of Specn. IS—5.
Insulation : $\frac{1}{2}$ " thick asbestos spray under roof.					

intermediate stages for the louver shutters as a positive safety measure against injury due to the falling of shutters. Incidentally, they provide a break in the fall which avoids damage to the shutters themselves. The exhaust type of roof ventilators has been provided generously in the compartments and the lavatories. The interior of the roof is sprayed with $\frac{1}{2}$ " thickness Limpet Asbestos for heat insulation in addition to the air space between the outer skin and the inside panelling.

THE FLOORING of the Compartments is finished with Oxy-chloride flooring composition of Red Colour.

LAVATORY EQUIPMENT

Two spacious lavatories fitted with necessary amenities are provided per compartment. The fittings



Interior view of Lavatory Compartment in Integral Coach.

and furnishings in these lavatories are of high standard sanitation. Stainless steel lavatory pans with

flushing arrangements, polished stainless steel wash basins with push cocks, mirrors with shelves, lotah shelves and towel rails form the lavatory equipment. The flooring of the lavatory is of polished mosaic and the walls are fitted with painted Aluminium panels.

LIGHTS AND FANS.

Two 16" sweep fixed ceiling type fans with close mesh guards and individual switches have been



Interior view of Integral Coach showing lights and fans.

provided in each bay of 10 seats, a total of 16 fans per coach. Each compartment has 10 main ceiling lights. Embarkation lights have been provided on the outside of the coach. They light up when the coach is stationary or when it runs at low speed as when nearing a station. This arrangement facilitates embarkation and disembarkation of passengers during nights.

The COLOUR SCHEME for the interior and exterior has been designed to give a pleasing appearance and to give better effect to the internal lighting.

RUBBER AND CANVAS CONVEYOR AND ELEVATOR BELTING

The Indian Standards Institution has prepared a draft specification for Rubber and Canvas Conveyor and Elevator Belting [Doc: EDC 42 (553)]

This standard covers the requirements for the rubber cover, fabric, and tests for rubber and canvas belting for conveyors and elevators. The draft standard will be circulated shortly to interested producers, consumers and technologists for eliciting technical comments. The comments received will be taken into consideration before the draft standard is finalized.

Rumania—A Traditional Producer of Rolling Stock

By T. Niculescu

Counsellor at the "Industrialexport" Company

RUMANIA boasts a long standing tradition in the construction of rolling stock; in 1890 the first big railway car works was set up. In the interval, a number of factories have been fitted out to this end, Rumania thus becoming one of Europe's main producer of rolling stock.

Nowadays Rumania is currently turning out for export numerous types of rolling stock, including: 28 ton covered freight cars on two axles; 29 ton open freight cars on two axles; 50 ton open and covered freight cars on four axles; 50 ton self-discharging metal cars on four axles; 40 m³ (80 ton) dumping cars on four axles; 45-50 m³ tank cars on four

axles with or without frame; second-class passenger cars with 72 seats; Diesel electric and Diesel-hydraulic railcar trains and railcars; industrial and standard steam locomotives; Diesel mine locomotives; electric mine locomotives with accumulators, mine tubes, etc.

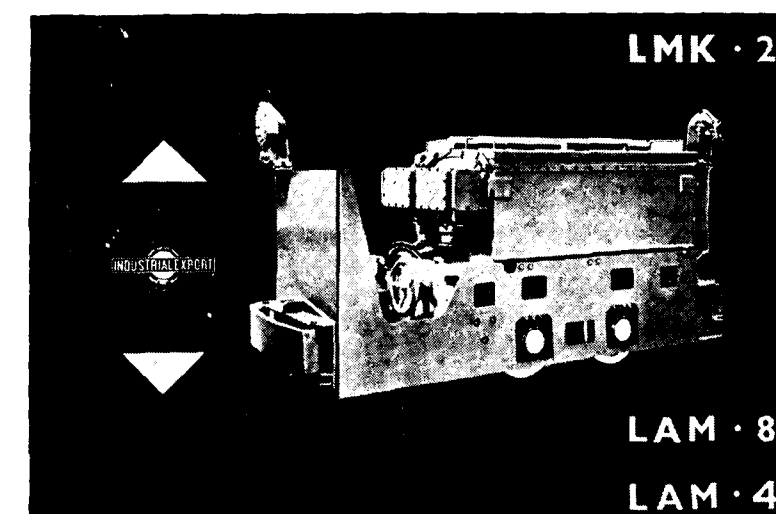
The covered and open freight cars on two and four axles are of modern design. The general trend—and measure are constantly being taken to turn that trend into reality—is to reduce tare weight while increasing the real load, and to generalize large scale manufacture of railway cars in keeping with UIC-ORE prescriptions and standards.

INDUSTRIALEXPORT

2, Gabriel Peri Street

BUCHAREST-RUMANIA

Cables: INEXPORT-Bucharest



EXPORTS

Mine Diesel Locomotives, Type LMK-2

for 600-630 mm gauge, with 4-stroke Diesel engine of 45 HP at 1500 r. p. m., developing a maximum traction power of 1400 kg.

Electric Mine Locomotives with Accumulators

- Flame proof execution—600-630 mm gauge —
- type LAM-8, with 2 motors of 8.5 kW each and a

battery of accumulators of 296 Ah, 110 V, developing an hourly traction power of 1080 kg.

- type LAM-4, with 2 motors of 4.5 kW each and a battery of accumulators of 296 Ah, 72 V, developing an hourly traction power of 470 kg.

All the above locomotives are guided in curves of 5 m radius.

The self-discharging car, made from riveted steel and sheet iron, is of high standard all-metal design.

The dumping car is a high capacity car designed for industrial purposes, viz. the transport of ores and coal. Great stability as well as the devices ensuring compressed air, dumping, locking electric signalling etc. have caused the car to be much appreciated by foreign clients.

The tank cars provided with pressed sheet steel bogies and roller bearings are of a modern design.

On request, they may be fitted with interior heating coils. At present measures are being adopted for the manufacture of tank cars with special lining for the transport of bitumen and of tank cars of increased capacity.

Rumanian Diesel-electric and Diesel-hydraulic railcars embody all the improvements made so far in this field. The railcars, with completely automatic controls, are provided with every modern convenience. At present measures are being adopted with a view to reducing the tare weight of railcars.

The steam locomotives made in Rumania are highly efficient Type IEO steam locomotives for goods traffic boast high power traction ensuring safe trailing of trains up to 1000 tons. The locomotives for industrial purposes, both the standard gauge C 2 type

and the narrow gauge, D 2 type, are built to ensure light handling and negotiate small-radius curves.

Mine locomotives—Diesel mine locomotives and mine locomotives with accumulators—built to run along the small curve railway lines of mine galleries—show good traction efficiency. In addition Rumanian industry produces a comprehensive range of mine tubs—both fixed and dumping tubs—of various capacities.

Every attention is being given to the clients' requirements so that the rolling stock produced might meet the special technical and climatic conditions of certain countries.

The quality of Rumanian-made rolling stock is commended by foreign clients. So far Rumanian railway cars and locomotives have gone to a number of countries in Europe, Asia and Africa including Bulgaria, Czechoslovakia, the German D. R., Poland, Albania, the Soviet Union, Greece, Turkey, India, the Chinese P. R. the Democratic Republic of Viet-Nam, the Korean P. R. R., the United Arab Republic.

Satisfactory filling of the clients' orders, constantly improved quality and prompt deliveries bringing in ever larger indents, as well as the steadily increasing capacities of the producing works, account for the year by year rise in Rumanian rolling stock exports.

METALLIC MANGANESE, CALCIUM--SILICON AND SILICO-CHROMIUM

The Indian Standards Institution has prepared three draft Specifications for Metallic Manganese, Calcium-Silicon and Silico-Chromium [Doc: SMDC 8(226, 228 & 230) respectively].

Metallic manganese is commonly used in the ferrous and non-ferrous metals industries, both as a deoxidizer and as an additional agent to get improved physical properties. It finds special use for the production of alloy steels, cast iron, aluminium alloys, constantan, manganese bronze, monel metal, etc. The Indian Standard Specification for Metallic Manganese covers four grades of the material, which are commonly used in the non-ferrous metals industry.

Calcium-silicon is used in the iron and steel industry and is also commonly known as calcium silicide. It is used as a deoxidizer, desulphurizer and degasser in the production of steel. It is used in the ladle for the production of high quality and high tensile grey irons to control the inclusions. Calcium-silicon also

improves fluidity and reduces tendency to hot tearing in both carbon and alloy steel castings. Two grades of calcium-silicon commonly used in the iron and steel industry have been covered in the draft specification for this material.

The specification for silico-chromium covers requirements for two grades of silico chromium commonly used in the iron and steel industry. Low carbon silico-chromium is used in the production of chromium bearing alloy steels. Medium carbon silico-chromium is used in low alloy high tensile steels requiring simultaneous addition of silicon and chromium.

These draft standards (which are in English) shall be circulated shortly to interested producers, consumers, and technologists for eliciting technical comments and will be open for comments for a period of 3 months from the date of circulation. The comments will be taken into consideration before the draft standards are finalized.

HEAVY MACHINERIES, AND RAILWAY WORKSHOP MACHINE TOOLS SUPPLEMENT Hindustan Machine Tools Base for Country's Industrial Progress

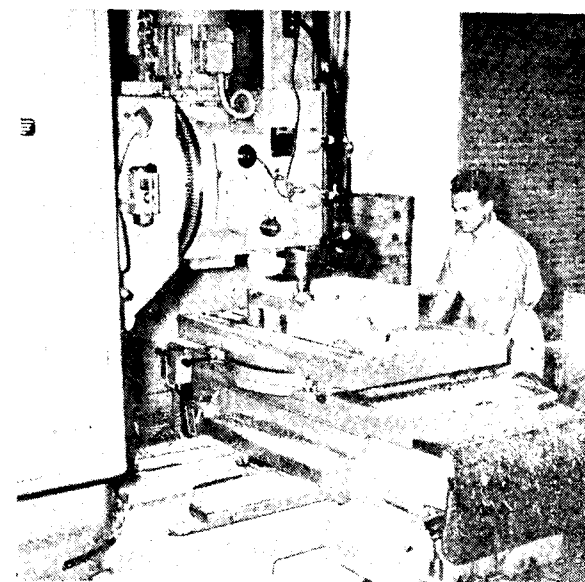
By An Engineering Correspondent

THE wide range of machines currently manufactured in the Hindustan Machine Tools represents the rapid progress India is making in the production of Machine Tools. The machine tools turned out in this factory include:

- 14 types of high precision lathes ranging in centre heights 225 mm to 260 mm and centre distance from 1000 to 5000 mm.
- 6 types of Milling Machines—Horizontal, Vertical and Universal—in two sizes
- 10 types of Radial Drills ranging in arm lengths of 1050 mm to 2200 mm in capacities of 50 mm and 60 mm in cast iron
- 44 types of lathes of Batignolles type ranging from 170 mm to 275 mm.
- 16 types of Cylindrical Grinders.

being increasingly manufactured in the country. The country is today producing its own Bicycles, Automobiles, Electric Motors, etc. Obviously, its requirements in terms of machine tools have been on the increase as can be seen from the following statistics:

Calendar Year.	Annual Production (in lakhs)	Production at H.M.T. (in lakhs)	Annual Imports (in lakhs)	Total requirement (in lakhs)
	Rs.	Rs.	Rs.	Rs.
1950	26.60	—	249.00	275.60
1951	47.31	—	250.00	297.31
1952	44.37	—	221.00	265.37
1953	44.07	—	312.00	356.07
1954	50.02	—	385.00	435.02
1955	74.40	—	528.00	602.40
1956	120.22	28.08	837.00	957.22
1957	250.84	124.08	1,464.00	1,714.84
1958	376.00	182.11	1,531.00	1,907.00
1959	435.37	210.82	2,000.00	2,435.37



With the advent of planning after Independence, India has been rapidly industrialising itself and engineering and Industrial goods until recently imported are now

This statistics only indicates that the Machine Tool Industry is perhaps the most vital link in the industrial growth of any country since it is this industry which in a sense provides the key to industrial growth by enabling it to produce all the plant and machinery needed for its factories.

The post independence Government, therefore, had to give immediate thought firstly to laying down this industry on sound lines and second to its sustained development.

HINDUSTAN MACHINE TOOLS

The Government of India therefore, entered into a contract with Messrs. Oerlikon Machine Tool Works, Buehrle & Co., of Switzerland, to set up a medium/heavy machine tool manufacturing unit in this country for the production of high speed precision machine tools. This agreement was entered into in 1949 and 'HINDUSTAN MACHINE TOOLS' Factory in Jalahalli came into being in the Public Sector in 1953. This was one of the first technical arrangement for establishing a new industry by the Government of India, who were entering for the first time into a major industrial activity of this magnitude—both its forerunners, Sindri and Chittaranjan, having been commenced or planned by the pre-Independence Government.

The establishment of Hindustan Machine Tools gave rise to some sort of misunderstanding between the private and public sectors. This resulted in considerable difference of opinion and overlapping of productive efforts. This anomaly was, however, rectified with the appointment by the Government in early 1956 a Machine Tool Committee representing both private sector industries as also the consumer interests. With the implementation of the recommendations made by this Committee an integrated plan of development of the industry was formulated. It can be safely assumed now that this industry is growing progressively with the concerted efforts on the part of both the public and private sectors.

The subscribed capital of the Company today is Rs. 5.31 crores. The net outstanding loans from the Government of India as on March 31, 1960 was Rs. 1,64,65,985—00. The Cash Credit Arrangement with the United Commercial Bank remained at Rs. 1.25 crores out of which the net amount of overdraft as on March 31, 1960 was nil.

The increase in production at this factory is a sufficient testimony to the progress made by this unit. From a small beginning of 131 machines in 1956—57, the factory has now reached the 702 mark during the period 1959—60, that too against its production of just 2 types of lathes, the factory today is in a position to give to the country 90 different types and sizes of machine tools which would otherwise have been imported. The rapid diversification in its production enabled the factory to secure good support from the consumers as can be seen from the fact that the factory had on its books 1,222 orders against its production of 702 machines for the year 1959—60.

The factory has been able to reduce its cost of production and this advantage has been directly passed on to the consumers, by a considerable cut in the prices of its products. The price of HINDUSTAN H-22 High Speed lathe which stood at Rs. 36,000 in 1956—57 now stands at Rs. 29,500. The landed cost of an imported machine of equivalent quality is Rs. 46,763.00. The prices of other machines have also been progressively reduced and compare favourably with prices of imported machines of corresponding quality.

EXPANSION PROGRAMME

The most creditable feature of this Project is that it has very ambitious expansion programme whereby its target capacity of 1000 machines will be doubled to 2,000 machines per annum. It is all the more creditable because its expansion programme is being implemented without any financial assistance from the Government of India. The project has been able to build adequate financial resources during the short period of its 4 year operation and these resources are being invested to implement its expansion programme. It is commendable to note that the project has been able to build these resources in spite of the fact that it has been able to write off from its profits a very heavy initial Development and Commissioning Expenditure of nearly Rs. 1 crore.

The total estimated expenditure involved in doubling this project will be Rs. 280.87 lakhs of which Rs. 114.35 lakhs will be foreign exchange expenditure.

With the planning of the expansion programme, this unit will be able to give to the country machine tools worth Rs. 7 crores or more per year and that too with its share capital remaining at the present level, viz., Rs. 5.31 crores. The doubling of this plant in effect means the building up of a second factory equal in capacity to the original factory without any foreign collaboration or assistance.

The net profits which exceeded Rs. 42 lakhs have been higher compared to the profits in the year 1956—57. It may be said that the same has increased by over 600%.

WATCH FACTORY

The other expansion programme of the factory relates to the establishment of a Watch Factory as an adjunct to itself. The Government of India have already entered into a technical collaboration

agreement with Messrs. Citizen Watch Co., of Japan and it is expected that in the near future, this watch manufacturing unit will turn out half a million watches for the Indian market.

The main consideration for locating this factory as an adjunct to the HMT is the 'high standard of precision' attained by its workers.

INDUSTRIAL ESTATE

Establishment of Industrial Estate has also been taken up and it is planned to set up 50 ancillary feeder industries in this Estate at an estimated cost of Rs. 16.24 lakhs. A beginning has already been made.

NEW WORLD BANK LOAN FOR INDIAN RAILWAYS \$ 70 MILLION FOR FINAL YEAR OF SECOND PLAN — PARTICIPATION OF SIX U. S. BANKS IN THE LOAN

The World Bank made an allocation equivalent to \$ 70 million to India for the improvement and expansion of the Indian Railways. The loan will cover the greater part of the foreign exchange required for the final year of the railway programme under Indian's Second Five Year Plan, ending March 31, 1961. The railway programme has been a central part of the Plan accounting for about one quarter of all public expenditure under the Plan.

The Bank's loan is for a term of 20 years and bears interest at 5½ per cent per annum including the 1 per cent commission which is allowed to the Bank's Special Reserve. Six private commercial banks are participating in the loan without the world Bank's guarantee to the extent of \$2.5 million representing the first maturity and part of the second which falls due between January 1964 and July 1964.

After having been approved by the Bank's Executive Directors, the loan documents were signed by Shri M. C. Chagla, Indian Ambassador in Washington, on behalf of India.

The Bank has now lent \$328 million for the Indian Railways, the largest amounts ever lent by it for a single project. A loan of \$33 million was made in 1949 for Railway rehabilitation and, since then, seven loans totalling \$295 million have been made to assist the financing of the Indian Railways programme expansion in the Second Five Year Plan.

Total investment in the railway programme in the first four years of the Second Five Year Plan is estimated at Rs. 8.7 billion (\$1827 million) and Rs. 2.3 billion (\$483 million) is expected to be expended during the current year of the Plan. Of the total

Three units have commenced production while by the end of the current financial year 15 units will have been set up.

Viewed from the production point of view, it can be said that HMT is the nucleus of the Indian Machine Tool industry. It has been for the past four years consistently accounting for over 50% of the entire production of Machine Tools in this country. Besides as admitted by experts, this unit which has brought the technical know-how for the manufacture of high precision machines has changed the entire conception of the Indian industry, viz., shifting of the emphasis to standardisation. That in itself is a great contribution.

amount, foreign exchange requirements are now estimated at \$718 million of which 40 per cent will have been supplied by the Bank and another 20 per cent from other external sources. The original foreign exchange estimate was \$893 million. This has been progressively reduced to the present figure of \$718 million because of the increased availability of railway equipment manufactured in India.

The Indian Railways estimate that \$85 million in foreign exchange will be required for purchases in the last year of the programme. The World Bank loan will provide \$70 million of this amount and will be used for the purchase abroad of rolling stock, track material and other equipment.

It may be recalled the representatives of the Governments of Canada, Germany, Japan, the U. K. and the U. S. A. first met at the invitation of the Bank in August 1958 to seek ways of helping India to keep the foreign exchange requirement of the remaining years of the Second Five Year Plan. At that time, the Bank indicated its intention of extending loans to India of the amount of \$225 million for the 2½ years remaining of the Plan. Total Bank lending for that purpose now amounts to \$255 million of which \$255 million is expected to be disbursed when the Plan period ends on March 31, 1961.

The Bank has now made 24 loans totalling \$662 million to India. In addition to the railways, the loans have been made for the expansion of iron and steel production and of electric power facilities for the purchase of commercial craft, for development of agriculture and ports and for a development bank to lend to private industry.

VERTICAL TURNING LATHES

THE general trend in the machine-tool building industry involves a continuous modernisation of design by adapting it to the latest technical developments as concerning turning. Such adaptations are much concerned with lengthening the life of a machine-tool and simplifying its operation and maintenance.

In the production of machine-tools, Poland has long traditions, reaching back into the period before the First World War. Polish machine-tools enjoy a high reputation on markets abroad.

To ensure optimal operational efficiency in the new vertical turning lathes, the latest technical developments in machine-tool building have been introduced into them. Among Polish universal vertical turning lathes special attention is directed to the following types:

Two-Column Vertical Turning Lathes, Type KCF 200 of bench diameter—200 mm., and type *KCF 320* of bench diameter—3200 m. m. The design of these vertical turning lathes, involves, among other innovations, the use of the bearing of the bench on flat guides, with linings made of plastics and the spindles on precise two-row roller bearings. This kind of bearing of the bench minimises the possibility of guides becoming jammed even when a vertical turning lathe is operated under its worst conditions.

By comparison with the vertical turning lathes previously produced—Type KCE 200 and type 2 KCE—the power of the main drive and the speed of the plate has been increased and control simplified.

Type KBA 700 single column vertical turning lathe is also a universal, used for turning pieces up to 700 m. m. diameter and weighing up to 50 tons. Type KBA 700 vertical turning lathe has the following operational advantages:

- (a) a wide range of variable speeds of the bench and feeds which give economical turning conditions, using the full power of this lathe and revealing the properties of sintered tools and tools made of high-speed steel;
- (b) robust and rigid construction giving high

output, precision and smoothness of turning;

- (c) the possibility of working simultaneously with several lathe saddles by means of centralised control from a control desk;
- (d) high resistance to wear of important parts and units of the lathe due to, for example, the use of rolling bearings for the bench spindle, linings made of plastics on guides of the bench, hydraulic relieving of saddle slides and a special guard to protect guides against chips;
- (e) the possibility of cutting inch and metric threads and cones by the use of special device;
- (f) mechanical clamping of bars, saddles and slides, a feature which cuts down time absorbed in auxiliary processes and the effort required of the worker;
- (g) a further device giving precise remote adjustment of the turning tool to the desired dimensions;
- (h) hydraulic relieving of guides which facilitates servicing and ensures appropriate relieving.

RAILWAY VERTICAL TURNING LATHES

The introduction of new design details into vertical turning lathes used for turning a full range of bandless railway wheels (solid), wheel blanks and bands, calls for a more detailed description of construction.

A. TYPE KLA SEMI-AUTOMATIC VERTICAL TURNING LATHES FOR TURNING WHEEL BANDS

Produced in three types differing only as to size: type KLA 112, type KLA 170 and type KLA 210.

The numbers in the denominations of vertical turning lathes indicate the maximum turning diameter in centimetres.



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Type KLA vertical turning lathes are used for turning holes, grooves for clamping rings, and stop flanges in railway wheel bands of various shapes of internal profile. The design of this vertical turning lathe allows a completely automatic working cycle of the lathe independently of the type and dimensions of the bands to be turned. Type KLA vertical turning lathes have two saddles which move horizontally along stationary saddle bar integrated with the body of the column. A special slide of very robust construction moves vertically in each saddle. The right hand saddle is used for rough turning of a two-step hole in a bank by means of two lathe tools: for finishing turning a hole of larger diameter one lathe tool is used. The left hand saddle is used for cutting in a groove for a clamping ring by means of a pair of lathe tools; for simultaneous turning stop flange by means of one lathe tool and a chamfer along the periphery of a hole using an additional lathe tool. When turning bands of diameters smaller than 750 mm., the right hand saddle is used first and then the left hand one. For turning bands of diameters larger than 750 mm. the two saddles are used simultaneously: successive use of both saddles in an automatic cycle is also provided for.

With type KLA 112 vertical turning lathe a spring-operated chuck may be used for mounting bands; loosening can be by mechanical, pneumatic or hydraulic means according to buyer's specification. Type KLA 170 and KLA 210 vertical turning lathes are provided with spring-operated chucks, loosened by mechanical means. The bench plate has flat guides lined with Tekstolit (phenolic-fabric laminate) which lengthen effective life without any possibility of jamming even in the event of brief interruptions in lubrication. The bench plate is fastened to a spindle flange mounted on adjustable two-row roller bearings which ensure sufficient stiffness in the mounting and give prolonged operation. A tapering hole in the middle of the plate is for removing chips in the direction of the centre of the bench. Chips fall through this, tapering hole into a trolley, located under the bed of the lathe, thereby considerably facilitating removal and transport and also giving increased security to the operator.

The main drive in all railway vertical turning lathes functions in the same way. The drive generated by an electrical motor, located at the back of the lathe, is transmitted to the plate by means of belts, gear box, conical circle-arc tooth gear transmission and spur bevel gear transmission. This transmission causes the plate to revolve uniformly without vibration. Gear boxes—

identical for all railway vertical turning lathes—give 12 speeds for rough machining and 12 speeds for finishing. The increase in plate revolutions for finishing machining = 3.15, at speed progression ratio = 1.26, gives 17 rotational speeds. The variation of rotational speeds, when shifting from rough to finishing machining is effected by multi-plate electromagnetic clutches giving automatic change. Hardened and ground gears of the gear box are made of alloyed steel, and all rollers are mounted on rolling bearings. Gear is manual by way of a cam mechanism. Plate revolutions are set by turning a hand wheel located on the front wall of the bed. An electromagnetic brake is set in the gear box for braking the plate.

The automatic working cycle of type KLA vertical turning lathes is started by means of a push-button. The precision of the shifting of saddles in automatic cycle is achieved by the introduction of electromagnetic clutches for vertical shifting of slides and for hydraulic shifting of the saddle in the horizontal directions. When slides shifted vertically, an automatic decrease in shifting speed follows at a distance of some millimetres from the working position, a feature which increases the precision of cycle according to the stop dogs is simple and demands no highly skilled service.

Lubrication of the main drive of type KLA vertical turning lathes is centralised and effected by means of an oil pump driven by a separate motor. Lubrication of saddle mechanisms is effected by separate oil pumps.

A cooling system together with an electro-pump for the coolant can be embodied if specially requested by buyers who machine with high-speed steel tools.

B. TYPE KLB 120 AND 160 SEMI-AUTOMATIC VERTICAL TURNING LATHES

Type KLB vertical lathes are used for training bandless railway wheels and wheel blanks. The numbers in the denominations of type KLB indicate in centimetres the maximum turning diameter of bandless wheel banks or maximum turning diameter of wheel blanks. Type KLB vertical turning lathes have been specially designed to minimise labour involved in machining and machine stock in works producing railway unit as well as in large works building rolling stock.

The possibility of complete machine of handless wheels may make superfluous the application of special

lathes for machining railway units. The advantage of machining railway wheels on type KLB vertical turning lathes lies in the fact that a high degree of wheel balancing is possible, a feature important for the sets of modern high-speed coaches, electrocars and motor unit.

The complete machining of wheels by copying ensures a high degree of wheel balancing. This vertical turning lathe has a four saddle system. The turning saddle is used for rough and finishing machining the hole in bandless wheels or wheel blanks. The vertical saddle is used for copying the side surfaces of wheels, wheel bosses, and, if necessary, wheel discs. Side saddles are used for rough and finishing machining of profiles of bandless or banded wheels, as also the external diameter of wheel blanks. The bench plate is made as an entity with a special hydraulic self-centering chuck is provided with three jaws for mounting when rough machining and three jaws for finishing machining; accurate control of jaw adjustment is a feature. The spindle is mounted on two-row roller bearings of large diameter and radial play can be controlled. At the bottom, plate rests on a longitudinal ball bearing.

The Plate drive is analogous to that described above for type KLA vertical turning lathes.

The copying device used in vertical and side saddles consists of multi-plate electromagnetic clutches with very short shifting times, electromagnetic brakes, indicating head with three pairs of switches and special quick-acting electrical relays. The use of the indicating head with three pairs of switches makes the

copying process sufficiently accurate and enables high feed speeds to be used.

The lathe saddle is driven by separate electric motor by way of a six-stage gear box. The drive of feeds from the spindle is also transmitted by a six-stage feed box. A separate electric motor is used for quick shifting the slide. The quick shifting of the saddle in horizontal direction is by means of an hydraulic mechanism. The precision of working position is ensured by a stationary stop dog and a decrease in shifting speed near the stop dog. The saddle carriage is automatically blamped at the working position by hydraulic clamps.

Vertical and side saddles are driven by the main drive through intermediate gear boxes and feed boxes with electromagnetic clutches for copying. Quick shifting of saddles is effected by separate electric motors connected with the feed boxes by electromagnetic clutches.

The hydraulic system is fed by a double oil pump of high and low pressure driven by a separate electric motor, and is used for driving the hydraulic cylinder for mounting the wheel, shifting the saddle, lifting the guard of the bench and for lubricating the main drive mechanisms.

The bench guard, together with an hydraulic lifting mechanism is lifted automatically after a wheel been mounted in the chuck and is lowered after the chuck has been loosened. The lifting of the guard may be disconnected when the lathe is being set up.

HINDUMALKOTE-GANGANAGAR LINE ON NORTHERN RAILWAY

The Deputy Minister of Railways, Shri S. V. Ramaswami told the Lok Sabha during question hour that the final location survey of the proper railway line between Hindumalkote and Sri Ganganagar had recently been completed and the project report and estimate were being prepared by the Northern Railway Administration.

The Deputy Minister said that until the report and estimate were received and examined by the Railway Board, it would not be possible to indicate as to when the work would be commenced. He added that the work was expected to be completed in about 1½ years after it was commenced. Replying to another part of the question, Shri Ramaswamy said that about 210 acres of cultivable land would be covered by this

railway line and the compensation for the land would be paid in cash to the cultivators. The Deputy Minister said this in a written reply to the question by Shri P. L. Barupal and two other members.

* * * * *

REMODELLING OF DELHI RAILWAY YARD

The Deputy Minister of Railway, Shri S. V. Ramaswamy informed Shri D. C. Sharma and Shri Pangarkar during question hour in the Lok Sabha that the work of remodelling of the Delhi railway yard was nearing completion.

He added that the expenditure incurred so far in respect of the metre gauge remodelling was Rs. 17.27 lakhs and for broad gauge remodelling, Rs. 37.75 lakhs.

WELDING SUPPLEMENT

Newly-developed Equipment for the Gas-welding Technique

By Prof. Dr.-Ing. Erich Zorn
FRANKFURT/MAIN

THE term "gas-welding technique" not only refers to welding but to related procedures as well, as e. g. to brazing, gas cutting, powder gas-cutting, oxygen descaling, flame scarfing, and marginal fields like rust-removal, straightening, heating etc. All these processes are characterized by the application of flames of high temperatures and intense generation of heat. A typical representative of this flame group is the oxy-acetylene flame which has the advantage of universal applicability, besides its high thermal qualities. Depending on the field of application, other fuel gases are used, too; even fuel gas/air flames belong in special fields to the general term "gas welding technique".

Oxy-acetylene or torch welding, formerly one of the main application fields of the oxy-acetylene flame, did not have the same success—especially in the industrial sector—as those other welding processes which make use of the electric arc as their source of heat. Gas cutting in its various forms, however, has remained as one of the most important fields of application. Possibilities for extended use of the gas-welding technique are given in some marginal fields in those cases where the use of the high-grade flames is satisfactory from an engineering as well as economic viewpoint.

WELDING AND CUTTING APPARATUS

Until some years ago, the suction or injector blowpipe was predominant; in recent times, the injectorless blowpipe, which has to be operated with fuel gas of higher pressure, is used more and more. By using blowpipes of this design, welders and gas cutters have more freedom in adjusting the flame cone. In welding, it is possible in this way to adapt the flame more easily to the various plate thicknesses and materials; in gas cutting, the flame can easily be adapted to the intended purpose, depending on whether the material supplied is clean or rusty and whether exact structural cuts or quick parting cuts are required.

The so-called combined cutting and welding blowpipes generally consist of a handle with separate blowpipe heads for welding and cutting. Combined blowpipes differ from the conventional design in that it is necessary to change only the nozzles instead of the whole heads when changing from welding to cutting or vice versa. The welding nozzles have only one central opening for the flame, while the cutting nozzles have a central opening for the cutting oxygen and annular borings for the heating flames. The welding range of this blowpipe is from 0.5 to 4 mm. (special design 9 mm.), the cutting range from 3 to 10 mm. (special design from 0.5 to 50 mm.). On account of their low gas consumption, the pressure reducing valves are of an especially light construction.

Fig. 1 shows a cutting blowpipe which also makes use of the principle of the pressure-mixture. The six heating and cutting nozzles for this blowpipe with a range from 3 to 300 mm. are one-piece block nozzles in hammered construction; by hammering, especially smooth orifices are obtained. The cutting-oxygen valve is operated by means of a lever which can be operated rapidly or slowly as desired. The lever is equipped with a slide for locking the valve in the "open" condition without pressing the lever.

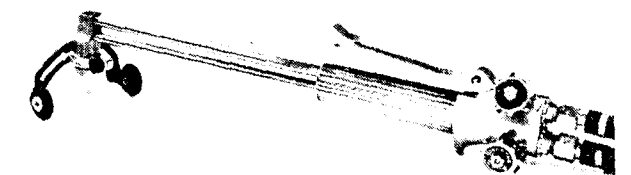
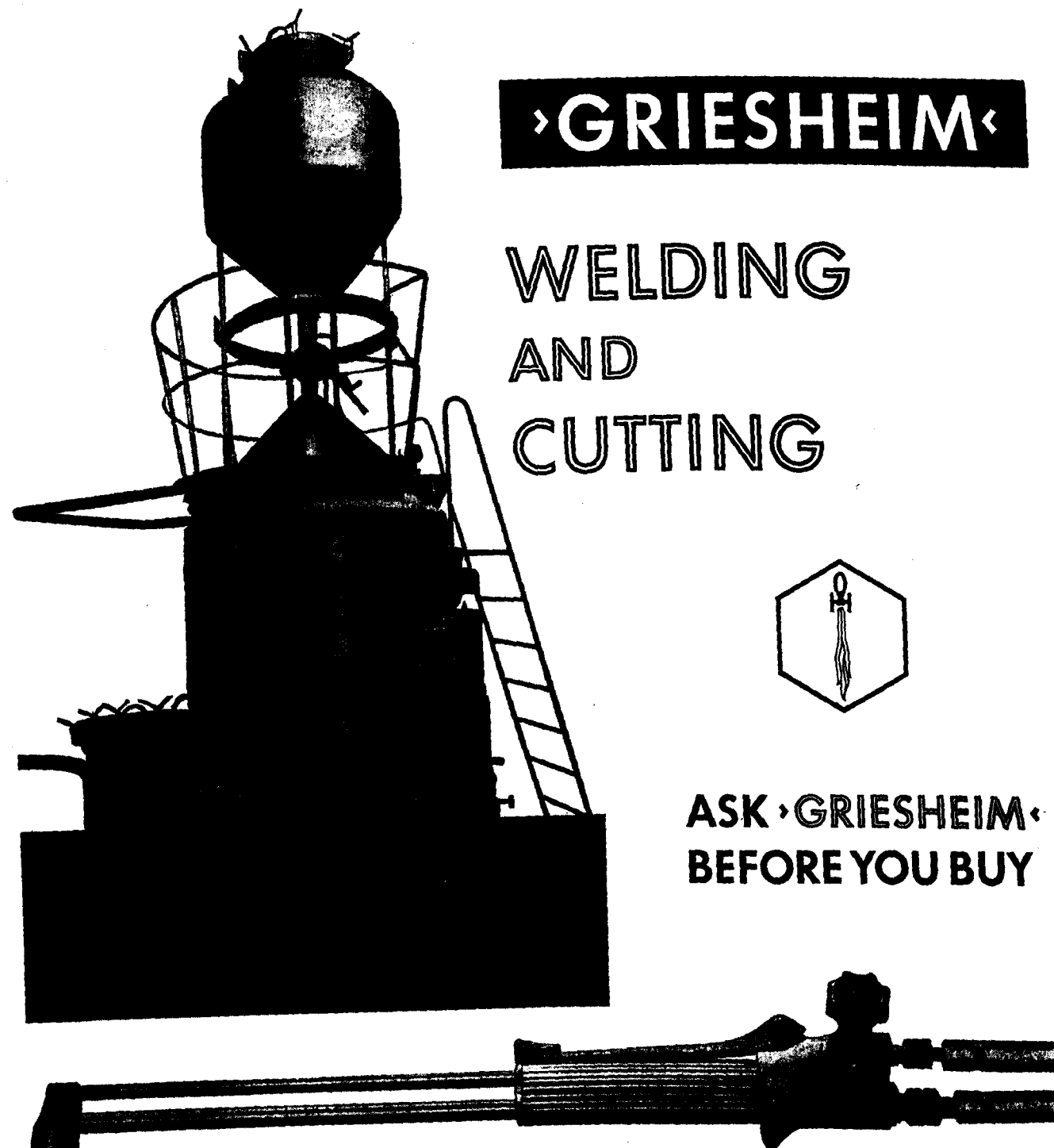
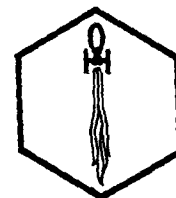


Fig. 1



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The cutting blowpipe can also be used in connection with a blowpipe carriage. This carriage is particularly recommended when using the quick and economic method of longhole cutting for cutting in massive plate. In designing these blowpipes, great importance has been attached to giving them a pleasant appearance.

Gas cutting in iron and steel works is in part widely different from cutting processes in the steel working industry. Special jobs in iron and steel works include the cutting of thick workpieces, cutting at high temperatures, cutting in semi-continuous and continuous casting, and cutting with flying start. For the cutting of high temperature work-pieces water-cooled cutting blowpipes and on certain occasions even water-cooled nozzles are necessary. The thin tube at the side of the blowpipe serves as feed pipe for iron powder, be it for powder gas-cutting of high-alloy stainless steel or cast iron, be it for gas-cutting of plain carbon steel with powder start.

Fig. 2 illustrates the top of a cutter developed for the cutting of slabs or billets in steel works. The machine is controlled from a control desk to which two or more machines can be connected in order to make several cuts at the same time. It is possible to arrange two machines in opposite direction in order to cut e. g. a slab simultaneously from both sides. The cutting blowpipe is protected by water-cooled pads against contacting the workpiece. The blowpipe is lifted during the return stroke, its movement being automatically limited by stops.

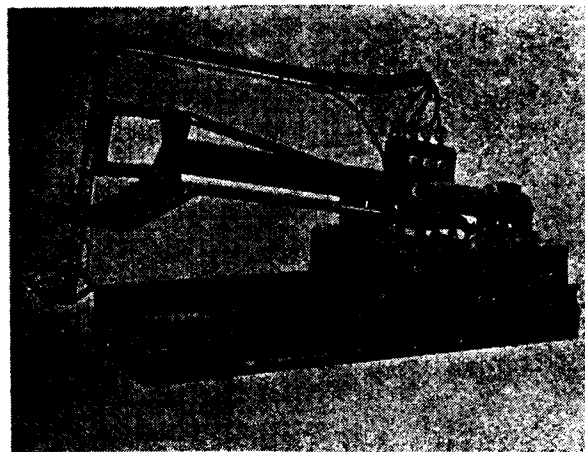


Fig. 2

PRESSURE REDUCERS

Furthermore, the iron and steel industry made additional demands on the pressure reducers or

regulators. The addition of oxygen in melting processes of various kinds and the oxygen feeding of flame-scarfing machines with high instantaneous consumption have caused the development of large-size pressure reducers for oxygen which can be used for other gases as well. Depending on the primary pressure, single or multi-stage valve designs are used. These large-size pressure reducers are equipped in most cases with pneumatic control and hydraulic damping in order to obtain a uniform working pressure. Fig. 3 shows a single-stage pressure reducer for 4,000 standard cubic meters oxygen per hour at a primary pressure of 200 kg./sq. cm. gauge and a secondary pressure of 30 kg./sq. cm. gauge.

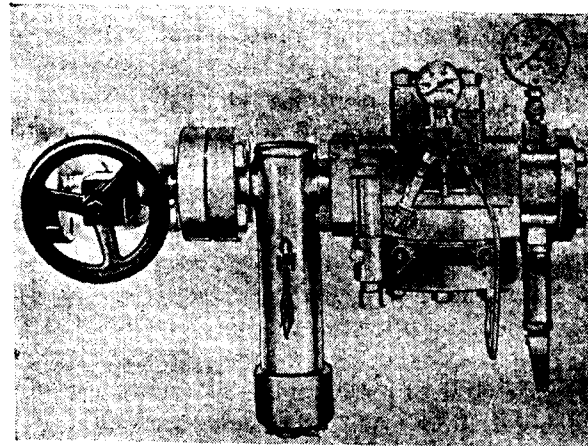


Fig. 3

Interposed between pressure reducer and shut-off valve a filter unit is to be seen, which is indispensable with pressure reducing valves of this type to check the fouling of the valve seat from the inlet side. The outlet side of the pressure reducer is equipped with a safety valve. Pneumatically controlled pressure reducers are also offered for smaller gas volumes.

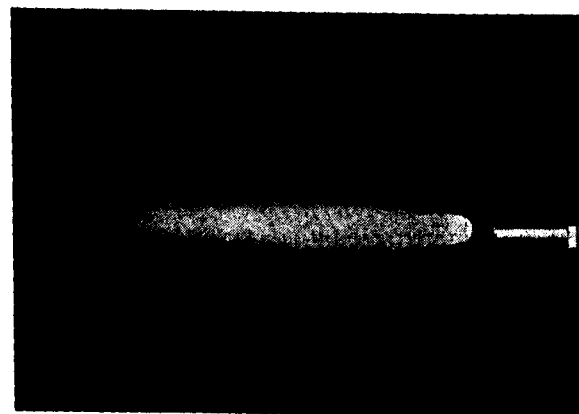


Fig. 4

SPECIAL-TYPE BLOWPIPES

Removal of rolling-mill scale and rust from plates and sections by means of wide-flame rust-removing torches has been thoroughly examined in recent years by metallographers. Neither a deformation of the surface nor a thermal degradation of the material could be detected.

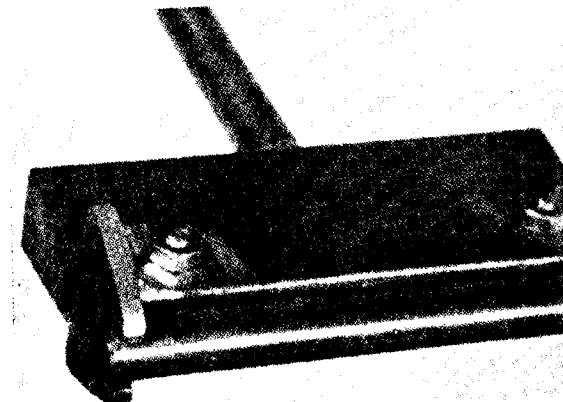


Fig. 5

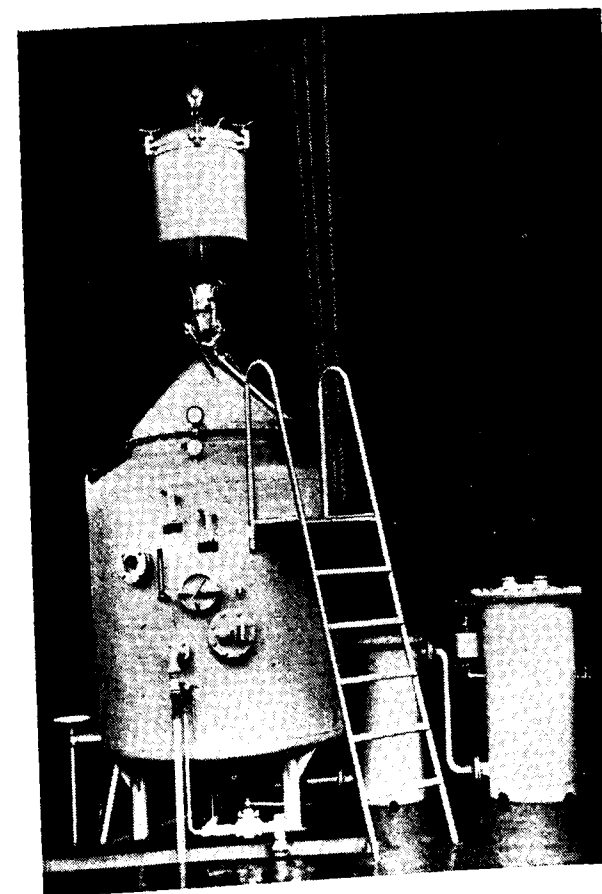


Fig. 6

A wide-flame torch with guide pads at both sides of the head is illustrated in Fig. 4. The users prefer torch-head widths of 50, 100, and 150 mm.; in shipbuilding yards 250 mm. and occasionally still wider heads are used.

Trouble-free operation of the blowpipes is as important for heating and straightening work as it is for welding and cutting. Fig. 5 shows by means of example in what manner protection against flash-back can be obtained. Oxygen and acetylene, which are discharged at high speed, mix only outside of the nozzle. The flame produced after lighting and adjusting has a spherical core which floats freely at a certain distance before the tip. It is possible to touch the nozzle, with the flame burning, by the unprotected hand. The burner illustrated has an oxygen and acetylene consumption of 3,500 litres per hour each.

ACETYLENE GENERATORS

For installations which produce their own acetylene

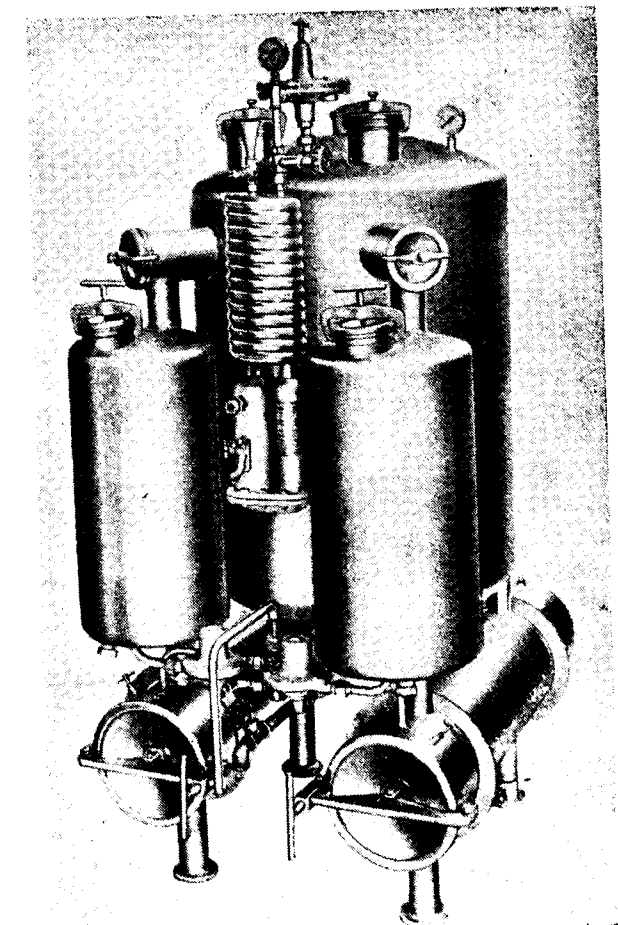


Fig. 7

supply from calcium carbide, high-pressure generators are becoming increasingly popular. These generators are of a size large enough to take the entire daily consumption of calcium carbide. Fig. 6 shows a generator of this type functioning as a water-to-carbide generator.

For large-volume acetylene feeding of welding plants, granulated-carbide generators like the one

shown in Fig. 7 have proved quite a success. Carbide of a particle size of 4 to 7 mm. is automatically fed in only such quantities as are required by gas consumption. The after-generation of this generator is so small that an additional gasholder can be dispensed with. It is also possible to provide the 200 kg. generator shown in Fig. 7 with a carbide hopper of 1,000 kg. capacity. The working pressure of this generator type is 0.9 kg /sq. cm. gauge.

RAILCOACH PRODUCTION

ONE YEAR AHEAD OF SCHEDULE

The Hindustan Aircraft Factory at Bangalore, a Public Undertaking under the Ministry of Defence, is understood to be making rapid progress in the manufacture of "all steel light weight Integral Type Broad Gauge Railway Coaches". As early as 1948 the Factory developed its own design of 'all steel' light weight railway coaches built on conventional underframes supplied by the Railways, adopting more or less the same constructional features as applied to Aircraft manufacture. These coaches became very popular on the Indian Railways and the factory contributed in no small measure in helping Indian Railways to rehabilitate a large number of overaged stock which could not be replaced during the period of the war.

PRODUCTION AHEAD

In October 1956, the Factory, in consultation with the Railway Board, entered into a Collaboration Agreement with Messrs. M. A. N. a leading Rail-coach Manufacturing firm in West Germany, to establish the manufacture of all steel light weight Integral Type Broad Gauge Coaches using steel available within the country. It was envisaged that peak production of 25 coaches per month would be attained in progressive stages by October/November 1961. But this new project has, in the intervening years, made such rapid progress that production has already reached a level of 22 coaches per month. With the progressive development in the manufacture of Integral Coaches, the production of the old conventional type has been tapered down and the last coach of this type is expected to be turned out in September 1960. Simultaneously, the production of Integral Coaches is expected to be stepped up to the peak level of 25 coaches per month—about one year ahead of schedule.

NEW BOGIE

One of the special features of the integral coaches turned out by HAL is their excellent riding quality mainly due to a new type of Bogie which has been incorporated in them. This has not been used in India before and this bogie is, in fact, the most modern type even in the West. The trials carried out by the RAILWAYS RESEARCH CENTRE have already confirmed the supremacy of these new bogies as compared to any other type of bogie now in use on the Indian Railways.

INTERIOR FURNISHINGS

The Interior fittings and furnishings of these new Integral coaches incorporate all modern amenities and ensure travel in comfort for the III Class passengers and particularly, for long distance passengers. The interior colour-scheme of the coaches is so designed as to give a pleasing appearance and better effect to interior lighting.

INDIGENOUS MANUFACTURE OF COMPONENT FOR I.C.F.

The Deputy Minister of Railways, Shri S. V. Ramaswamy, told the Lok Sabha during question hour that out of about 1244 different types of components required for the manufacture of coach shells in the Integral Coach Factory, only one component was fully imported. He added that about 1,000 components were manufactured in the Factory itself, about 237 components were procured from indigenous sources and six components partially imported. Shri Ramaswamy said this in a written reply to a question by Shri Ram Krishan Gupta.

RAILWAY OVERHEAD ELECTRIFICATION SUPPLEMENT RAILWAY OVERHEAD CONTACT LINES

By Matthias Wittgenstein, Dipl.Ing.,
Kummler & Matter A.G., Zurich

Design and construction for high speed working

THE sole and exclusive criterion for the quality of a contact line is that it shall give absolutely uninterrupted transfer of current from the wire to the pantograph under all conditions including high speeds. The fact that a number of railways in various countries, after thorough tests and investigations, have decided to use high-voltage single phase alternating current at 25 kV and 50 cycles permits the choice of light-weight, and hence small bulk, supporting device and cross sections of wire and cable, able to meet this requirement.

Overhead contact lines generally used consist of a contact wire suspended from a catenary by means of vertical hangers, and laterally fixed to the suspension points. To ensure the carbon of the pantograph being worn down evenly, the wire is strung zig-zag, so that it alternates from one side of the pantograph to the other. On the basis of calculations, taking into account both traffic density and weight of trains, the following copper cross sections were arrived at:

Main catenary for through main stretches ... 0.101 sq. in.



Fully elastic contact lines

Only the K + M slanting-pendulum system enables a fully elastic suspension of contact lines for trolley-buses and street cars. Operations on stretches totalling 1000 miles have proved that high speeds do not entail derailments, and that wear on contact wire and collector shoe is minimal. Furthermore, spans up to 150 ft. being practicable, considerable savings in construction and maintenance costs result.

PLANNING, SUPPLY, CONSTRUCTION

Aktiengesellschaft KUMMLER & MATTER, Zurich (Switzerland)

Main catenary
for sidings ... 0.082 sq. in.

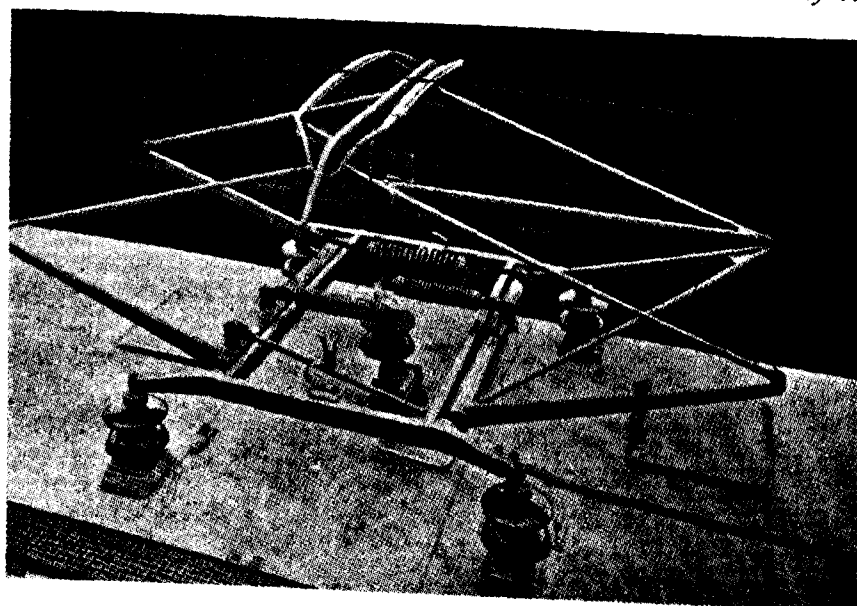
Contact wire for
through main
stretches .. 0.166 sq. in.

Contact wire
for sidings .. 0.14 sq. in.

As not only the contact wire, but also the catenary, is included in the electrical cross sectional area, the hangers already mentioned must be electrically conductive. The maximum travelling speed for which the contact line must be built has been specified by one important authority as 100 m. p. h.

If a cable or wire is suspended at two points with a horizontal mechanical tension, it forms a curve shaped almost like a parabola. If the points of suspension are at equal level, the greatest sag is equidistant from both points, and the horizontal mechanical tension is equal at every point of the cable. Along the curve made by the cable, the vertical weight component bearing down each part of it is greatest at the suspension point—where it is equal to half the weight of cable or wire—and zero in the centre of the span between two poles.

A pantograph of the design generally used today exerts an upward force on the contact wire amounting



Pantograph of modern design (Siemens Austria).

to from 12 to 24 lb., which causes the contact wire and the catenary to be lifted from the normal position to the working position. The pantograph will raise the wire higher in the middle of the span than under the suspension points, which means that the contact line is elastic at the centre of the span, but remains practically rigid at the suspension points, as shown in Fig. 1. These various degrees of elasticity between suspension point and span centre must be prevented by suitable structural measures, to enable the pantograph to run along at the same level without any appreciable change caused in the contact pressure. The pressure of the pantograph lifts the contact wire and the bend or wave, flattens out again at some distance before and after it, see Fig. 2, and, when it is in motion, accompanies it continually. To ensure continuous spark-free current collection and uniform contact pressure, this travelling

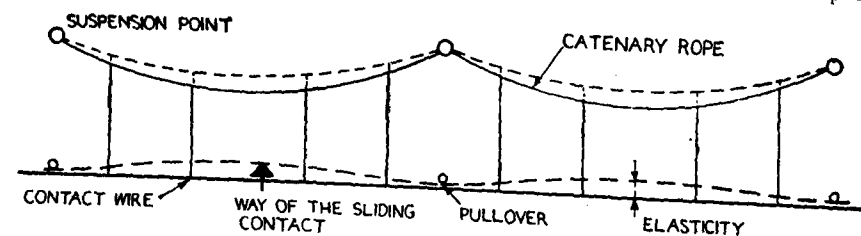


Fig. 1—Normal and working position of the contact wire and catenary

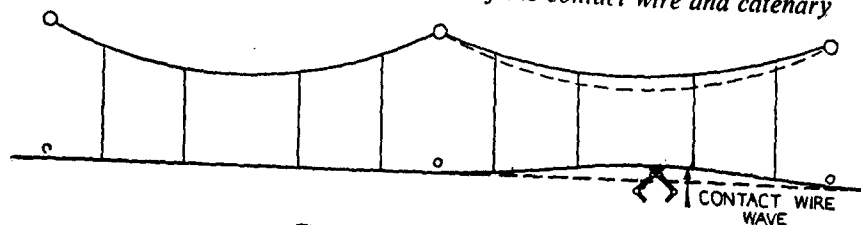


Fig. 2—Contact wire wave

wave must never be interrupted. The higher the speed of the pantograph, however, the more do additional weights on the wire, e. g., hanger clamps and pull-offs (side-holders) at the suspension points, make themselves noticeable through increasing mass inertia in the form of so-called hard points which interfere with, or deform, this wave and cause irregularities in the contact pressure; even sparking in extreme cases. The weight of the hanger clamps and pull-offs must consequently be kept to a minimum, and correctly suspended.

A phenomenon in connection with this wave action is the fact that the upward bend of the contact wire is more pronounced at low than at high speeds, during which the mass inertia of the contact wire gradually increases. This effect of the contact line elasticity decreasing as the pantograph speed increases is compensated by the raising of the contact pressure by the slipstream.

With a knowledge of the dimensions of the sliding collector piece, the lateral wind pressure, the reduced mass inertia of the pantograph and the contact pressure, the engineer first determines the distance between two poles and then calculates the elasticity. On the basis of these calculations, the mechanical tensile forces exerted by the catenary cable and by the contact wire, are equated to one another, and the distance between the hangers established. On this calculation depends

the extent to which the elasticity of the contact wire must be increased artificially at the suspension points. Contact lines meeting the high demands made by main line working will most likely require a somewhat more expensive construction than would suffice for those for lower speeds. The length and the prestress of the auxiliary catenary are determined from the elasticity calculation.

Two hangers are attached, as shown in Fig. 3, to the auxiliary catenary, one before and one behind the pull-over, whereby the elasticity of the contact wire is artificially increased at the suspension point. The zig-zag of the wire in relation to the poles results in a pull on the suspension at one pole A and a push at the next B. Since a side-holder in tension produces a different elasticity from one in compression, it is found necessary to employ what is called the auxiliary tube. This is suspended by two hangers in a V-shape directly from the catenary, and consequently always participates in the temperature-responsive rotations of the brackets. Furthermore, the use of this auxiliary tube enables making the pull-offs at alternate poles short, light, and of equal length; this results in uniform elasticity in spite of the variations in stress due to the zig-zag. The greater elasticity of the contact wire at the span centre is additionally compensated by providing somewhat longer hangers there, producing a pre-sag of the wire at this centre part, as shown in the figure.

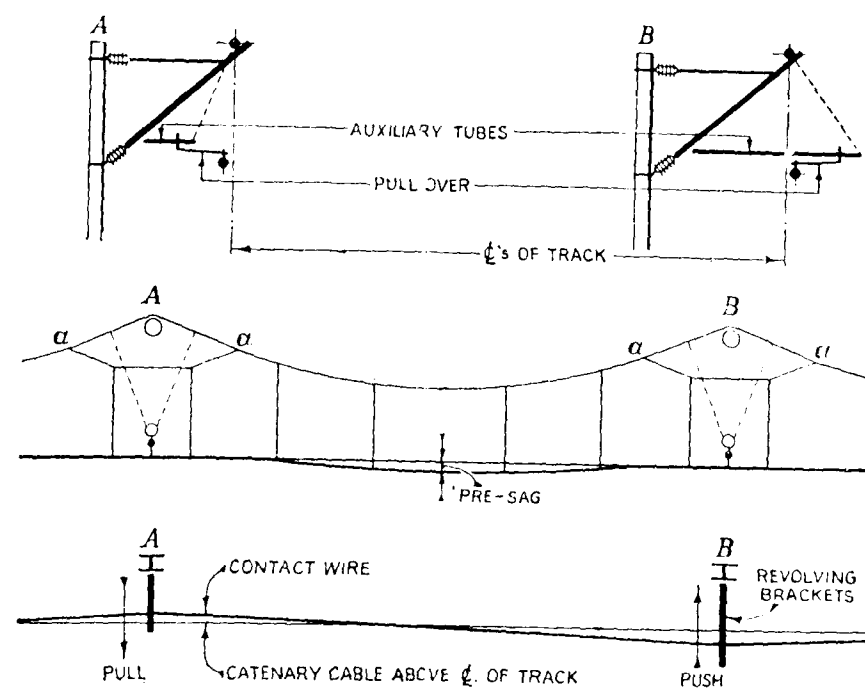


Fig. 3—Arrangement of suspension

MECHANICAL TENSIONING

Contact wire and catenary cable are subject to temperature-responsive changes in length that affect the sag between suspension points and thereby also the path of the pantograph. On the Continent one still frequently finds contact lines with rigidly strung catenary and a contact wire tensioned by weights. Such forms of construction do not, however, ensure satisfactory contact conditions at speeds of 75–80 m. p. h. or more. The latest specifications require that both catenary and wire be tensioned so as to ensure the same mechanical tensions throughout the year resulting in uniform sag and elevation of the contact wire. The mechanical tensioning devices are located along the open stretches 0.8 to 0.9 mile apart, as shown on Fig. 4, and as far as possible should not be located in curves. Exhaustive measurements have shown that high mechanical tension of the contact wire results in more favourable contact conditions and better running of the pantograph, but it can have serious consequences, since the lateral stress exerted on the poles and concrete foundations is also increased, involving considerable extra expense.

An intersection of two wires and also any transition from one length to another in the case of mechanical tensioning constitute particularly difficult problems. The moment the pantograph meets a second contact wire at an intersection, it has to lift double the weight of wire, but since the contact pressure remains constant, the pantograph is pressed downward, and this interferes with the desired horizontal run and, the same time, with the constant pressure of the sliding piece. In this case, too, the elasticity of the contact wire has to be artificially enhanced by a suitable V-shaped suspension of the parts of the contact wire adjoining the point of intersection. The best contact conditions result in the minimum of wear on the contact wire and sliding-contact carbon, because such is directly proportional to the degree of irregularity in contact pressure.

Tests have been carried out by all railway managements using electric overhead contact lines, which have compared the different types of design and construction. Graphs have been drawn showing simultaneously the positions of the points where the pantograph breaks contact with the line and also its up-and-down motion at different speeds. Attempts to measure the contact pressure itself by suitable instruments have so far been without result; the dead weight of such apparatus, which has to be attached to the sliding piece of the pantograph, invariably distorts the results. A simple method of finding the elasticity of a contact line is to use a film to photograph it at rest and again by a second exposure, when the pantograph is travelling along. In the photograph reproduced on page E.5, is seen the difference in elevation between the normal and working positions.

As most railways were built without thought of electrification, alternative designs of contact line are required to meet special conditions in stations, tunnels, and under bridges. Compromise is often necessary and extensive experience required to arrive at the most efficient solution. At large stations with electrified sidings the whole network moves under temperature variations. A great amount of designing and planning is therefore unavoidable, while cost, of course, must be kept within a reasonable figure. Appearance is a matter of taste, but as a rule the most efficient contact line also is the best looking.

PANTOGRAPH

Although the pantograph belongs to the electric locomotive, it is closely related to the contact line, both statically and dynamically as explained. Consequently, the contact line engineer includes the roof of the locomotive when designing. To be capable of planning his line system in the first place he must have the principal facts relating to the pantograph. This information consists primarily in the contact pressure and in the

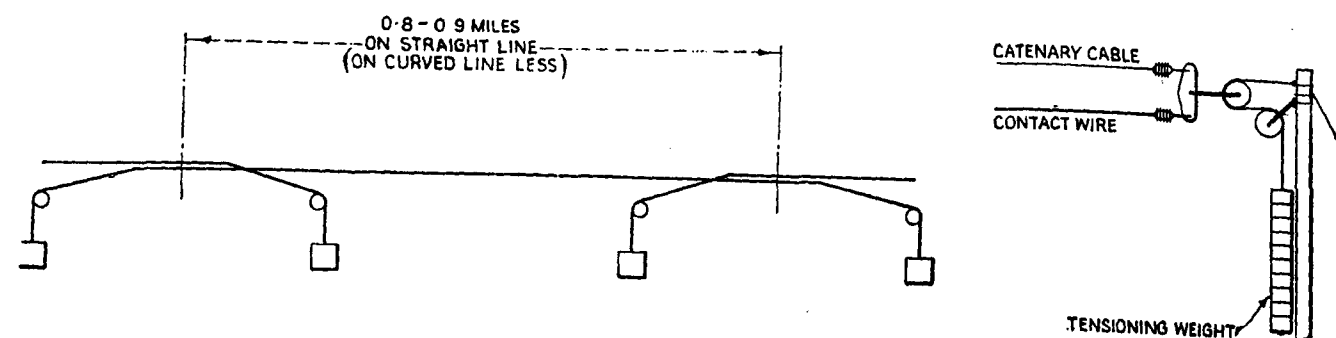


Fig. 4—Weight tensioning

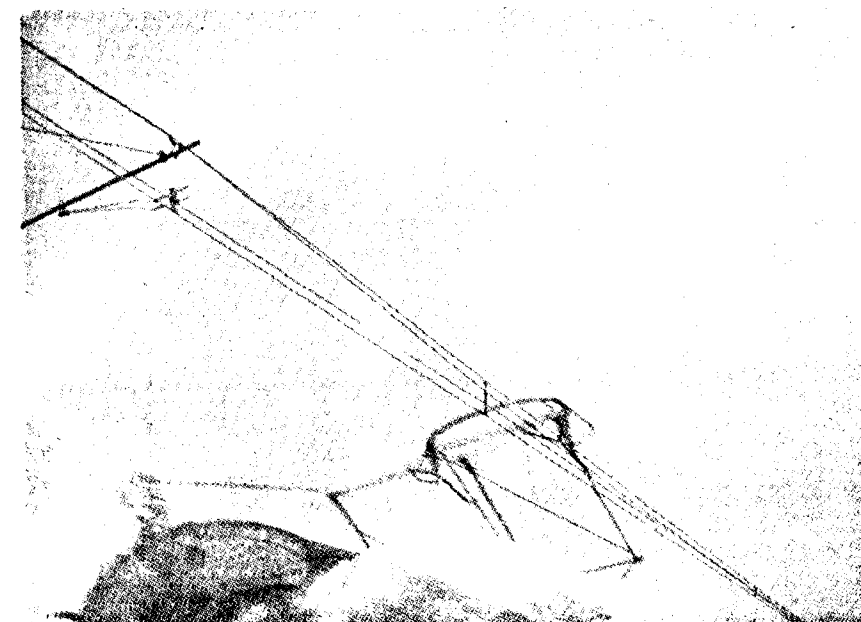
breadth of the sliding piece employed. In addition to this, however, there is the lateral deviation due to the stress exerted by cross winds. This factor determines the maximum distance between the poles along straight stretches, because the lateral deflection of the contact wire by the wind must never be great enough to prevent the wire from remaining within the useful range of the sliding piece. The breadth of the sliding piece is the decisive factor governing the distance between poles on curves where the contact wire must move within the useful breadth of the sliding piece, regardless of lateral wind effect. The zig-zag makes the contact wire wander from one side of the pantograph to the other and back and the speed at which it does so must be kept within a certain limit whilst the sliding piece must not be too strongly arched, as the sideward motion would otherwise make the contact wire fly off it. Another important criterion for the design of a pantograph is its mass inertia. The ability of the sliding piece to accelerate vertically should be as high as possible at the given contact pressure.

Apart from dynamic factors, the pantograph must meet the given requirements as to mechanical stresses. These can reach very high values at high speeds due to the uneven motion of the vehicle and, above all, to the counterwind. The pantograph, on account of the lateral shaking it is subjected to, should have the greatest lateral stability possible. The slipstream—and particularly the upwind produced by the

front fairing of the locomotive—creates an additional but undesirable contact pressure. Although every electric locomotive is provided with two electrically parallel pantographs, Austria and Switzerland have adopted the practice of using only the rear one (in relation to the direction of travel). At this point the counter air current has subsided to such an extent that it streams along parallel to the roof of the locomotive, and the additional pressure is therefore much reduced. A further advantage in operating with only one pantograph, is that the constant conditions under which the overhead line then works are not disturbed, and the reciprocal effect on the dynamics of the line of two pantographs is avoided.

MASS INERTIA

The ability of the sliding piece to accelerate vertically is vital and for this the mass inertia must be reduced at point A in Fig. 6. A theoretical calculation is very difficult to make, as inaccuracies in bearing friction cannot be exactly allowed for. Fig. 6, however, shows a comparatively simple method of arriving at what is desired. Spring S, which provides the contact pressure, is removed and the pantograph suspended at A by a coil spring. Its effective weight is measured and also the extension x of the coil spring between loaded and unloaded positions. Point A is then made to oscillate vertically and the frequency f



Normal and working positions of pantograph.

noted. The reduced mass inertia may then be found from

$$m_{red} = \frac{Wg}{4\pi^2 \cdot x \cdot f^2}$$

The contact pressure is then the product of the mass inertia and acceleration and the ability to accelerate at point A may be calculated with a knowledge of such pressure, giving a simple method of comparing designs of pantograph.

COMPLETED SCHEME

The final scheme, in which all the suspension points, mechanical tensioning devices, supporting yokes, etc., together with all necessary measurements are taken into account, is drawn up with the aid of accurate

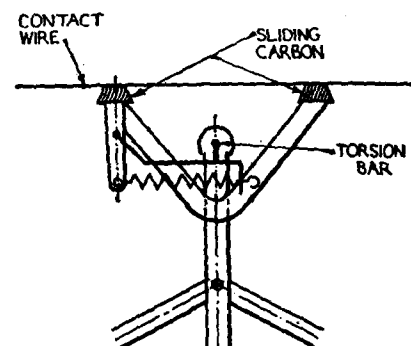


Fig. 5—Springing of a modern type of pantograph giving even contact and slight mass inertia (Siemens Austria)

route maps and traverse sight lines of the lengths of line and stations, after the construction engineer has personally studied the route in detail. This planning has to be done with the closest attention to detail and accuracy, and consequently represents the main contribution to the whole project. From the care and accuracy with which it is accomplished depend the smooth supply of material and, above all, the organisation of the erection work. In the case of electric lines for railways, the erection as such is handicapped, first of all, by the fact that the work extends over many miles, rendering inspection and supervision and organisation more difficult.

RAIL LINK WITH JAMMU & KASHMIR

The Deputy Minister of Railways, Shri S.V. Ramaswamy, confirmed in the Lok Sabha that the Government had chosen the site at the river Ravi for crossing railway line beyond Madhopur in the Jammu & Kashmir State.

The Deputy Minister, who was replying to a question by Shri Ram Krishan Gupta and six other Members, said that the railway line would cross the river Ravi about 1600 ft. down stream of the road bridge on the National Highway from Madhopur to Jammu.

Secondly, traffic density in certain countries leaves only little time between trains for the erection gangs to accomplish the necessary assembling and adjusting work on the contact line which has to be minutely planned and organised beforehand. This factor is especially decisive in choosing the system of overhead line to be employed. There exist today other systems,

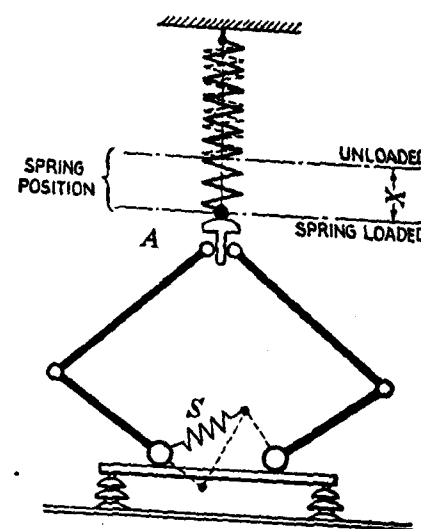


Fig. 6—Influence of mass inertia

besides the one described, possessing excellent current collection characteristics, but they take a considerable time to install and cannot be considered in the case of railways having a close train headway.

Just as it takes more than mere theory and a few drawings to design and construct a machine, the sound planning, engineering and construction of a contact line for high speeds requires a large measure of feeling and instinct. It would be practically impossible theoretically to evaluate and structurally determine such complicated dynamic processes which are necessary for the satisfactory operating of electric contact lines.

Here, too, the final finishing touch is of the same vital significance as is the seemingly unimportant last adjustment that an old experienced foreman makes in a machine.

Rural Electrification— A Plea for Decentralised Generating Units

By Ravi Kirloskar* and G. N. Paraki§

THE economic prosperity of any country is judged today largely by the amount of electricity it consumes. The *per capita* annual consumption in India is only 25 units, whereas those of the other industrially advanced countries go as high as 4,400 units, the world average being approximately 600 units. With this large leeway, the planners in our country are naturally embarking on large schemes of power generation which assure us doubling of the installed capacity for generation every five years. The total generating capacity in India at the beginning of the First Plan was 2.3 million kilowatts and during the First Plan period 1.1 million kilowatts was added, thus bringing the installed capacity to 3.4 million

kilowatts by the end of the First Plan. During the Second Plan, a programme was drawn up for doubling it to approximately 6.9 million kilowatts. This figure is likely to be achieved without much difficulty except that the time by which the bulk power would be available in the final stages may be postponed by 5-6 months. The Government's objective is to attempt another doubling in the Third and subsequent Plan periods, if financial and technical man-power resources permit. It has been declared that if the Government's long-term objectives are to be fulfilled in respect of increasing the standard of living, we will have to maintain the present rate of expansion of power facilities over several Five-Year Plan periods. How and on what basis it should be planned is admittedly the responsibility of engineers and planners.

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A policy decision of the nature indicated above has got to be examined in the proper perspective before blueprints are drawn for the Five-Year Plans. Today the emphasis has been on large projects which give power at a fairly low cost of generation. Also considerations of Zonal and Regional Planning introduce certain political elements which the engineers find difficult to keep by, at the time of consideration of the plans for the future. Some regions in the country are well suited from the point of view of development of hydroelectric power, some from the point of view of thermal power, and possibly some others from the point of view of development of atomic power. The way of thinking so far has been so conventional that the ultimate cost of generation has been kept as the basic consideration and plans approved accordingly, have been schemes involving heavy capital expenditure.

Experience in the country during the last ten years has brought out certain vital points for consideration. Amongst them are:—

- Chronic shortage of skilled personnel for project planning, execution and maintenance.
- Problems of cost control and raw material procurement.
- The persistent difficulty in procurement of sufficient foreign exchange.
- In hydroelectric project areas the problem of settlement of displaced population.
- Suitable means of communication to the project sites and facilities for handling heavy equipment.
- Delay in execution due to abovementioned reasons.
- Shortage of power from Hydro Stations in summer due to scarcity of water in certain parts of the country.

The problems mentioned above are only a few of the many that are faced by persons in charge of projects. We always look to the experience of others and in our attempt to follow the latest and modern practices existing in foreign countries, we sometimes forget that the Indian economic background and culture are different from those countries.

Should our objective be to improve the standard of living of the average Indian, it will be inevitable to have a power network which will enable the majority of the country's population to get the benefits of

electric power. An attempt has been made for extensive rural electrification in different States of India. So long it has been the practice to select reasonably remunerative places here and there, and electrify them piecemeal. Some of these may have been economically attractive from a short-term point of view, while some others have entailed expensive construction procedures, with the result, the cost of power delivered at the village would have to be subsidised by the more well-to-do consumer. At the moment, we have so far electrified a negligible percentage of the five and a half lakhs villages in India. Of the total number of villages whose population is less than 20,000 we have hardly touched 1.8% of them. Experienced engineers have begun to have second thoughts about the present method of rural electrification. They have begun to feel that complete surveys should be undertaken on the Regional State-Board basis, the taxing of the urban consumer has its own limitations, and should not retard the rate of load growth.

Compared to urban areas, the load density in rural areas is very small. The villages are far apart and the capital investment per consumer becomes naturally high. People have a low *per capita* income. Industries which yield substantial profits are always located in places where more conveniences are available. The countryside can, therefore, provide only agricultural and small industrial loads which do not consume large blocks of power and have a very poor load factor thus resulting in poor financial returns. This low prospective revenue, in relation to the capital outlay, continues to be a big problem. The charges on account of interest, depreciation, etc., on the capital investment are piled up to large astronomical figures. The situation cannot be improved by merely continuing the schemes which are subsidised by the State by way of interest-free loans and by taxing the urban consumer out of proportion of his ability to pay, and continued economic aid from other countries. The real solution to the problem may be achieved in tackling the problem in a straightforward objective way, by encouraging individual entrepreneurs or village co-operatives who can afford to invest small blocks of capital and set up small stations so as to cater the needs of small load centres.

It has been estimated that it costs on an average approximately Rs. 65,000 to bring electricity to an average Indian village by the present conventional transmission system. This is the cost of transmission only. It is, therefore, worthwhile investigating

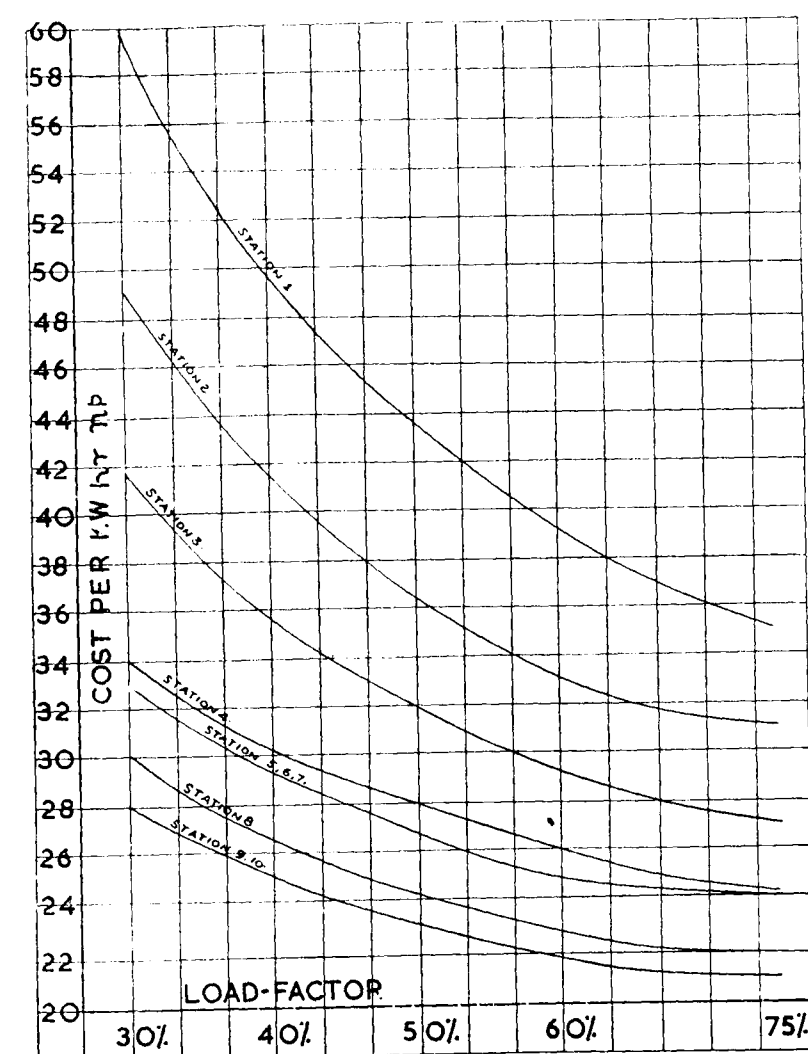


Fig. 1

whether alternative methods of power generation can be considered which do not require a heavy capital investment. We can consider the installation of small diesel engine-driven alternator sets of varying capacities depending on the ability of the village to absorb power. The first reaction to such a proposal would be that it would be extremely prohibitive as far as cost of generation is concerned. The cost of generation in these small diesel generating stations may appear high compared to the large stations. The law on which it works is very much the same as in industry. Organized large-scale units can produce goods cheaper and to an accepted standard. Why then should we organize the small-scale industry and subsidise it? It provides employment to many more and the objective is to absorb the idle man-power as fast as we can. The cost aspects are not considered at all. Similarly in power generation we can reach

the villages much faster by taking the generating units to the villages, instead of reaching these villages by a network of transmission and distribution lines.

Let us consider the points in favour of the proposal. The capital cost will be of the order of Rs. 70,000 for a 50 kW station. How many villages in the country can absorb 50 kW load with a good load factor? A smaller village can have a 25 kW set which will cost approximately Rs. 40,000 with a 12.5 kW standby plant. This capital investment is within the capacity of the co-operatives. As the load grows and the rate of repayment increases, larger sets can be installed. Once the load grows to 100 kW with a load factor of about 50—60% it will be worthwhile connecting this village to the network. Such a scheme will enable the country to develop faster.

The fuel required is at the moment imported but the chances are that it will be indigenously available early. The cost of this fuel is about Re. 1 per gallon excluding the Central, State and Municipal Duties. There exists already, a good distribution system for Kerosene which can distribute diesel fuel. The consumption of Kerosene will also proportionately drop down.

The capital equipment required can be manufactured indigenously. The manufacturers will assist in setting up good servicing and spares service. Standardisation of components and sizes will enable this service being obtained at a low cost.

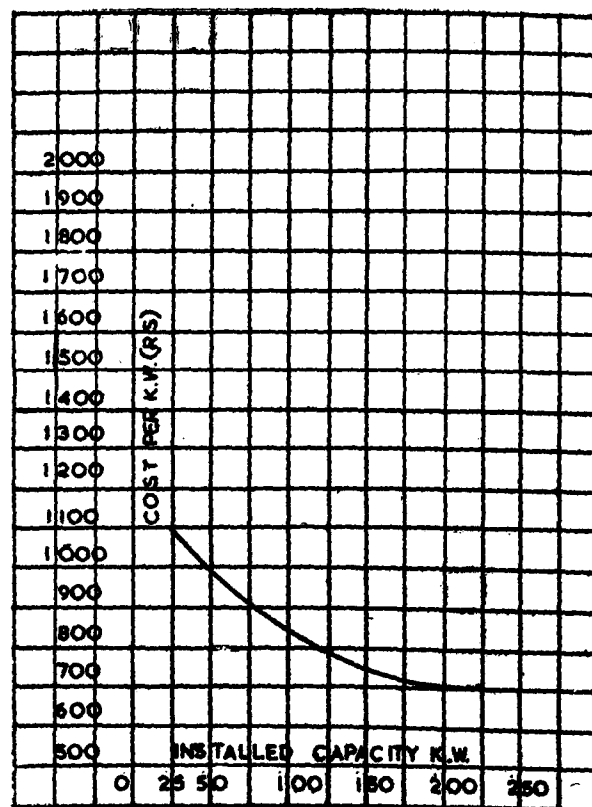


Fig.2

The extent to which skilled personnel will be required to construct and run such plants is not likely to be a problem. The bright boys from the village who are now drifting to the urban areas for employment will get jobs in their own villages. A couple of them can run stations of this type and maintain them. They can also be trained in manufacturers' works for short periods.

The ownership of such stations vesting with the co-operatives will eliminate the profiteering motive of

the individual proprietor. If the State can give subsidy for present rural electrification, the same can be paid to these co-operatives to meet 50% of the cost of the plant and balance in the form of a loan. A crore of rupees subsidy will electrify 500 villages.

Details have been worked out for ten different stations. The Pundits can study the economics of such a scheme keeping in view that power can be made available to rural areas much faster and the repayment by results will also be faster. These stations will help the load growth and the power from large generating plants can be transmitted at higher voltages for bulk power. As and when the grid power becomes available the diesel station can be shifted to some other area.

The following data on the cost of generation and operation in diesel power stations would make an interesting reading. The detailed calculations have been tabulated in convenient tables and curves are drawn to show the variable factors that control the costs. The various conservative assumptions made for calculating the cost per kWhr. have also been listed.

Since the nature and requirement of power may vary from village to village and also depend upon the application, the cost of operation per kWhr. has been calculated for a number of power stations listed in Table I and as a typical example, the detailed calculations have been given for a station of 50 kW capacity. All generators are of L. T. type, rated for 400/440 volts, 3 phase, 50 C. P. S., 0.8 P. F., 4-wire.

The following assumptions are made to calculate the cost of operation per kWhr. of every station:—

- (1) The operating costs stated in the following tables are only calculated values and hence are approximate.
- (2) Any state taxes imposed by Government on energy generated have not been considered.
- (3) The cost of energy is calculated as at the terminals of the Alternator. The total cost of distribution per station has not been estimated as the calculations become very vague.

TABLE I

Station No.	Total installed capacity kW	Comprising of	Remarks
1	25	1 No. 25 kW diesel generating set	An additional 12.5 kW set is included to serve as a standby
2	50	2 Nos. of 25 kW diesel generating set	..
3	50	1 No. of 50 kW diesel generating set	An additional 25 kW set is included to serve as a standby
4	100	2 Nos. of 50 kW diesel generating set	..
5	150	3 Nos. of 50 kW diesel generating set	..
6	200	4 Nos. of 50 kW diesel generating set	..
7	250	5 Nos. of 50 kW diesel generating set	..
8	150	1 No. of 100 kW and 1 No. of 50 kW diesel generating set	Alternative to Station No. 5
9	200	2 Nos. of 100 kW diesel set	Alternative to Station No. 6
10	250	2 Nos. of 100 kW and 1 No. of 50 kW diesel set	Alternative to Station No. 7

(4) The generating set is assumed to work at N.T.P. and altitudes not generally exceeding 500 ft. The output of the diesel engine decreases with increase in ambient temperature, relative humidity and altitude.

(5) To arrive at the total equipment cost at the purchasers' destination, a total of 12.75%

has been added to the equipment cost which calls for freight and insurance, packing, loading and unloading charges. The local sales-tax, the interstate sales-tax and octroi have not been considered.

(6) The cost of the power house has been estimated at the rate of Rs. 1,500 per 100 sq. ft. The power house is assumed to be built up of brick masonry and R. C. C. roofing.

(7) The depreciation period for the entire equipment, power house, distribution board, etc., has been assumed to be 15 years.

(8) The rate of interest is taken as 4% per annum on total capital investment.

(9) The cost of spares, tools and maintenance is taken very conservatively to be 10% of the total capital investment per annum.

(10) The price of High Speed Diesel Oil is taken to be Rs. 2.39 per gallon. The split-up price of diesel oil is as follows:—

	Rs.
(a) Net price per gallon	1.00
(b) Excise duty	1.03
(c) Sales-tax	0.19
(d) Octroi 1-9/16%	0.00316
(e) Dealer's commission	0.08

TOTAL 2.303

Plus 4% extra for handling to isolated places 2.39 per gallon.

Further calculations have been made on the basis of Rs. 2.39 per Imperial Gallon.

(11) The price of Lubricating Oil is Rs. 8.6 per gallon.

The following are the detailed calculations, as an example, of the cost of operation per kWhr. of Station No. 3 rated for 50 kW and having a 25 kW as a standby.

(A) Total Capital Investment:

1. The 50 kW Generating Set consists of the following:

	Rs.	(E) Total Fixed Cost per day	39.40
(a) 1 No. 80 H. P. diesel engine made to B. S. S. 649/1958 (based on current British equipment prices)	14,200.00	(F) (a) Diesel Oil Cost per day (based on continuous 12 hours running of the set) :	
(b) 1 No. Radiator Cooling System.	2,200.00		
(c) 1 No. Base Plate	750.00		
(d) 1 No. Flexible Coupling	150.00		
(e) 1 No. 50 kW 0.8 P. F. 400/440 volts, 3 phase, 50 C. P. S. Alternator with Control Panel	16,000.00		
	33,300.00		
Plus 12.75% extra	4,140.00		
TOTAL	37,440.00		
2. The standby set of 25 kW consists of :	Rs.		
(a) 1 No. 40 H. P. diesel engine made to B. S. S. 649/1959	7,590.00		
(b) 1 No. Radiator	900.00		
(c) 1 No. Base Plate	300.00		
(d) 1 No. Flexible Coupling	125.00		
(e) 1 No. 25 kW, 0.8 P. F., 400/440 V, 3 phase, 50 C. P. S. Alternator with Control Panel	6,350.00		
	15,265.00		
Plus 12.75% extra	1,999.00		
TOTAL	17,264.00		
3. Capacitor for maintaining the P. F. at about 0.85, 36 kVAR, 3 phase, 400/440 V, 50 C. P. S.	1,200.00		
4. Power House 30' X 25'	11,250.00		
5. Erection Charges	2,000.00		
6. Distribution Board	600.00		
Total Capital Investment	69,754.00		
(B) Annual Provision for Interest and Depreciation	7,450.00		
(C) Depreciation per day	20.40		
(D) Spares, Tools and Maintenance	69,754 X 10		
Cost per day	365 X 100		19.00

The costs of operation per kWhr. for every station mentioned earlier have been calculated exactly as above and have been given in Table II for easy and quick reference :—

TABLE II									
Station No.	Installed capacity kW	Total capital investment Rs.	Fixed costs per day Rs.	L. F. %	Diesel oil cost per day Rs.	Lub. oil cost per day Rs.	Total cost per day Rs.	No. of kW hrs per day	Cost per kW hr. nP.
1	2	3	4	5	6	7	8	9	10
1	25	41,214	23.3	30	29.3	1.46	54.06	90	60
				40	34.5	1.72	59.52	120	49.5
				50	40.0	2.05	65.35	150	43.5
				60	44.5	2.26	70.06	180	39
				75	53.0	2.63	78.93	225	35
2	50	47,228	26.8	30	58.6	2.92	88.32	180	49
				40	69.0	3.44	99.24	240	41
				50	80.0	4.10	110.90	300	37
				60	89.0	4.56	120.36	360	33
				75	106.0	5.26	138.06	450	31
3	50	69,754	39.40	30	33.3	1.83	74.53	180	41.5
				40	42.6	2.34	84.34	240	35
				50	53.4	2.93	95.73	300	32
				60	62.6	3.44	105.44	360	29
				75	77.4	4.25	121.05	450	27
4	100	94,530	53.06	30	66.6	3.66	123.86	360	34.4
				40	85.25	4.68	143.48	480	30
				50	106.80	5.86	166.26	600	27.70
				60	125.20	6.88	185.68	720	25.7
				75	154.80	8.50	216.90	900	24
5	150	136,520	77.0	30	99.9	5.50	182.4	540	33.8
				40	127.8	7.00	211.8	720	29.4
				50	160.0	8.77	245.77	900	27.2
				60	187.88	10.3	275.1	1080	25.4
				75	232.0	12.75	321.75	1350	24
6	200	177,760	100.7	30	133	7.3	241.0	720	33.4
				40	170	9.36	280.06	960	29.2
				50	214	11.7	326.4	1200	27.2
				60	250	13.7	364.4	1440	25.2
				75	310	17	427.7	1880	23.7
7	250	220,500	124	30	167	9.15	300.15	900	33.4
				40	213	11.70	348.70	1200	29
				50	267	14.60	405.60	1500	27
				60	313	17.20	454.20	1800	25
				75	387	21.20	532.20	2250	23.6

TABLE II (Contd.)

Station No.	Installed capacity kW	Total capital investment Rs.	Fixed costs per day Rs.	L. F. %	Diesel oil cost per day Rs.	Lub. oil cost per day Rs.	Total cost per day Rs.	No. of kWhrs per day	Cost per kWhr. nP.
1	2	3	4	5	6	7	8	9	10
8	150	118,170	66	30	91.5	5.2	162.70	540	30
				40	118.6	6.74	191.34	720	26.5
				50	148.4	8.43	222.83	900	24.7
				60	173.6	9.88	249.48	1080	23.0
				75	216.4	12.30	294.70	1350	21.7
9	200	141,810	80.3	30	116.3	6.74	203.34	720	28
				40	152.0	8.80	241.10	960	25
				50	190.0	11.0	281.30	1200	23
				60	222.0	12.88	315.18	1440	22
				75	278.0	16.10	374.40	1800	21
10	250	183,800	103.5	30	149.6	8.57	261.67	900	29
				40	194.6	11.14	309.24	1200	25.5
				50	243.4	13.93	360.83	1500	24
				60	284.6	16.32	404.42	1800	22.4
				75	355.4	20.35	479.25	2250	21

The data given above have been prepared purely from the point of view of focussing the attention of the engineers and planners to a scheme of this type, so that they may consider this proposal dispassionately.

Statisticians and economists may work out their figures and finally decide that this scheme is either practicable or impracticable. But one thing seems definite that if this scheme is pushed through, it will give an opportunity for the creative section of the community to come on its own. Power will be available in all villages in the country which are accessible by road and it may in the long run prevent a drift of rural population to urban areas. Industry will get gradually decentralised and production of more consumer goods will be done at the rural centres. The cost of transportation and marketing which are quiet considerable today will be reduced. All the benefits of a planned community development will be made available to the population very much earlier than what could be achieved by intensive rural electrification by the conventional method of transmission and distribution lines. Power can be more usefully employed on remunerative schemes and load factors can be properly controlled in view of the decentralised nature of the stations. The cost curves shown in the

article indicate how steadily the cost falls as load factor improves.

The difficulties enumerated often for accomplishing large-scale electrification schemes, viz., the shortage of generating capacity, overloading of transmission and distribution schemes due to rapid development of urban industries, non-availability of required material and technical personnel and the limitations which the State Governments had perforce to impose on capital expenditure, etc., can all be overcome satisfactorily in a scheme of this type, which can be planned and implemented by the community itself. The maintenance of such stations does not require very skilled personnel. The equipment can be so designed as to make it reliable and self-protecting.

If opportunity is given to the community to invest its own savings and develop their own stations in the form of co-operatives, and an opportunity is given for the indigenous industry to take up the challenge to meet the requirements of the country, the chances of such schemes succeeding are more.

If this article has created sufficient interest in the power planners in the country to make them work out further details, the objective of the authors will have been achieved.

An Important Announcement

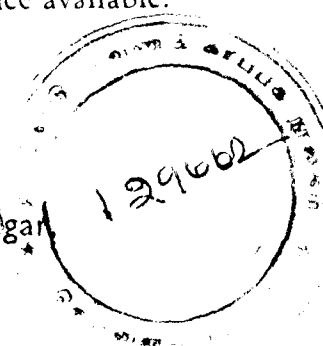
We have great pleasure in announcing to all our readers and advertisers that we are incorporating a special supplement entitled "INTEGRAL COACH FACTORY SUPPLEMENT" along with our January 1961 edition. We need not very much stress the international importance of this gigantic coach-building unit of the Indian Railways in the whole of Asia. The Supplement will contain interesting articles specially contributed by eminent engineers about this largest coach-building factory in the public sector.

We take this opportunity of requesting such of those engineering firms who have had the privilege of contributing their mite to this great State undertaking to subscribe by way of technical articles on various aspects of coach-construction to our above Supplement.

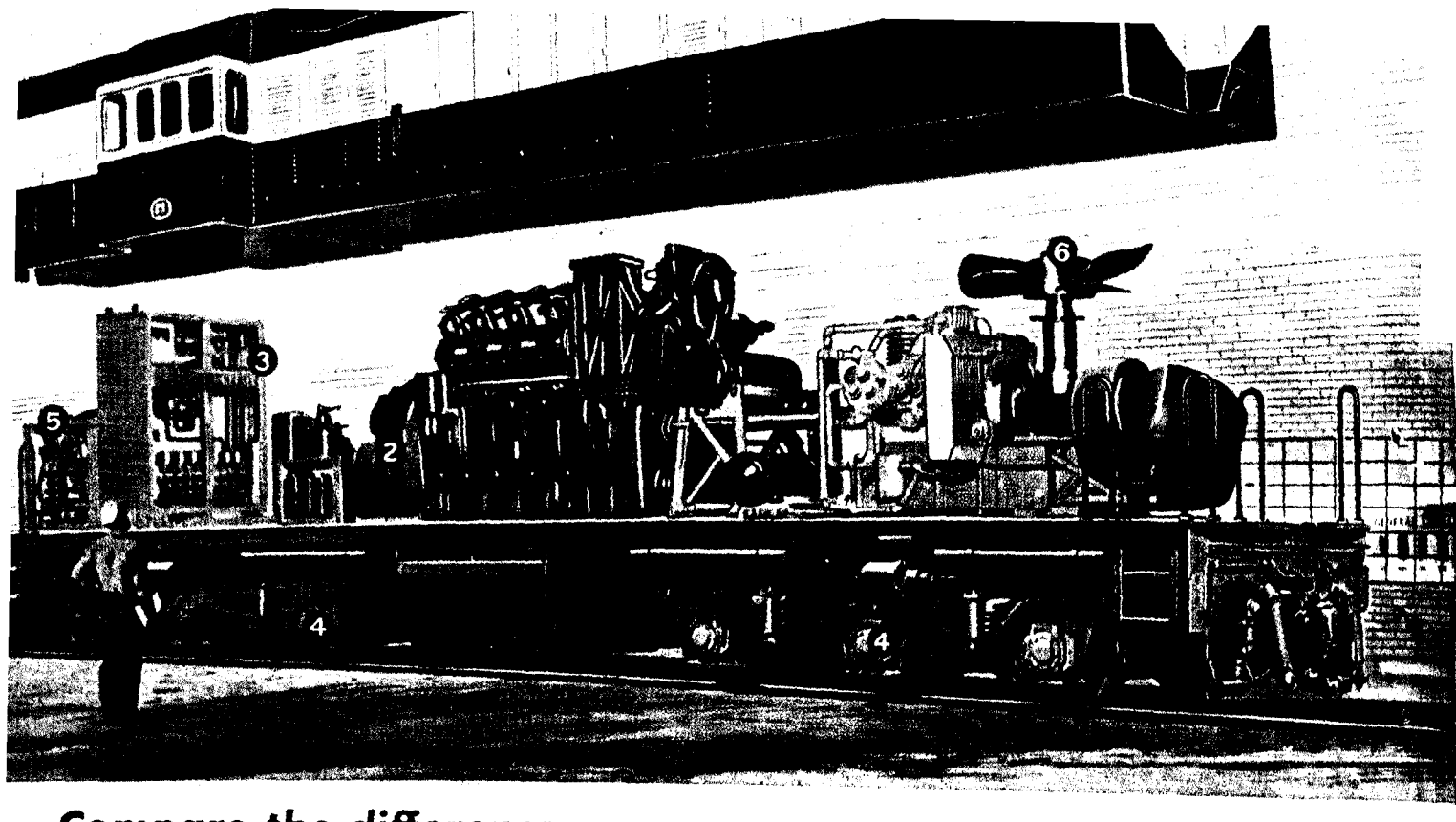
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