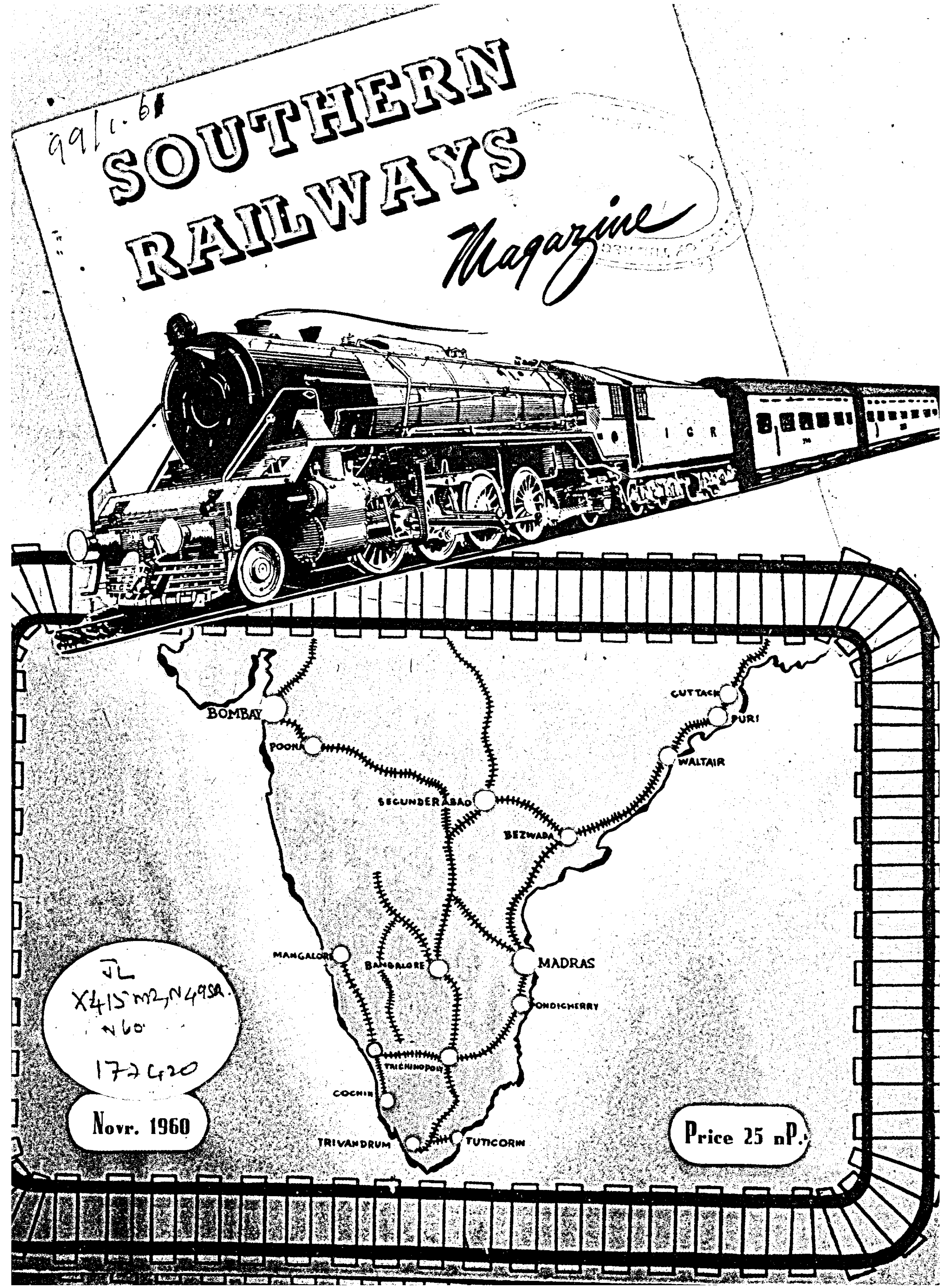
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(Inserted in the interests of Travelling Public)

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 one 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 quantity during many years of service is called endurance. The higher the capaciy 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

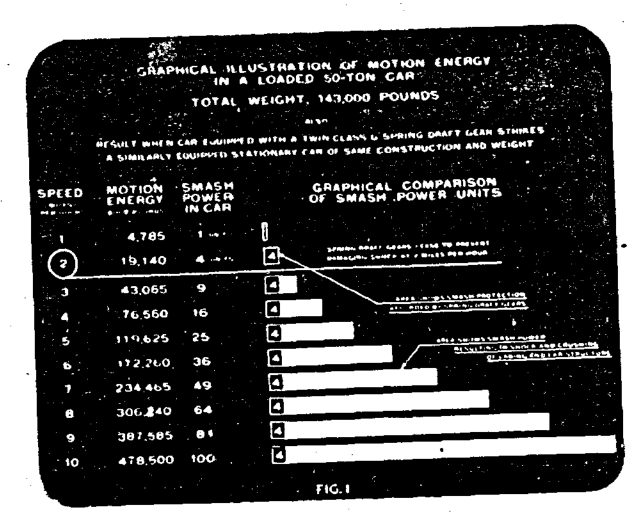


FIG. 1

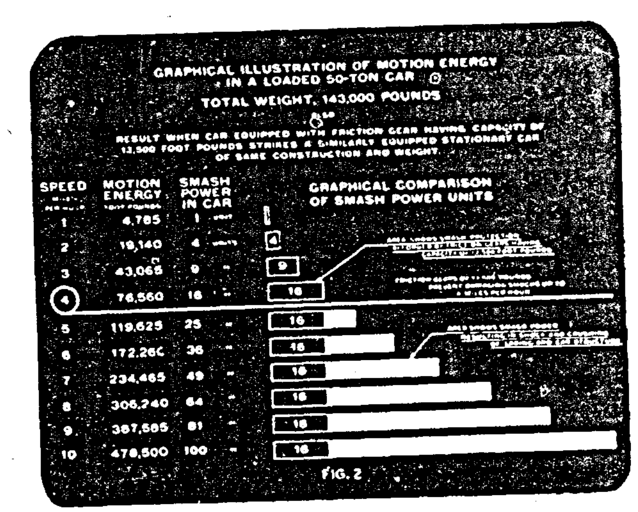
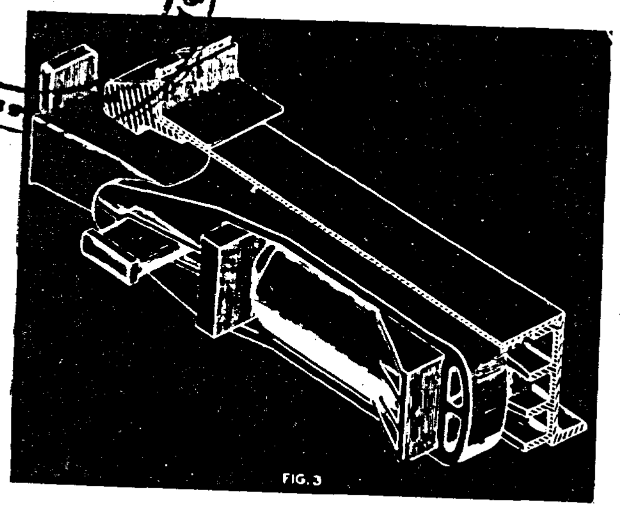


FIG. 2



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 effect upon structure and lading. The better designs of approved friction gear use surprisingly little of this safety valve 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

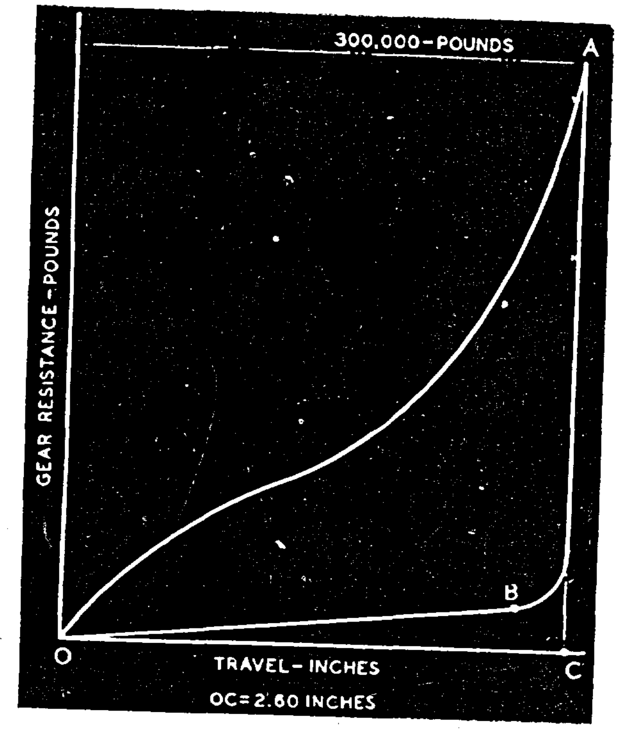


Fig. 4.

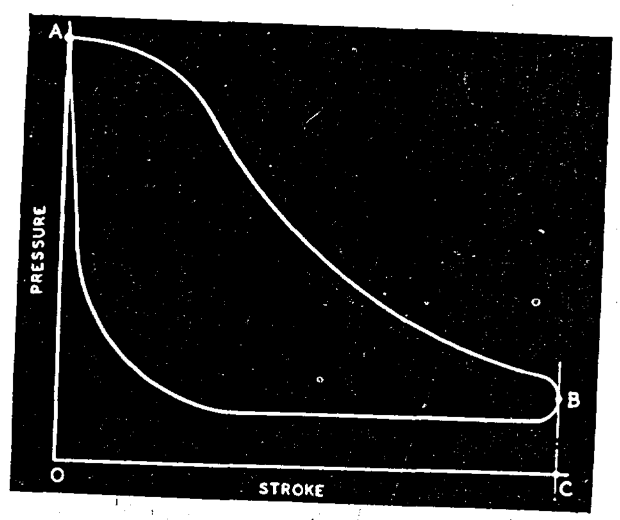


Fig. 5.

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 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 ensured by perference 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

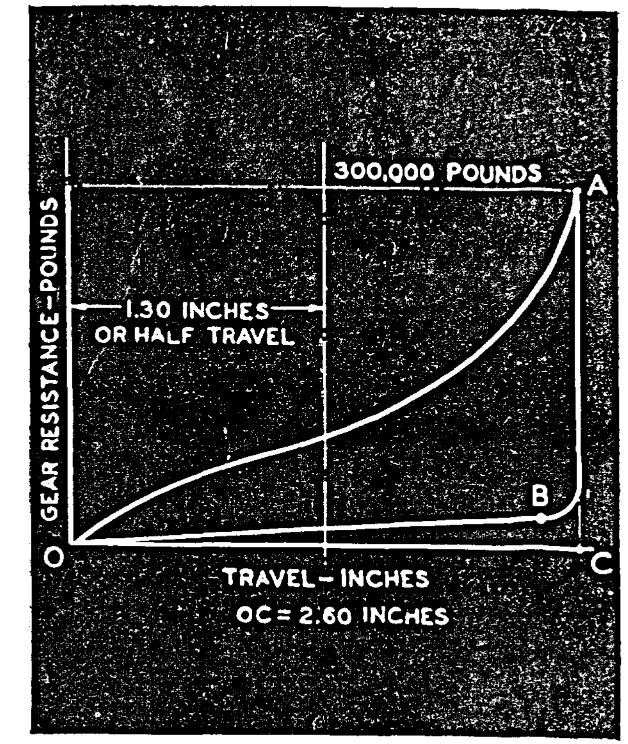


Fig. 6.

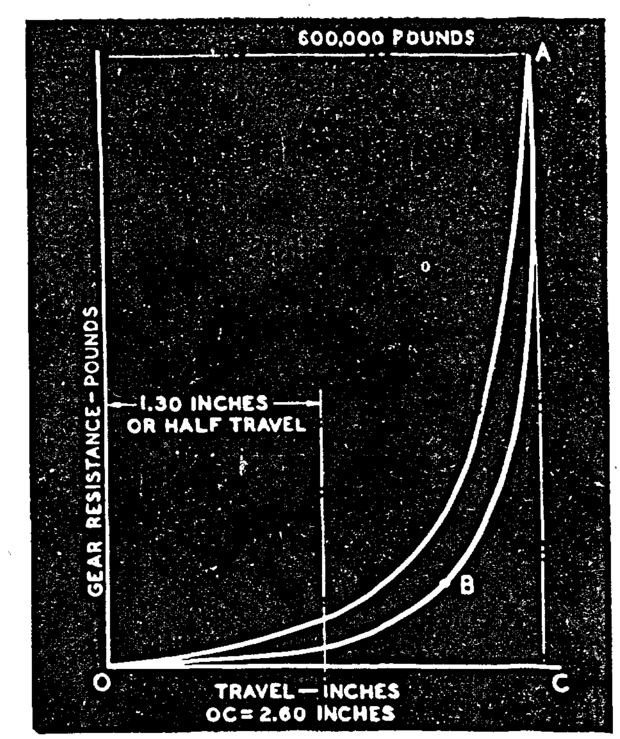


Fig. 7.

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.

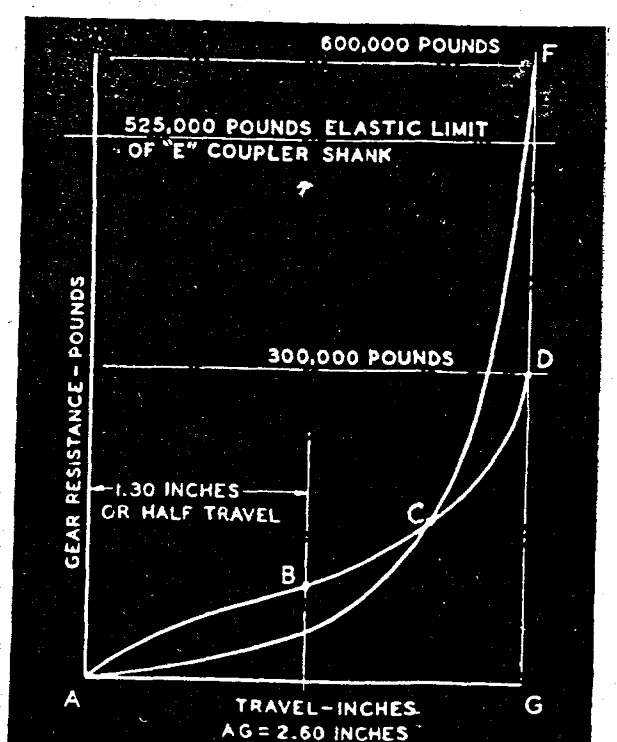


Fig. 8.

It should be emphasized that the use of rubber in a 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

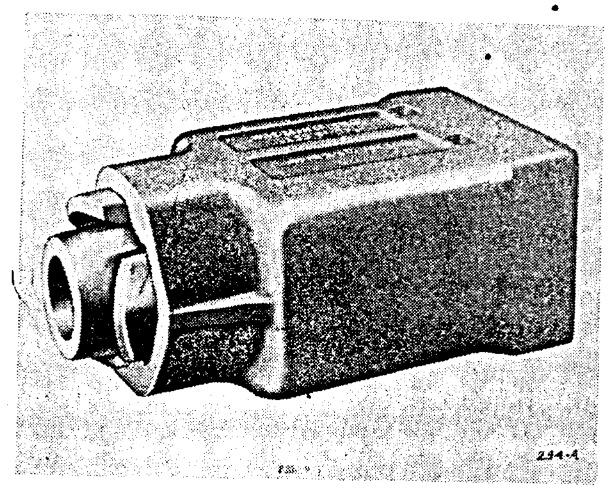


Fig. 9.

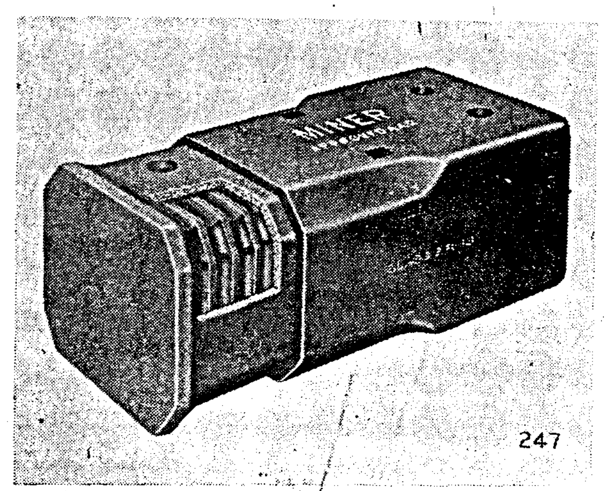


Fig. 10.

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.

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 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 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.

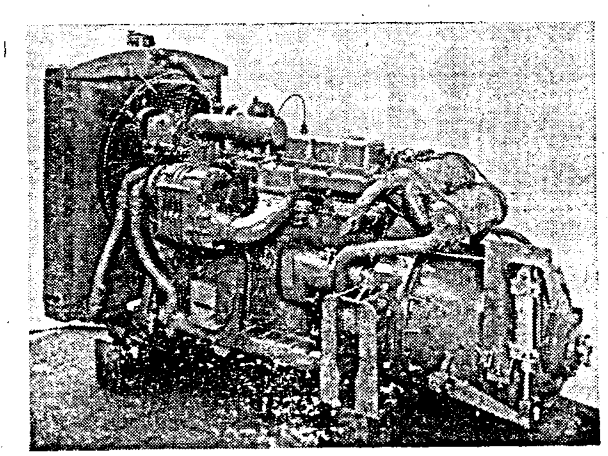


Fig. 1. Typical diesel-hydraulic unit for 700 h.p. shunting locomotive. These units can be shipped from England for local installation.

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

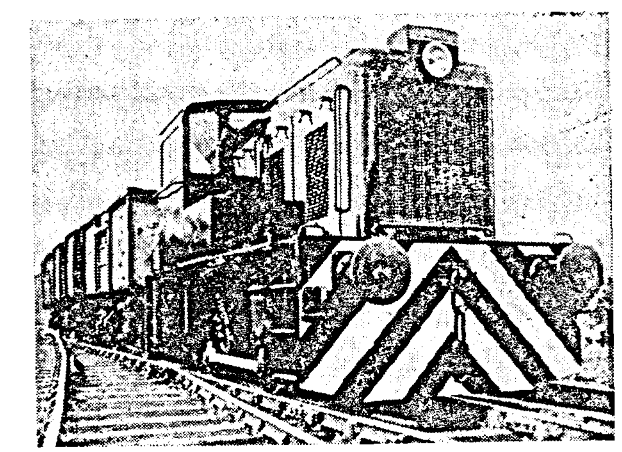


Fig. 2. Yorkshire Engine Company's 170 h.p. locomotive uses a diesel-hydraulic set: it is inexpensive to buy and easy to maintain: driving is simplicity itself.

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.

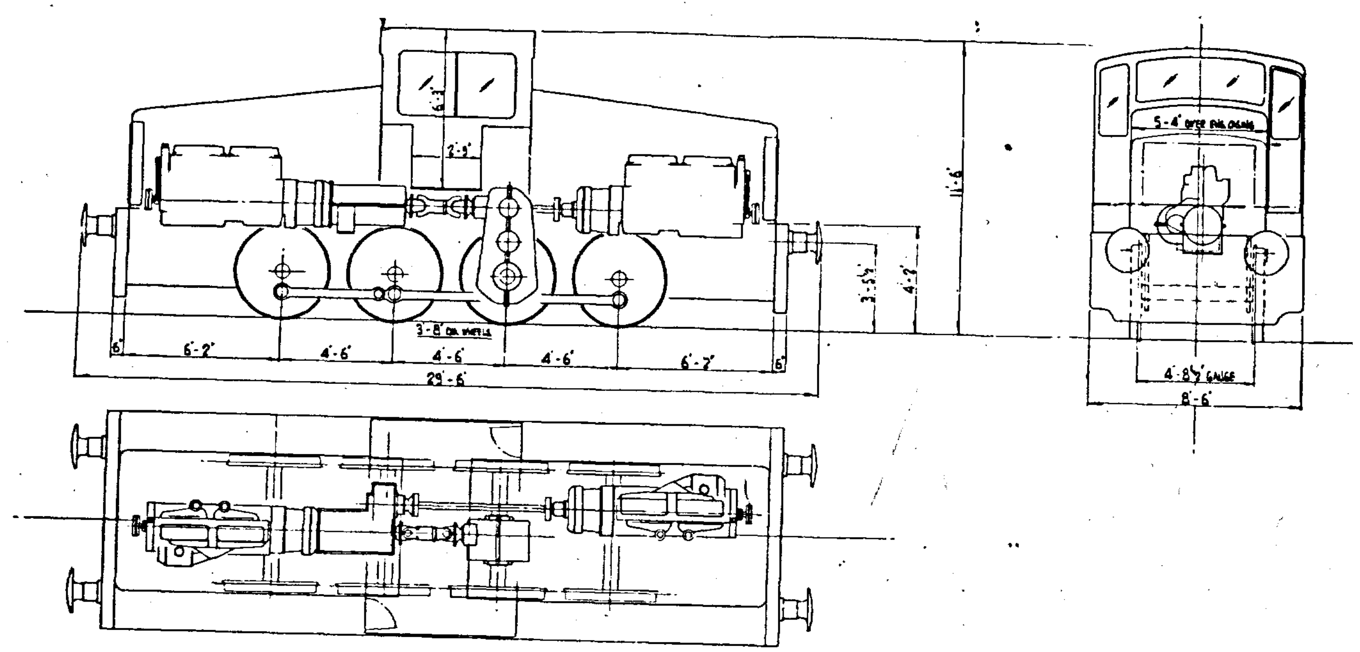


Fig. 3. Layout of Rolls-Royce differential transmission in typical locomotive.

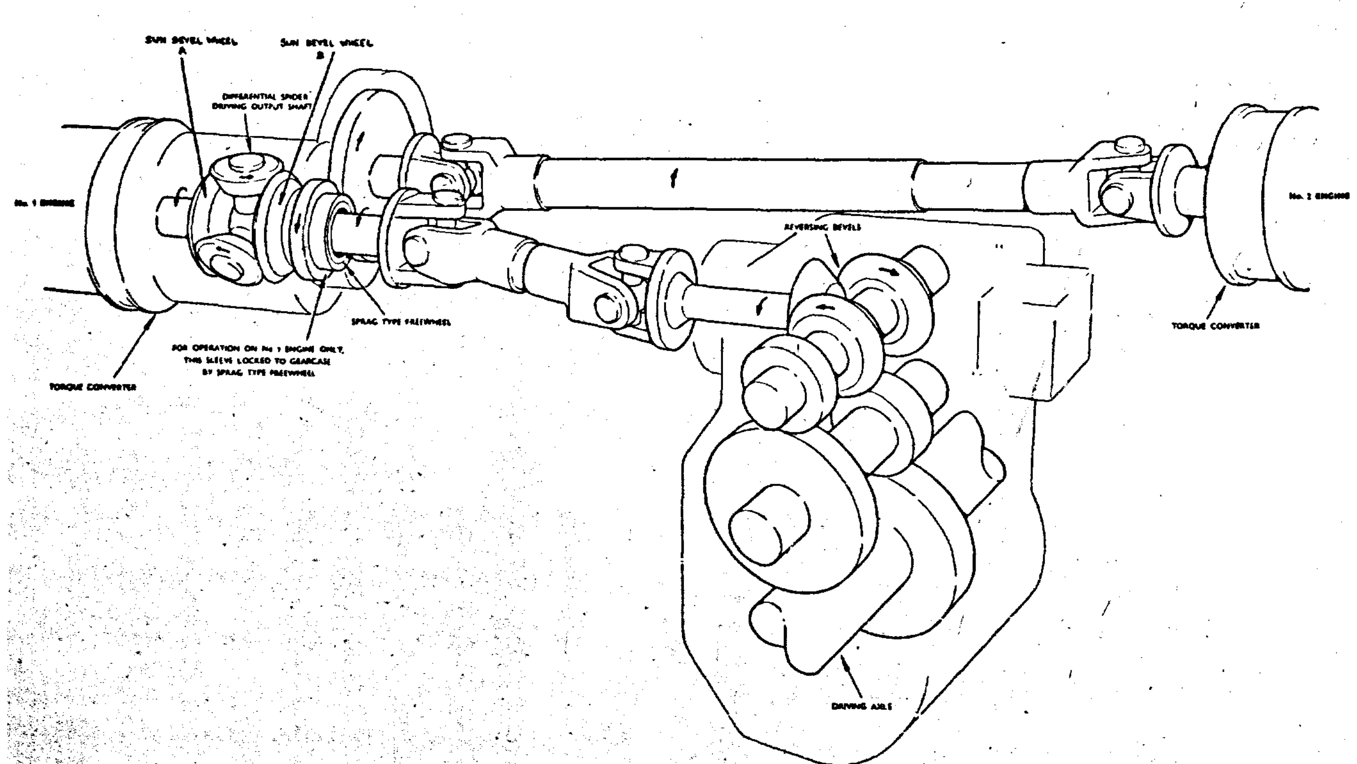


Fig. 4. Principle of operation of differential transmission.

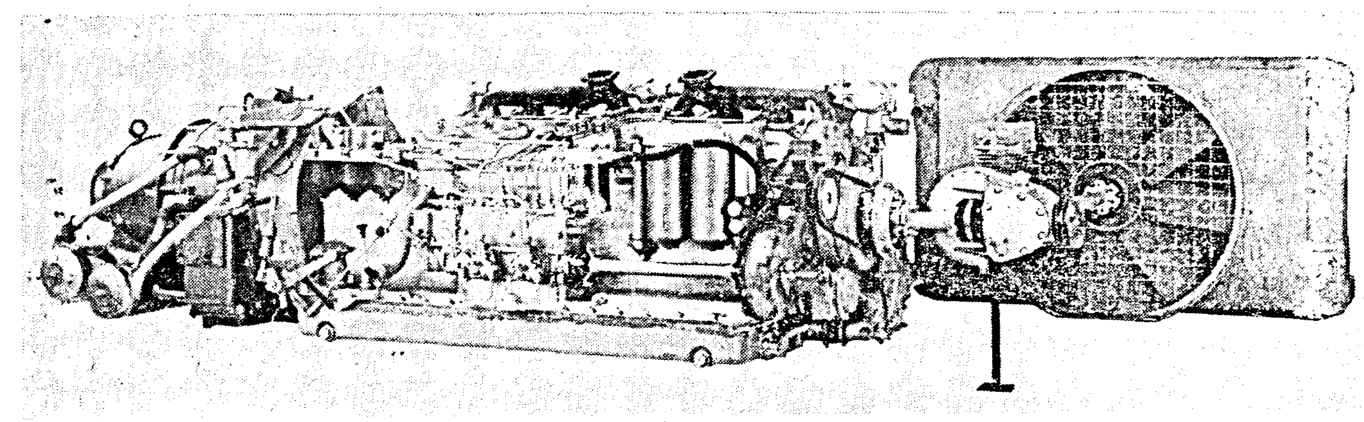


Fig. 5. Underfloor diesel-hydraulic power unit, complete with radiator and fan.

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 machanism.

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.

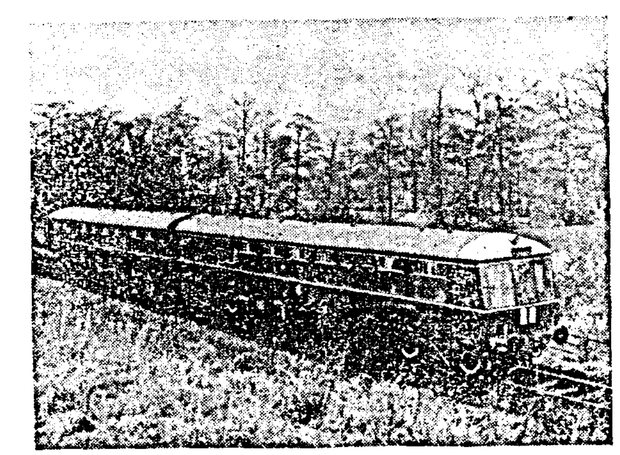


Fig 6. British Railways' two-car unit. The power car has a twin diesel-hydraulic installation.

(Continued on page 16)

Contribution of RIV Products to the improvement of Railway equipment

By Giovanni Conti

— Higher speeds and quicker accelerations.

— Higher payloads.

— Improvement of conditions making for passenger comfort.

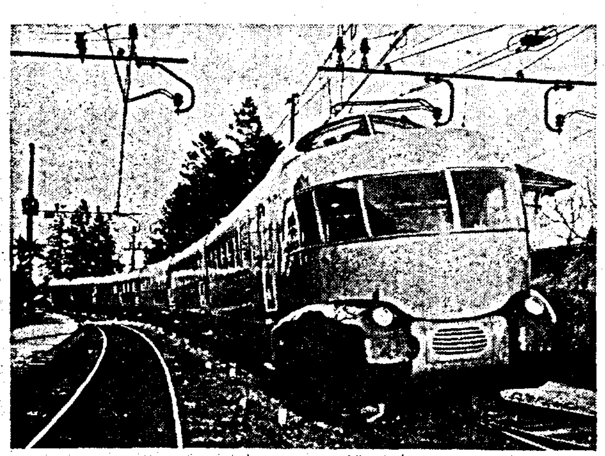
— Safer operation.

— Higher equipment turnover.

— Less maintenance.

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

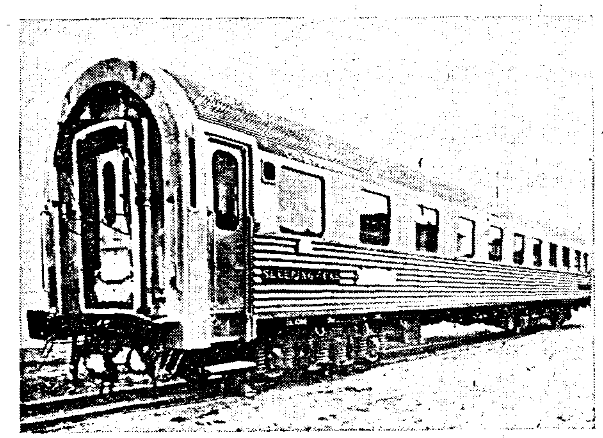
The 202-km-per-hour mark reached by the State Railway-Breda three-unit articulated electric train on a straight stretch of the Room-Formia run some twenty-five years ago—this still being something of a record for determined working conditions—is certainly eloquent evidence of the progress made in the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



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

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

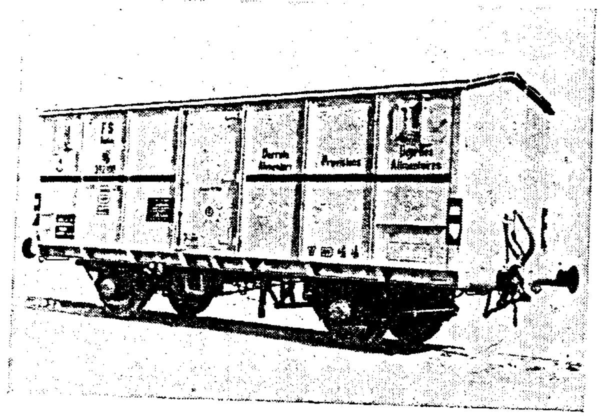
An answer to the third problem is provided by the comfort standard which can now be enjoyed by riders on certain carriages, especially those in crack trains, by reason of the excellent suspensions, freedom from objectionable noise, air-conditioning amenities.



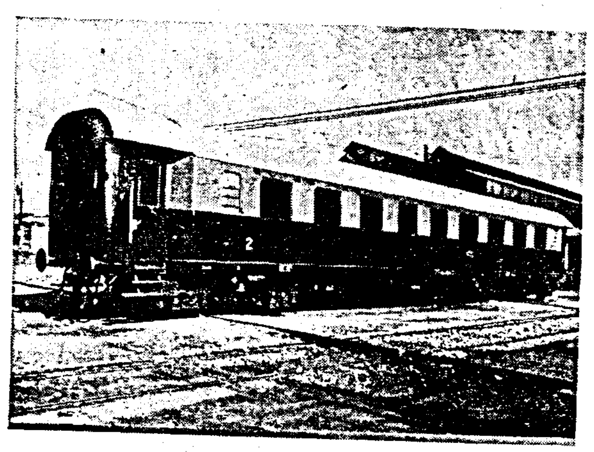
Type "P" stainless steel sleeping car manufactured by ANSALDO for Compagnie Internationale des Wagons-Lits equipped with RIV Tr 233 spherical roller bearing axle-boxes.

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

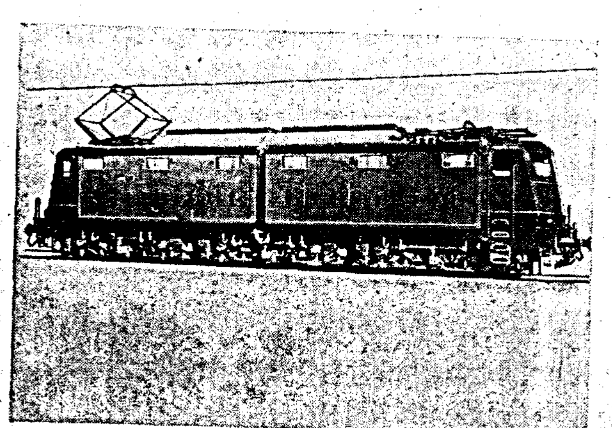
This summary information will serve as an introduction to the development of our thesis about the magnitude of RIV's contribution to the solution of the problem. A brief description of the range of products brought out by RIV for railway applications will serve the purpose of underlining that contribution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



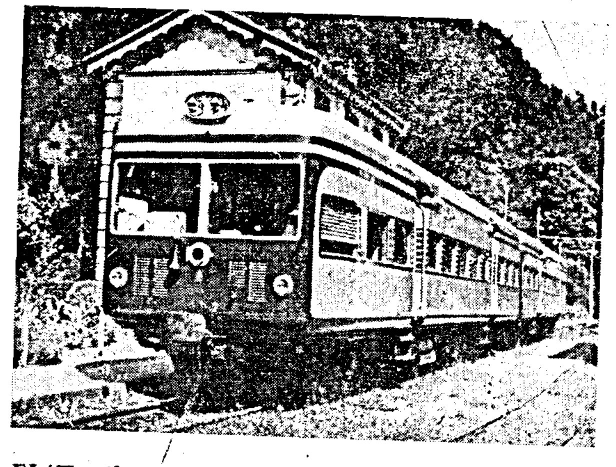
British-form refrigerator car type "Hgb" series 390,000 of the Italian State Railways, with RIV Tr 191 taper roller bearing axle-boxes.



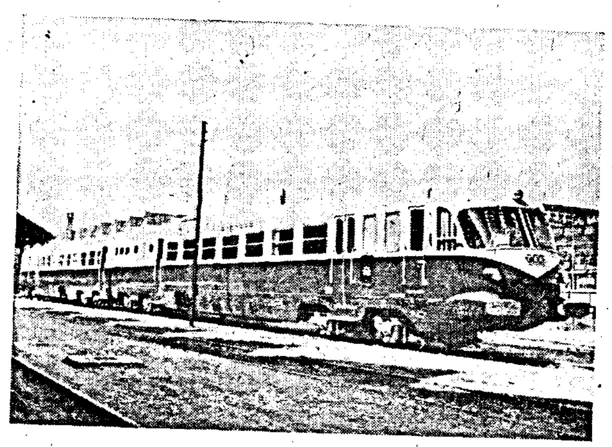
Italian State Railways 2nd class passenger coach, manufactured by BREDA, equipped with RIV Tr 196 cylindrical roller bearing axle-boxes (journal dia. 130 mm).



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



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



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

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

ROLLER BEARING AXLE-BOXES

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

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

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

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

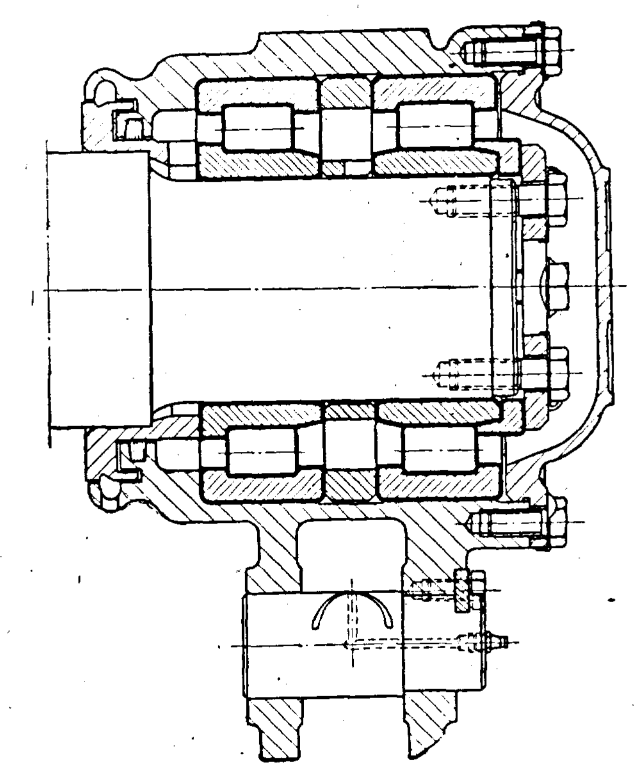


Fig. 1. Axle-box with two cylindrical roller bearings.

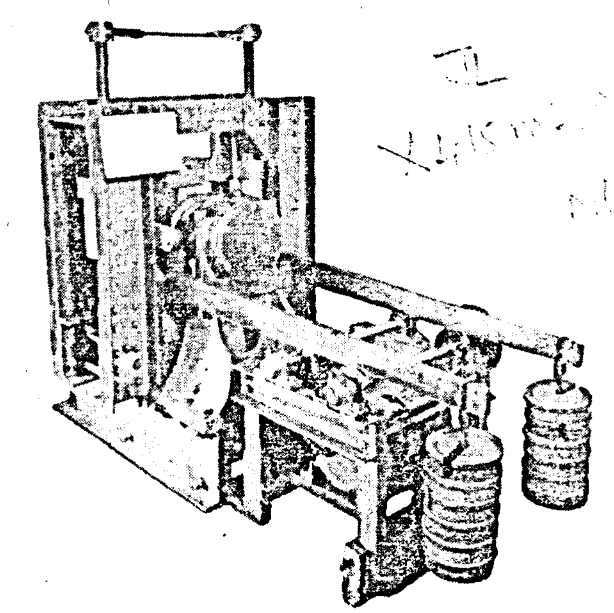


Fig. 2. Machine for testing railway axle-boxes under load.

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

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

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

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

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

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

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

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

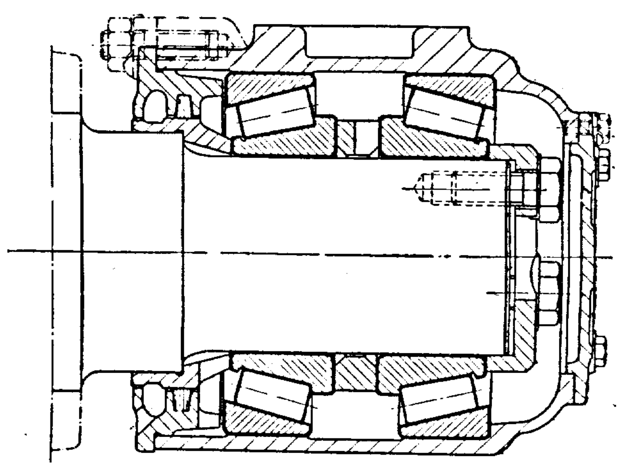


Fig. 3. Axle-box with two taper roller bearings.

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

The boundary dimensions being equal in either case, these taper roller bearing boxes have a slightly higher load capacity than the cylindrical roller type; on the other hand, they call for somewhat more frequent inspections because taper roller bearings develop a slightly higher friction. This is the reason why taper roller bearing axle-boxes have much to recommend them for freight car applications where the yearly mileages are as a rule substantially lower than is the case with passenger cars and locomotives. In these boxes, too, about 1 kg. of grease will do for 200,000—300,000 km.

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

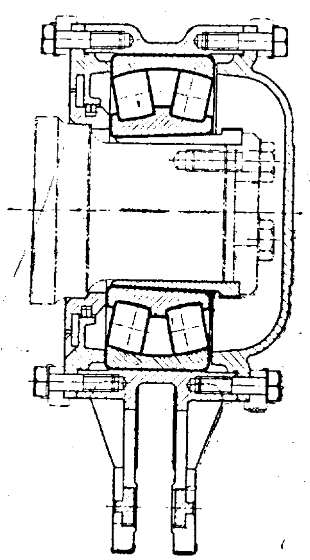


Fig. 4. Axle-box with one self-aligning bearing.

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

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

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

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

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

VARIOUS ANTIFRICTION BEARING APPLICATIONS

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

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

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

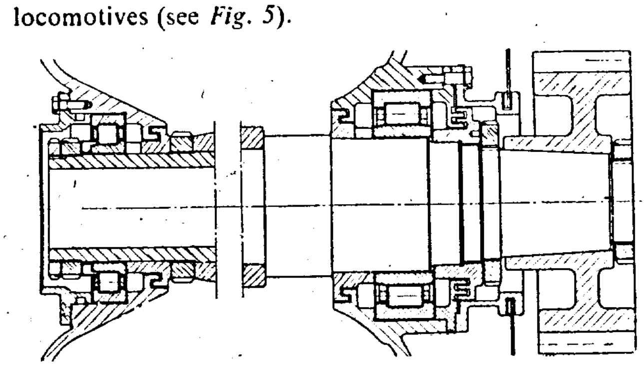


Fig. 5. Traction motor equipped with cylindrical roller bearings.

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

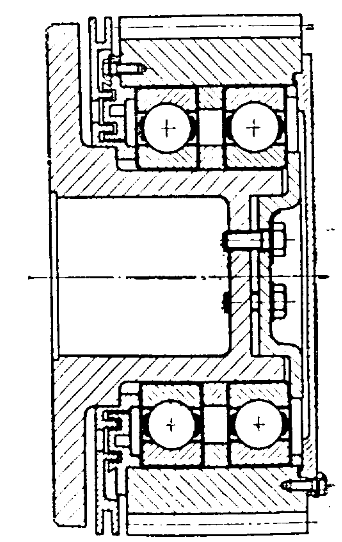


Fig. 6. Reduction gear for locomotive.

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

— A very easy end-shield mounting, because inner and outer rings are mounted separately in their respective seats and are only brought together when the various motor components are assembled ;

— A simple disassembly operation for inspection or replacement purposes;

— The possibility of matching rotors and frames of the same type without the need for any selective assembly of the bearings :

— Sufficient lubricant retention, it being possible to devise very good protection schemes and adequate grease chambers without taking up too much axial space.

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

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

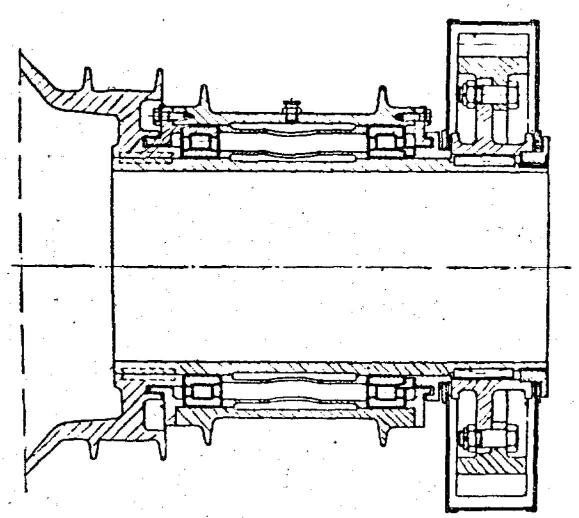


Fig. 7. Roller Bearings fitted on hollow axle of electric rail car

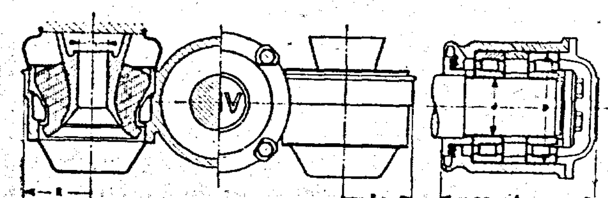


Fig. 8. Rubber springs fitted to a railway axle-box

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

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

RUBBER SPRINGS, SILENTBLOCS AND ANTIVIBRATION MOUNTINGS

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

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

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

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

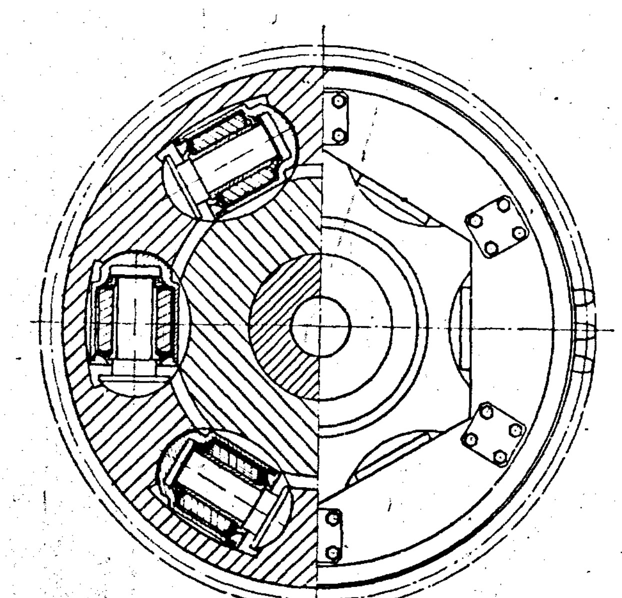


Fig. 9. Silentbloc flexible transmission.

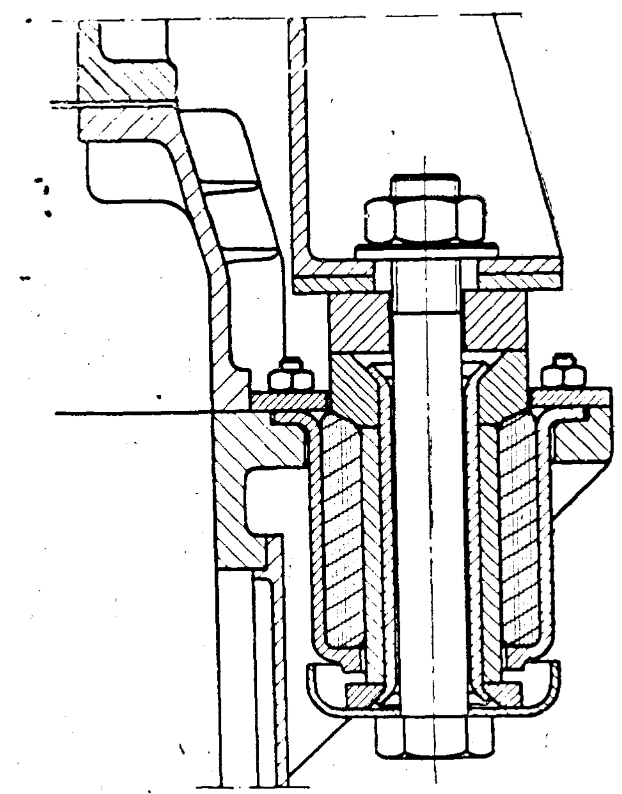


Fig. 10. Motor suspension equipped with antivibration mountings.

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

HYDRAULIC SHOCK ABSORBERS

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

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

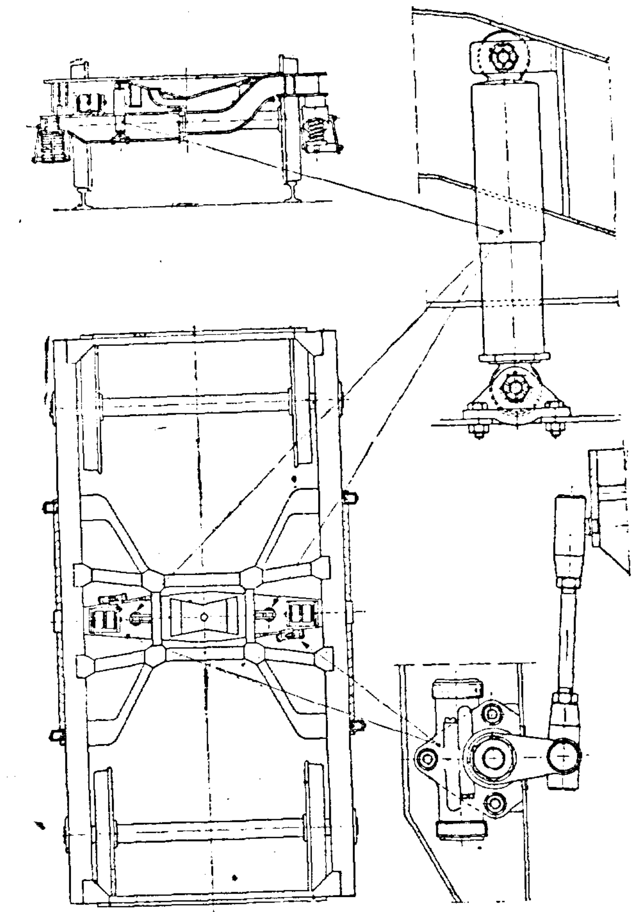


Fig. 11. Shock absorber arrangement on rail car bogie.

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

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

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

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

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).

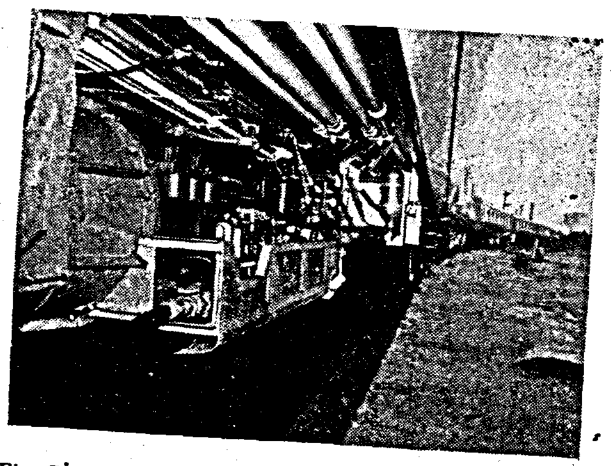


Fig. 7. Two of these horizontal engines give power for air-conditioning, heating and lighting in British Railways' new Pullman expresses.

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 coupled or detached for running to different destinations. It occupies less space in station platforms, and

(Continued from page 7)

dispenses with the need to turn locomotives round at terminals.

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 over-seas builders wishing to construct their own rolling stock, and the Company provides a consultant service on its power equipment and controls.

LEAD PIPE, ROLLED ZINC PLATE, SHEET & STRIP AND ROSIN CORED SOLDER WIRE

The Indian Standards Institution has prepared the following three draft specifications concerning lead pipes, rolled zinc plates and solder wire:

1. *Lead pipe [Doc: SMDC 12(247) (Draft Revision of IS: 404—1952)]*—The specification for lead pipe was first issued in 1952 and covered the requirements for lead pipes other than those used for chemical purposes. In this revision, metric sizes of lead pipes have been given and the requirements for lead pipes for use in chemical industry have also been incorporated.

2. *Rolled Zinc Plate, Sheet & Strip [Doc: SMDC 12(256)]*—The draft specification covers the requirements of zinc base alloys in wrought form used for eyelets and gromets, address plates, extruded and soldered battery cans, photo-engraver's plate, weather strips, boiler and ship plates, etc.

3. *Rosin Cored Solder Wire [Doc: SMDC 12(231)]*—The draft specification covers five grades of rosin cored solder wire of circular cross-section having one or more continuous cores of fluxes, either 'activated' or 'non-activated' used in radio, tele-communication and electrical industries.

These drafts, which are in English, will be circulated shortly to the interested producers, consumers and technologists for eliciting technical comments, for a period of three months.

MOBILE POWER STATION FOR RUSSIA

IN the face of severe Continental competition, Ruston and Hornsby Limited of Lincoln won an order to supply Russia with a mobile power station, which they have now despatched.

This British-built plant (the first of its kind) is powered by a Ruston Mark TA 1,000 kW gas turbine, the first British industrial gas turbine to be exported to the USSR. Mounted on a specially constructed railway wagon, the plant will be used as an electric power source for semi-isolated civil construction sites (where power distribution lines are not available) and for small townships temporarily cut off from electric supplies by severe weather.

The gas turbine burns oil or natural gas fuel and drives a 6.6 kV 3 phase alternator. It was designed to operate in extreme climatic conditions, with air temperatures as low as-40°C. This type of gas turbine is now in use throughout the world, both on land and sea, for a variety of purposes ranging from auxiliary power supply on board a naval vessel to pumping power for oil pipelines. Outside the United States, Ruston and Hornsby is the only company manufacturing gas turbines of this type on a batch production scale. Since commencing production on this scale they have sold more than 100 gas turbines of the TA type.

The complete rail wagon assembly (with gas turbine, electrical equipment and auxiliary plant) weighs about 65 tons and measures approximately 66 ft. by 14 ft. by 10 ft. The weight of the railway wagon accounts for about half the total assembly weight, and the chassis for this 30 ton unit was specially constructed in Belgium and shipped to Lincoln. The bodywork of the wagon and the remaining equipment (apart from the electrical and compressor gear, and minor ancillary equipment) was designed and manufactured by Rustons.

When the wagon is stationary and the power plant operating, the sides of the wagon body can be opened upwards to form flaps, as illustrated, to facilitate operation and allow maintenance work to be carried out. Strip lighting (8) is used inside to provide uniform illumination when the body flaps are down or when the plant is operating at night.

ARRANGEMENT

Divided into three main sections, the mobile power plant is entirely self-contained and may be transported as required.

The first section (shown at the right-hand end of the wagon) houses the mechanical auxiliary equipment which includes the fuel supply system with a 1,000 gallon oil fuel tank (7), and a diesel-driven gas compressor (5). When the turbine is operating on natural gas (which is piped from an external source since space restrictions preclude the storage of this fuel) this separate compressor is necessary to bring the incoming gas to a suitable working pressure. The two-stage reciprocating compressor is driven by a Ruston 6YDA air-cooled 110 b.h.p. engine (6) from the company's most recent range of air-cooled diesels and represents the largest air-cooled engine they manufacture. An air-cooled diesel was necessary for this duty because such an engine is not handicapped by extremely low temperatures as is a water-cooled unit.

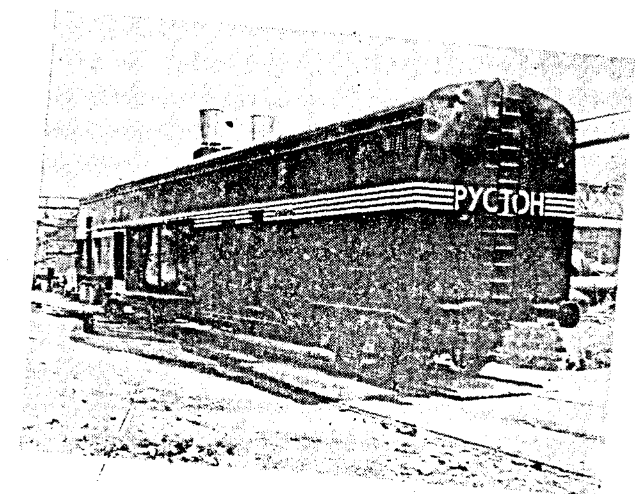
The centre-section of the wagon contains the heart of the power station. Here the Ruston TA gas turbine (1) is installed, together with the alternator (2) that it drives. The gas turbine weighs about 6 tons (less than one-tenth the complete station) and occupies just over one-fifth the wagon's total length. This compact and relatively lightweight power unit may be started from cold in a matter of seconds, or immediately shut down from full-load. This is made possible by the "kinematic" design which allows free thermal expansion and contraction, while maintaining alignment during heating or cooling.

Some details of the Ruston TA gas turbine, a simple, open-cycle type with free turbine, now follow:

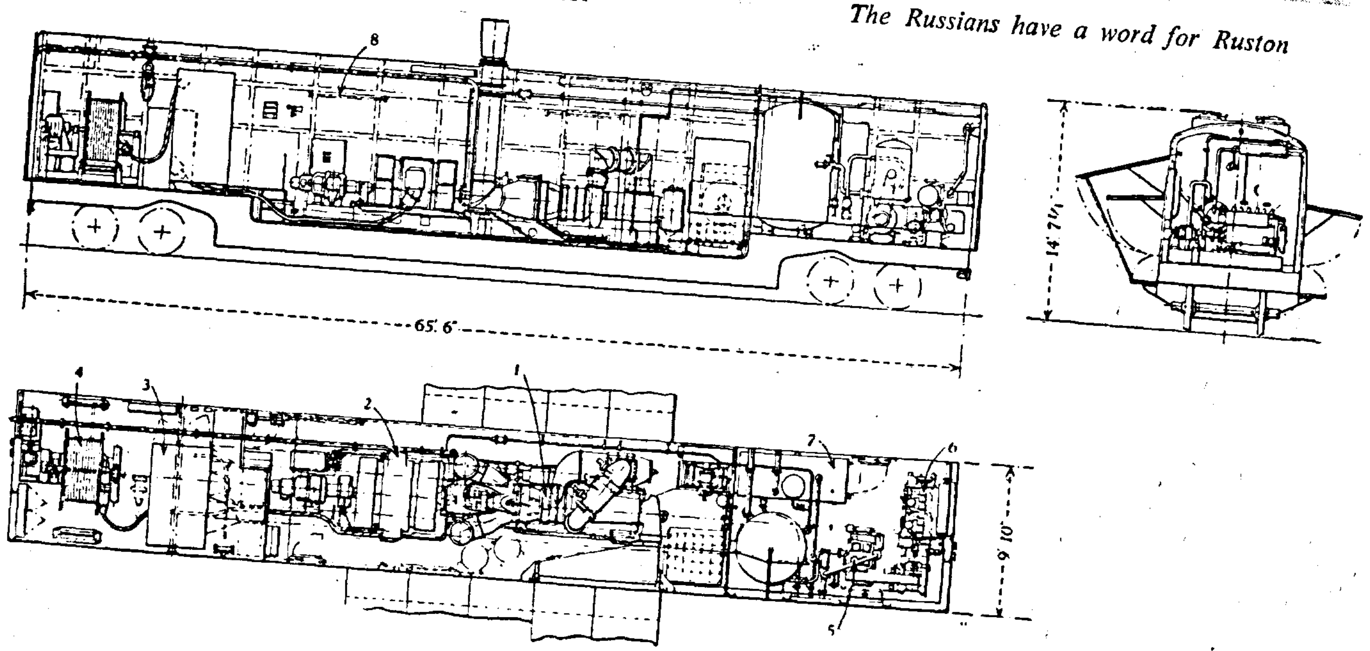
THE TA GAS TURBINE

Air enters the 13 stage compressor under atmospheric conditions, the inter-action of the succeeding rows of rotor and stator blades producing a steady increase of pressure. On delivery from the compressor, the air is heated to maximum temperature and greatly increased in volume by burning liquid or gaseous fuel, a process which takes place in the combustion chamber with minimum loss in pressure. High temperature gases from the combustion chamber are partially expanded through the compressor turbine, which is directly coupled to the compressor. This unit forms a gas generator, the output of which is varied automatically according to the load. The gases are finally expanded to atmospheric pressure in the power turbine, which is independent of the gas generator rotor system, but coupled through reduction gearing with the driven machine.

Mobile power station leaves for USSR



The Russians have a word for Ruston



Layout of the wagon noting installation details

GAS TURBINE SPECIFICATION

Rating—Normal continuous rating, in an ambient temperature of 80°F: 1,260 b.h.p.

Output shaft speeds—Standard output shaft speeds: 1,200, 1,500, 1,800 and 6,000 r.p.m.

Compressor—13 stage axial flow.

Turbines—Both the compressor and power turbines are 2 stage axial flow, the rotors being cooled by air fed from the compressor.

Combustion chamber—Single all-metal, elbow type, combustion chamber, equipped with burners suitable for liquid and gaseous fuels.

Starting system—24 volt d.c. starter motor engaging with the front end of the compressor shaft. Starting is carried out by the operation of a single hand wheel which controls the fuel supply and the operational sequence of the electrical circuits during the starting cycle.

Bed-frame—Fabricated steel. The bed-frame also forms the lubricating oil reservoir.

Control system—Hydraulic control system supplied with servo-operating oil from the engine lubrication system. Governor of standard counter-weight type fitted. Control cubicle also contains turbine instruments and controls, including the starting control.

Protective devices—Automatic devices for protection against overspeed, loss of lubricating oil pressure and excessive gas temperature.

The third section houses the electrical equipment:—switchboard, voltage and current transformers, circuit-breakers and a motor-operated reeling drum (4) which accommodates 100 yards of armoured, flexible 3 core cable capable of carrying the 1,000 kW 6.6 kV supply. The electrical power take-off via this drum may be obtained from either side of the wagon through suitable outlets in the wagon body so that the cable can be paid out at will.

All the electrical equipment, alternator with exciter and pilot exciter and control gear was supplied by Crompton Parkinson Limited. A brief description follows:—

ELECTRICAL EQUIPMENT

The alternator has an output of 1,250 kVA, 0.8 power factor, 6,600 volts, 3 phase, 50 cycles 1,500 r.p.m. It is a filter ventilated machine, there being an aerofoil pattern fan at each end of the rotor. Each fan draws in air through two Vokes filters mounted in the end covers, and this air circulates through the windings and is exhausted through an opening at the top of the stator frame. The Vokes air filter for the main exciter is mounted in the bed plate underneath the commutator endshield. The pilot exciter is totally enclosed.

The control gear consists of two fixed steel cubicles carried on anti-vibration mountings and is designed for both single and parallel running. The two voltmeters, synchroscope and frequency meter are mounted on a fixed steel panel immediately above the neutral earthing switch.

Protection comprises a PBO over-current relay and a separate relay to give restricted earth fault protection. The field suppression equipment is mounted inside the exciter cubicle, which also houses a 7½ kVA transformer which provides power for the axiliaries. Because this transformer is required to be energised whenever the machine is running, irrespective of whether the main circuit breaker is open or closed, it is fed directly from the incoming terminals and is protected by HRC fuses and included in the zone of restricted earth fault protection.

The automatic voltage regulator (by Brown Boveri) can maintain the voltage within plus or minus 0.75 per cent.

(Courtesy: Engineering)

Draft Indian Standards for Structural and Metals Industry

The Indian Standards Institution has prepared the following seven draft standards of interest to the structural and metals industry:

Flattening Test on Steel Tubes [Doc: SMDC 3(276)]—This standard specifies flattening test on steel tubes having an external diameter nut greater than 400 mm and a thickness not greater than 15 percent of the external diameter. However, individual specifications for material may specify the maximum diameter and thickness of tube to which this test is to be applied in particular circumstances.

Bend Test on Steel Tubes [Doc: SMDC 3(277)]—This standard prescribes the method of conducting bend test on steel tubes in full section, having an external diameter not greater than 60 mm.

Flanging Test on Steel Tubes [Doc: SMDC 3(278)]—This standard applies to the flanging test on steel tubes having an external diameter not greater than 150 mm and a thickness not greater than 9 mm.

Drift Expanding Test on Steel Tubes [Doc: SMDC 3(279)]—This standard prescribes the drift expanding test on steel tubes of circular cross section, having an external diameter not greater than 150 mm and a thickness not greater than 9 mm.

Calibration of Brinell Hardness Testing Machines [Doc: SMDC 3(280)]—This standard applies to the calibration of testing machines for determining Brinell hardness.

Test for Expansion of Copper and Copper Alloy Tubes [Doc: SMDC 3(281)]—The method of test specified in this standard is applicable to copper and copper alloy tubes having an external diameter not greater than 100 mm. for the discovery of defects and verification of ductility.

Mercurous Nitrate Test for Copper and Copper Alloys [Doc: SMDC 3(282)]—This standard prescribes the method for conducting the mercurous nitrate test of wrought copper and copper base alloy products. It is an accelerated test for the purpose of detecting the presence of residual (internal) stresses that might bring about failure of the material in service of storage through stress corrosion cracking.

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Whiter Non-Ferrous Metals in Railways

By M. R. Sreenivasan *

THE main stay of the Non-Ferrous metal manufacturing units in India is the Railways, who are the major consumers of Non-Ferrous Metals and Alloys in this country. In the absence of sufficient encouragement from the Indian Railways the Non-Ferrous Industries in India will be affected to a very great extent in as much as it cannot use its installed capacity at least partly.

The Indian Railways have an obligation in this respect to help the Non-Ferrous Industries in keep-going. It is but natural that the railways will as far as possible not only keep the Industries going but also will not themselves undertake the manufacture of any Non-Ferrous Metals and Alloys in their shops.

Broadly the requirements of Indian Railways fall under the following categories:

1. *Regular Demands:*
   - (a) Copper Based Alloys conforming to I. R. S. Specn. N6/49 Class I, Class II, Class III & Class IV.
   - (b) Antifriction Bearing Metal I. R. S. Specn. N10/54 Class I, Class II, Class III & Class IV.
2. *Occasional Demands:*
   - (a) Railways also require Phosphor Copper for de-oxidising purposes and also
   - (b) Soft Solder for Soldering purposes.

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Outright purchases of these Alloys are channelled through the Director General of Supplies & Disposals, New Delhi, while the conversion of Non-Ferrous Arisings out of machining operation of the respective Railways are handled by the purchasing branch of the Railways. The exact figures of consumption of the above Railways are not available but experience shows that the requirements of the Indian Railways fall between 4,000 to 5,000 Tons per year. This does not take into account the two Locomotive manufacturing units in India.

1. The Tata Locomotive and Engineering Works Ltd.
2. The Chittaranjan Locomotive Works.

The main stay of the Non-Ferrous manufacturing units in the country are the Railways in as much as at present there is no other industrial undertaking requiring Non-Ferrous Metals in such large quantities as these units can produce and supply basing on their installed capacity.

Baring the small percentage of copper ingots manufactured by the Indian Copper Corporation in West Bengal. India has to look to foreign sources for the supply of balance quantity of Copper and the entire requirements of Lead, Tin and Zinc. This being the situation whatever arisings the Railways obtain from the machining operation of the castings they produce out of the Alloys made available to them assume greater importance. The Non-Ferrous Borings offered by the different Railways from time to time cannot be used for the grade of Alloys they specify against such accumulations, the reason being the Railways are not taking proper care to have the different grades of Borings stored separately taking care to have the foreign matters, such as Iron, etc., do not get into these accumulations. It will be more profitable for the Railway to exercise proper care to have these accumulations of different grades of Alloys separately, in that they would be able to obtain more favourable quotation for conversion of these arisings into that particular grades.

At times it is found that the scrap lot offered for conversion is to be simply traded in for as the manufacturers have to provide their own raw material, in which case, naturally, the conversion charges are bound to be higher.

It is observed from the tenders and orders issued by the DGS & D that large quantities of virgin metals are procured on behalf of railways presumably for the manufacture of different grades of alloys in their own workshops. This procedure is not conducive to the satisfactory working of the Non-Ferrous units of this country since they are deprived of that much of quantity of Non-Ferrous Alloys made by the Railways themselves. It is also doubtful whether the Railways can manufacture these Alloys as economically as the Smelters and Refiners can do, in as much as the latter is specialised in handling such production.

There are instances where some Railways are disposing of their accumulations of Non-Ferrous Borings, whereas looking to the present tight foreign exchange position of the Indian Government it would be more advantageous for them to invite tenders and have these accumulations converted into grades of Alloys they require.

* Bombay Metal & Alloys Manufacturing Co., Private Ltd., Bombay.

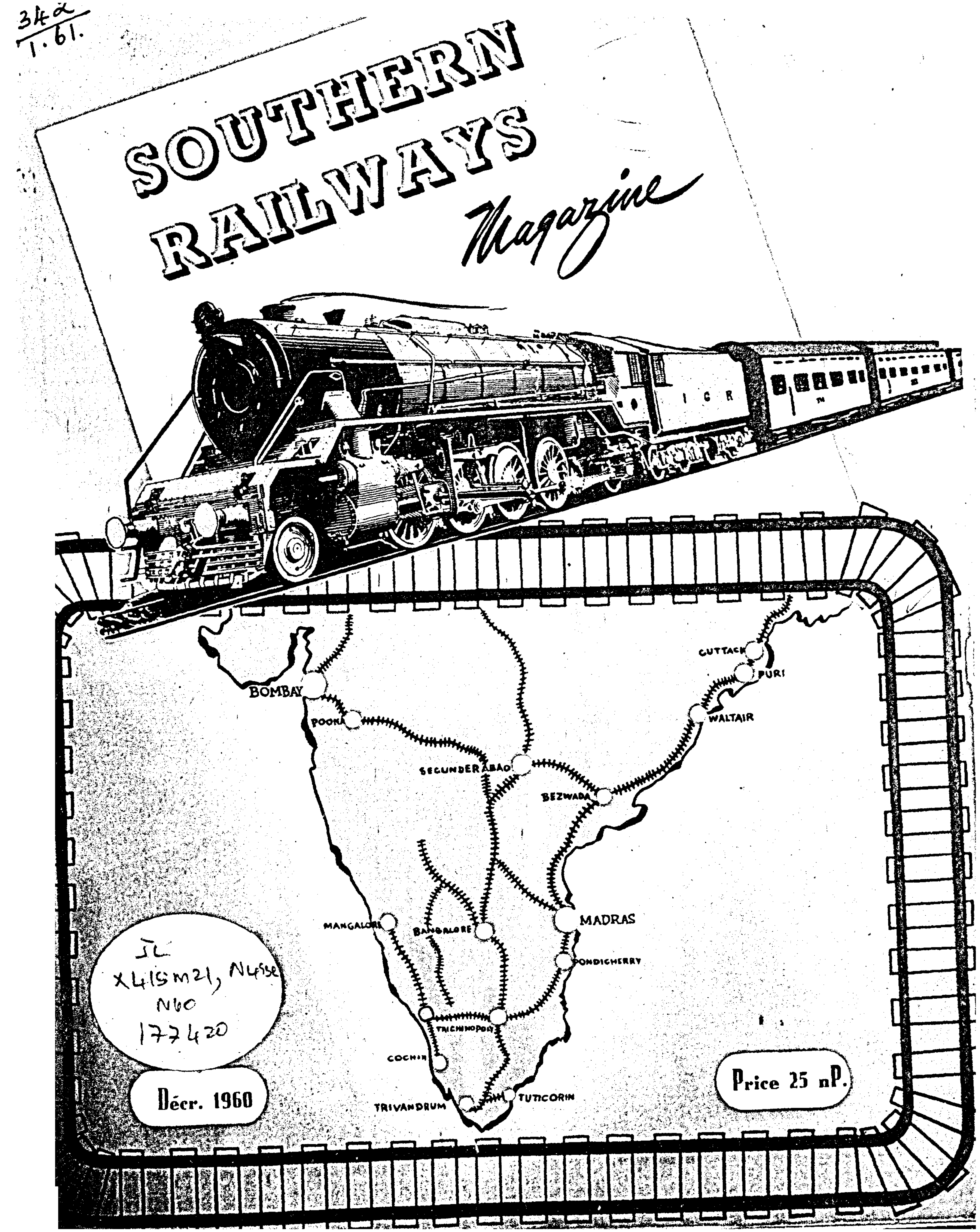
CLEANLINESS LEADS TO HEALTH AND HAPPINESS

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

Cleanliness prevents disease; medicine only attempts to cure.

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

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



HOW TO RESERVE ACCOMMODATION

Unless you reserve your berth (I Class) or Seats (II and 3rd Class long distance) in advance, you may not be sure of getting accommodation on the train you wish to travel by.

Application should be made to the Station Master of your starting station at least 3 days in advance specifying the date and train by which you intend travelling and the tickets must be bought in advance. The reservation fee leviable is 50 nP. per seat or berth.

Reservation by I and II Class from intermediate stations by Express trains can also be made similarly, but reservation ticket can be issued only after getting an advice from the Reservation Centre that the reservation has been made.

Tickets will be issued only if accommodation is available.

If the reserved seats or berths are not occupied at least 5 minutes before the booked departure of the train the reservation will be cancelled and the seat or berth given away to another.

Reservation fee is not refundable

III Class seats are also reservable on Express and certain other important trains for long distance passengers from the train-starting stations on payment of a reservation fee of 25 nP. per seat.

Do not occupy a berth or seat reserved for another, as you are liable to be displaced at the last moment.

If you find another person occupying the berth or seat reserved for you and if he will not vacate it on demand, report it to the Guard or Station Master. They will help you.

(Inserted in the interests of Travelling Public)

Bagnall's Contribution to World's Railways

By An Engineering Correspondent

Messrs. W. G. Bagnall Limited of Stafford, England are one of the old locomotive builders and railway engineers.

The business was first started in 1875 and the company has concentrated on manufacturing locomotives, wagons, turntables and all kinds of light railway rolling stock for every conceivable purpose and in the early years built an enormous amount of smaller type steam locomotives for use in quarries, tea and sugar plantations and such light services at home and abroad.

During the last twenty-five years, however the works have been considerably extended and the plant made of suitable capacity to handle the large locomotives now running on the British main-line systems and the main Indian Railways and all railways of other countries abroad.

For the last six years they have designed and built diesel mechanical and diesel hydraulic locomotives as well as building diesel electric locomotives.

Connection with diesel locomotives, however, dates back to 1933 when an order was received for a 22 h.p. double-bogie mine locomotive. This was fitted with a two-cylinder DEUTZ two-stroke engine of 22/24 b.h.p. at 700 r.p.m. It was completed in 1934 and delivered for underground working at a colliery in North Wales.

Another order was received in June 1934 for a larger machine. This time a locomotive powered by a 45/50 b.h.p. DEUTZ engine running at 1000 r.p.m. for working underground in conditions involving fire-damp. Complete elimination of harmful gases from the exhaust was effected and there was no danger from fire. The locomotive weighed eight tons in working order and had four speeds. It was delivered in January 1935 for service in Scotland at King's Hill Colliery, owned at that time by Coltness Iron Company Limited, New Mains, Lannark.

Prior to the last war and for several years following about 60% of all orders were for export to India.

Numerous steam locomotives were designed and built for Indian Railways and the leaflet illustrates many types and gives details of them.

A number of fireless steam locomotives have also been designed and manufactured for use where there is a danger of fire and in all locations where adequate supplies of steam are available from stationary boiler plant. They can be built for very much less than the cost of diesel shunters of equivalent power, while the absence of a boiler and firebox make them cheap to maintain and operate. They also have a very high availability for traffic.

Many other steam locomotives were designed and built for use in this country and in other countries throughout the world.

When design and manufacture of diesel locomotives was re-started after the war the first order was for Ten 240-H. P. 0-6-0 shunters of 3′ 6″ gauge for the New Zealand Government Railways and one 240 h. p. 0-6-0 shunter for Tasman Pulp and Paper Company Limited, New Zealand.

Since then diesel mechanical locomotives have been designed and built for service in The Middle East, South Africa, and for the National Coal Board and other industrial concerns in England.

On the diesel mechanical locomotives the transmission consisted of Fluid Coupling, Cardan Shaft, Air Operated Change Speed Gearbox, Flexible Coupling, Air Operated Reverse and Final Drive Gearbox, Jackshaft and Coupling Rods.

At present diesel hydraulic locomotives are being produced and on this type the transmission consists of Torque Converter, Cardan Shaft, Air Operated Frame-mounted or Axle-Mounted Reverse and final drive gearbox and coupling rods.

The complete range of hydraulic locomotives cover H. P.'s of 30–700 and are divided into the following groups :

17/7/2020

30— 60 H. P. with chain drive from the final drive gearbox to the rail wheels.

70—100 H. P. with single stage torque converter and chain drive.

70—100 H. P. with three-stage torque converter and chain drive.

150 H. P. with three-stage torque converter and chain drive.

150—300 H. P. 0-4-0 type with rod drive.

232—456 H. P. 0-6-0 type with rod drive.

Leaflet No. B1 gives the leading particulars of the standard 0-6-0 diesel hydraulic locomotives for Metre Gauge upwards.

Leaflets Nos. B16 and B17 give details of the 70-100 H. P. standard 0-4-0 chain driven diesel hydraulic locomotives for Narrow Gauge and Standard Gauge respectively.

In 1951—2 Underframes, Bogies and Mechanical Parts were manufactured for 25 main line diesel electric locomotives of 1,000 h. p. for the Ceylon Government Railways. These locomotives were AIA-AIA type 5′ 6″ gauge and weighed 87 tons in working order. They had a maximum speed of 55 m.p.h., a starting tractive effort at 26% Adhesion of 33,700 lbs., a tractive effort (1 hour rating) of 30,000 lbs. at 9.2 m.p.h. and a tractive effort (continuous) of 24,000 lbs. at 11.7 m.p.h. The locomotives were powered by a Mirlees engine type JS12VT developing a continuous power at site of 1,000 h.p. at 850 r. p. m.

Since then the following diesel electric locomotives have been built for operation in steel works and at collieries in Great Britain.

0-4-0 type of 300 H. P., 0-6-0 type of 366 h. p. and Bo-Bo type of 515 b.h.p. In addition mechanical parts up to deck plate level have been produced for the 300 h. p. 0-4-0 type, 400 h.p. 0-6-0 type and 875 h.p. Bo-Bo type diesel electric locomotive. Further more mechanical parts up to deck plate level have been manufactured for British Railways type 2 diesel electric locomotives.

It will therefore be seen that the company by the construction of locomotives of varying size have given a demonstration of the capacity of their works and also of their ability as a firm to produce locomotives of the highest standard.

JL

One Plant will produce a Million Tons of Cement A Year

The new cement plant near Leningrad, construction of which is in the finishing stages, will have an annual output of nearly one million tons. It will be one of the world's most modern, fully automated plants. Its sacking machines, for instance, will have an hourly output of 2,000 sacks. No wonder this huge enterprise will have a staff of only 20 workers and engineers: a fraction of the personnel at any cement plant abroad. Six such plants are now being built in the USSR. This year the Soviet cement output will reach 45 million tons, much more than produced in Britain, Italy and France taken together. In the seven-year period cement production will double.

* * *

UNUSUAL TOWER CRANE

A new type of tower crane has been put into production at the Kuibyshev Construction Machinery Plant. In transporting the machine from one place to another there is no need to dismantle it. The arm is lowered and the whole aggregate folds into a horizontal position. Then wheels are put on its steel "legs" and a lorry hauls it to its destination. Once there, special mechanisms fitted to the crane push the arm and the body into an upward position again. The plant will build 15 such cranes before the end of the year.

Another interesting machine being assembled at the plant is a wheeled crane capable of lifting 20 tons.

* * *

40 COUNTRIES RECEIVE BYELORUSSIAN TRACTORS

There is one industrial establishment in Byelorussia to-day to every 3,200 of its population. Byelorussia has already outpaced the USA and Britain in the per capita output of tractors, which it exports today to 40 countries of the world. Its per capita output of metal-cutting machine tools and lorries is greater than in many European countries. Since January 1, industrial output has increased by 14 per cent in comparison with the corresponding period of last year. In the 1959-65 period the Republic will almost double the industrial production.

THE MACHINE OF THE FUTURE

By N. Pokidov

THE first Soviet-made gas-turbine locomotive built at the Kolomna Plant has 3,500 h. p., develops a speed of over 120 kilometres an hour, and has a maximum haulage capacity upto 2,200 tons. The "GT-OI"—as the new locomotive is called—has already passed a number of important tests and shown excellent haulage and service qualities.

GAS-TURBINE LOCOMOTIVES AND AUTOMOBILES

The first of these locomotives was followed by a second one, the still more perfect Soviet gas turbine locomotive "GT-IOI." It differs from the first model in that it has no gas-turbocompressors and is designed to a different scheme. The dimensions of its turbines are much smaller. Compressed gas is produced by gas generators of a new design which originated in the Soviet Union. The 3-thousand h. p. turbine operates at lower gas temperatures.

Instead of stopping here Soviet designers have gone further. They have devised a still more powerful machine—of 6 thousand h. p. Specialists are certain that the speed of main-line gas-turbine locomotives may be raised to 150-160 kilometres an hour.

The Soviet Union's first bus with gas-turbine engine is already on the road. It overtakes easily some "Pobeda" and "Volga" cars and develops a speed of 140 and even 160 kilometres per hour. This bus bearing the shining metal letters "Turbo-NAMI-053" is the creation of the designers at the Moscow Automobile and Motor Research Institute.

The turbine stationed in the bus permits to develop a speed that is impossible for a bus with an internal combustion gasoline engine. The turbine dimensions are such that it may be readily positioned in place of a 180 h. p. diesel motor. It weighs half as much as a diesel and is twice as powerful. The gas turbine stationed in the bus needs no water cooling system and works excellently even in the heaviest of frosts. The turbo-bus drive controls are quite simple. The driver's cab houses but two pedals: the gas and brake pedals. The harder the driver presses his foot against the gas pedal the greater the speed at which that bus travels.

The designers have far-reaching plans. They intend to station gas turbines on tip-trucks, power shovels and hoisting cranes.

There is a great future for gas-turbine automobiles. They will become indispensible on the roads of Siberia, Yakutia, and in the Polar areas of our country. Great heavy-duty tractors will drive whole trains of scores of trailers. That will be in the near future.

GAS TURBINES FOR POWER STATIONS

A 12 thousand kilowatt turbine made at the Leningred Metal Plant is installed at the Shatsk Power Station in Tula region. The gas for its operation is obtained by underground coal gasification. In the depth of the coal seam there roars an "underground fire," while the gas thus generated is delivered via special pipeline to the surface and passes onto the blades of the machine. Such power stations have no need in unwieldy steam boilers, fuel storages, immense water reservoirs.

The USSR national economy will derive great advantages from the use of gas turbines in thermal power stations. They are almost one-and-a-half times cheaper than steam turbines of similar capacity and efficiency.

The output of gas turbines in the USSR in the course of the seven years is to be sharply increased. An important part in this respect is to be played by the enterprises under the Leningred Economic Council. A 25-thousand-kilowatt machine will be completed at the Metal Plant by the end of this year already. Designers are now working on the engineering project of a 100-thousand-kilowatt gas turbine.

Soviet gas-turbine building is gaining in scope. The Leningraders are the pioneers in this sphere. But extensive research and designing work in the field of gas-turbine building is also under way at many of the country's other enterprises.

Thus a 50-thousand-kilowatt gas-turbine plant—the "GTU-50-800"—is under construction at the Kharkov Turbine Wosks. As compared with steam-turbine plants of identical capacity, the input of metal into its construction is reduced almost to a half; it will require but a third of the servicing personnel operating a steam turbine. The Works' scientific, engineering and designing staff is now working on the design of a still bigger, 100-thousand-kilowatt plant.

EFFORT TO INTEGRATE POSITIVE PROPERTIES OF STEAM AND GAS TURBINES

It is hard to say today which of the two 100-thousand-kilowatt gas-turbine plants—that made in Leningrad or that made in Kharkov—will be the better one. But one thing is quite clear: the creative collaboration of the staffs of both enterprises in their quest for the most efficient and correct solution is bound to yield excellent results.

The scientists and designing engineers are persistently striving to create plants that would integrate the positive properties of steam and gas turbines into a single whole.

Of great interest in this respect is the speech delivered by Academician S. Khristianovich at the July Plenary Session of the C. C. C. P. S. U., who spoke of the work conducted by Soviet engineers to devise steam-gas turbines. Such plant, working on a steam-gas mixture and making use of natural gas, are bound to prove economically quite efficient.

The gas turbine is being called the machine of the future. But it is today that this future begins. Soviet scientists, engineers, designers and workers have accumulated vast experience in manufacturing highly efficient machines for the Soviet Union's power industry.

THE MECHANISED RAJHARA IRON ORE MINE

[The mechanised Rajhara Iron Ore Mine of the Bhilai Steel Works was inaugurated by Shri Jagjivan Ram, Union Minister for Railways on October 31, 1960]

IRON ore is the principal raw material required for the manufacture of steel. The Bhilai Steel Works receive their requirements of iron ore from the Rajhara Mine. Huge power shovels and drills have been erected on the top of the Rajhara hill. The mechanised mine will supply 7,000 tons of iron ore daily to Bhilai.

SOVIET EQUIPMENT AND TECHNICAL ASSISTANCE

Equipment for the mechanisation of the Rajhara iron ore mines, weighing about 2,700 tons, came from the USSR and was erected under the technical guidance of Soviet specialists.

So far, float ore was being raised by manual labour and it was a difficult task to ensure the supply of adequate iron ore to feed the two blast furnaces now in operation at the Bhilai Steel Works. Continuous manual raising of large quantities of iron ore, transporting them to Railway sidings and again loading them into wagons was indeed a very difficult matter. Moreover the third blast furnace of the Bhilai Steel Works, which also is expected to go into operation by the end of December 1960, will further increase the Plant's requirements of iron ore.

Rajhara, located 55 miles south of the Bhilai Steel Works, has already been linked with Bhilai by a broad-gauge railway line. The installation of the heavy equipment and the construction of the large crushing and screening buildings on the slope of the Rajhara hill have completely changed the landscape.

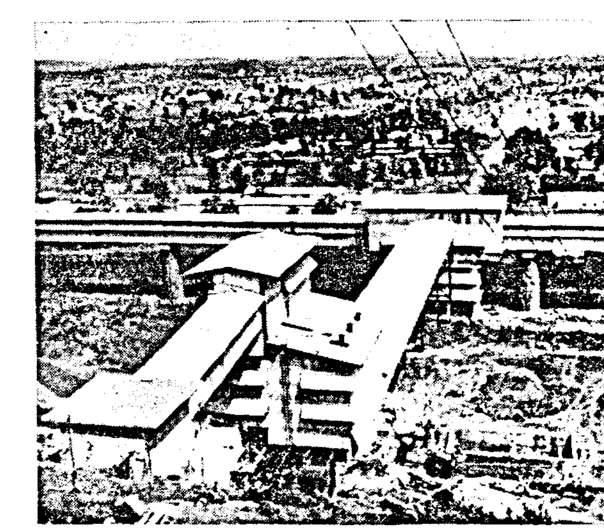
It is estimated that the Bhilai Steel Works will require about two million tons of iron ore annually for the production of one million tons of steel and about 300,000 tons of pig iron. These requirements will go up to nearly five million tons when the steel works are ultimately expanded to produce 2.5 million tons of steel annually.

The prospected deposits of iron ore in the Rajhara hills—which spread over a length of about four miles and go up to a height of about 1,920 feet above mean sea level—have been estimated to be of the order of 114 million tons. Besides, the Rajhara iron ore, with iron content ranging from 65 to 69 per cent, is considered to be one of the best ores in the world.

ELABORATE MECHANISATION

A rail line has been constructed right up to the massive iron ore deposits on the top of the Rajhara hill, thus enabling the blasted ore to be loaded straight into dump cars by power shovels and transported by rail to the crushing plant. After crushing and screening the fines, blast-furnace and open-hearth grades will be conveyed by belt conveyors to the storage yard, from where they will be loaded by power shovel into wagons for despatch to Bhilai, as and when required. Special type large capacity wagons have been provided for this purpose. The mines also include magazine for explosives, chemical laboratory, repair shops, etc.

The crushing plant comprises of two crushers—a jaw crusher and a cone crusher. The primary crusher will crush the big blocks of ore to 350



A view of the mechanised Rajhara iron ore mine that was commissioned on the 31st October, 1960.

millimetres size, and will have capacity to crush 560 tons per hour. The secondary crusher of the same capacity will crush the ore to 75 mm. size. The screening plant will screen the crushed ore into different sizes.

Smaller particles of ore will go to the sintering plant at Bhilai for making it into bigger lumps after mixing with limestone, dolomite and coke and heating by carrying it on a model conveyor through a furnace. The sintering Plant for this purpose is being erected at the Bhilai Steel Works itself.

AMENITIES FOR RESIDENTS

About 700 persons, including about 100 engineers and 475 workers and operatives would be required to operate the mechanised mines. To provide for the residential accommodation of the staff, a new industrial town with all the facilities of water, sanitation, electricity, hospitals, schools, shopping centre, etc. is being simultaneously built at Rajhara by the Bhilai Steel Project authorities. About 260 permanent houses out of the proposed 700 houses have already been constructed. A 30-bedded hospital has also been constructed here.

The town has been electrified and arrangements made to supply treated drinking water and water borne sanitation.

Provision has been made for a welfare building at the worksite with arrangements for a canteen, bath-rooms, lavatories, rest rooms and first-aid facilities.

Rajhara receives its electric power from Korba. The drinking water supply is drawn from a fully protected natural spring, and for industrial water supply a reservoir has been constructed to store the annual requirements.

RAJHARA MINE INAUGURATED BY Mr. JAGJIVAN RAM

On 31-10-60 in the emerald green lap of the Rajhara hills of Madhya Pradesh the biggest mechanised iron ore mine has come into being. The mine was inaugurated by India's Minister of Railways Mr. Jagjivan Ram.

The mine site wore a festive garb with splashes of golden sunshine. The Minister and his party consisting of the General Manager of the Bhilai Steel Plant Mr. N. C. Shrivastava, the Soviet chief engineer of the Plant Mr. N. V. Goldin and other distinguished personalities arrived at the meeting on the valley in which the mine is situated.

Speaking on the occasion Mr. Shrivastava informed the audience that the original idea to build an iron ore mine at Rajhara, so rich in the most important ore for the economic development of a country, was born in the mind of Pandit Ravi Shankar Shukla, the ex-Chief Minister of Madhya Pradesh. Mr. Shrivastava said that for power feeding of the mine a 60-mile-long transmission line has been laid from the power station at Korba which is one of the coal supplying centres for the Bhilai Plant. Mr. Shrivastava said that the mining designing bureau jointly manned by Indian and Soviet designers designed this mining works costing nine crores of rupees including the township. The Indian and Soviet engineers and personnel manifested an admirable co-operation which has now been crowned with a grand success, Mr. Shrivastava said. The Rajhara mine has so far supplied 14 lakh tons of ore to the Bhilai Plant. With the inauguration of the railway line from Rajhara to Bhilai 7,000 tons of ore are to be transferred to Bhilai every day.

"Bhilai particularly has a special significance for Indian railways", Mr. Shrivastava said, "because here we shall manufacture annually one lakh and ten thousand tons of broad and narrow gauge rails and 90,000 tons of sleeper bars and crossing sleepers. The Bhilai Steel Plant will thus have an important part to play in the expansion programme of the Indian railways".

Mr. Shrivastava said further that the mine has given employment to more than one thousand local persons and it is expected that direct employment would increase by some 2,000 and more would find employment in different ancillary industries.

After a short speech of greetings by Mr. Goldin, Mr. Jagjivan Ram spoke of the great significance of the Rajhara mechanised mine for the development of India's national economy. He declared that mechanisation would have to be introduced in India gradually for its industrial development. "We have to depend more and more on machines", he said.

Mr. Jagjivan Ram said, "This is the age of steel. How far it will remain so cannot be said. Science is progressing and steel may one day become obsolete. But today it is steel age and iron and steel are the barometer of a country's progress. India is behind in this respect. Therefore we have to build more and more steel plants."

Mr. Jagjivan Ram was happy to note that Bhilai would be producing rails, rail-sleepers and crossing bars which were in short supply in this country and were being imported.

He said, "The association between railway and Bhilai has become very close. Railways cannot carry on without iron and steel; steel plant cannot function without railways for transport of its raw materials and finished products".

The Union Railway Minister stressed that the country was engaged today in a two-fold task: to provide more employment opportunities to people and to raise their standard of living. Railways and Bhilai project were both making their due contribution in this respect.

At Rajhara where he was inaugurating the mechanised iron ore mine a great wealth lay hidden underground. Bhilai steel works had now been built to exploit this hidden wealth for the benefit of the country, he said.

The Union Minister congratulated Indian and Russian engineers of Bhilai Steel Plant on their rapid progress and their achievements. Here workers were not working merely to earn their living but they were also making a contribution to the development of the country. "Success of your efforts is its own reward for you", he said.

Mr. Jagjivan Ram then inaugurated the new hospital and the railway.

SOVIET AID TO CEYLON IN CONSTRUCTION OF IRON & STEEL PLANT

A group of Soviet specialists, staff members of the State Institute for Designing Iron and Steel Mills, is preparing to leave for Ceylon. The engineers will take with them blueprints of the first Ceylonese iron and steel plant, which will go up near Colombo.

This undertaking will consist of three principal departments: the blast furnace, open-hearth and rolling mill. The latter is to be built first. Its capacity will amount to 35,000 tons of rolled stock a year. Units are being produced for the rolling mill, intended to manufacture various grades of iron.

The rolling mill department is designed in combination with cold drawing of wire.

Orders for equipment for the first section of the Ceylonese plant are being filled by many Soviet undertakings. Soviet ships will shortly begin delivering to the port of Colombo, machine-tools and machinery for the firstling of the Ceylonese iron and steel industry.

* * *

GEOLOGISTS DISCOVER A SECOND URALS

New deposits of iron ore have been discovered in the Eastern Transurals area which is called by Soviet geologists "the second Urals". During the prospecting of the magnetic anomaly in the Kurgan district the exploration bore hole struck a stratum of rich martite (oxidized) ores at the depth of 330 metres. The bore hole penetrated the layer for more than 50 metres but as yet has not reached the end of it.

The new deposits form the continuation of the main ore-bearing region where exceedingly rich Socolovsko-Sarbai iron ore deposits and Gai copper deposits have been previously discovered. A brilliant future was foretold to this very region by the noted Russian explorer Academician Alexander Karpinsky (1847-1936). Karpinsky was convinced that east of the mining Urals region the "second Urals lies buried under a loose earth cover", whose mineral resources are as rich as those of the mountain ridge which divides Europe from Asia.

Three hundred teams of geologists worked last summer in the Urals and in the Eastern Transurals.

* * *

A THIRD IRON AND STEEL AREA IN THE SOVIET UNION

Soviet engineers have designed what will be among the world's largest iron and steel mills. It will be built near the town of Taishet, Eastern Siberia, in a locality extremely rich in iron ore and coal. The project will include several high-capacity blast furnaces, coke batteries, a rolling shop and a steel foundry. An idea of the project's scope can be obtained from the fact that the metal making shops alone will take up an area of 850 hectares.

Construction and Utilization of Modern Transportation Facilities for Railroad Service

THE modern RR service is naturally utilizing the rail as general means for transportation purposes. Since nowadays an interacting with other transportation facilities is absolutely necessary, it is the responsibility of RR administrations to deal efficiently with problems surrounding the transhipment of goods between rail and highway. Many RR administrations have solved this problem by acquiring even railless special-purpose vehicles and by utilising them in an economically justified manner at " places of joint " between rail and highway.

The West German Maschinenfabrik Esslingen (Machine Tool Plant is Esslingen), which has been shipping locomotives and RR cars to numerous countries throughout the world for the past 110 and more years, had adjusted itself so as to fully meet the requirements of RR administrations. For scores of decades, this plant also constructs railless transportation facilities such as forklifts, carts and related equipment, developed to a high degree of perfection and capable of meeting all operational requirements by attaching the appropriate accessories.

The Machine Tool Plant in Esslingen has acquired its outstanding reputation mainly by its ingeniously creative achievements in rail vehicle engineering and railless forklifts of all loading capacities.

The following furnishes a brief survey about both special fields:

RAIL VEHICLES

Locomotives of various gauges, designs and capacities, as constructed by the Machine Tool Plant in Esslingen, are in operation throughout nearly all countries in the world. Special locomotive designs, as developed by the Machine Tool Plant in Esslingen, have attracted great attention in foreign countries and worth mentioning is also the vast number of locomotive spare-parts and accessories completed in good craftsmanship. In this connection, mention is made of 40 locomotive replacement (exchange) boilers shipped to the Indian Government Railways in the early fifties.

Very early, the Machine Tool Plant in Esslingen, in the further development process of RR motor cars, has engaged in technical problems pertaining to the utilization of combustion engines as locomotive and motor-coach traction unit. In this connection, the complex problems arising from power transmission have also been dealt with. The constructive and useful tests go back to the nineties of the past century.

The first Diesel locomotive had been shipped to the Soviet State RR Administration as early as 1924. It was a 2—10—2 125-ton gross weight locomotive, equipped with a 1000/1200 hp. MAN Diesel engine and electric power transmission. This first large-type locomotive has been followed by other Diesel-electric locomotives shipped to Japan, Argentina, and the South-Manchurian Railways.

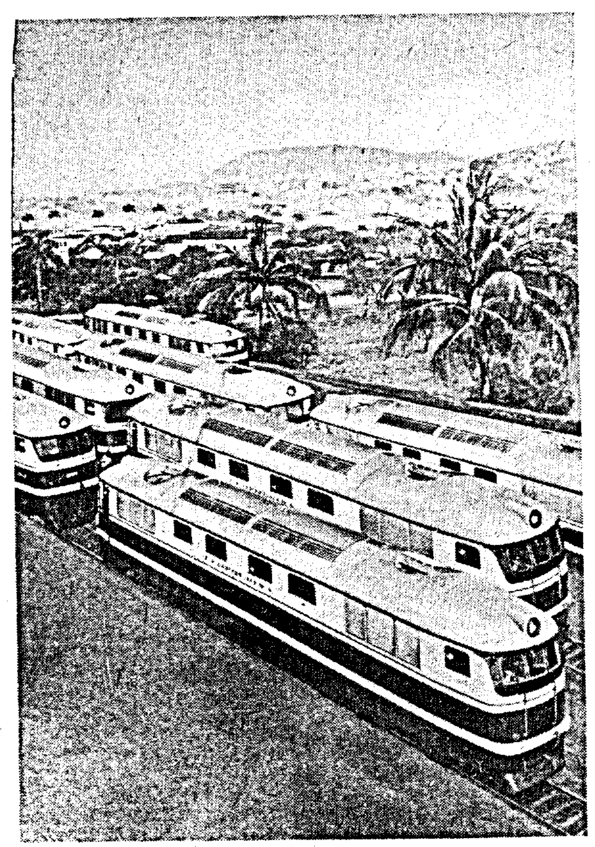


Illustration No. 1. 1900 hp. Diesel locomotives, constructed by the Machine Tool Plant in Esslingen, for Brazil.

A 1000-hp. capacity, pneumatic power-transmission-type Diesel locomotive has been developed and constructed for the German Reich Railways in the period from 1924 to 1929 in order to test another power transmission method. During the subsequent period, the rapid development of hydraulic drive has resulted in almost exclusive application of this power-transmission type for 170–1900-hp. Diesel locomotives, constructed in remarkably high numbers since 1950, and destined for South America (illustration No. 1), Sweden, Norway, Near East, South Africa, as well as for German industrial installations, secondary railways, and the German Federal Railways.

While under actual operation, certain capacity types of Diesel locomotives have developed and these have been used by the Machine Tool Plant in Esslingen as a basis for a standard production programme of up-to-date and efficient Diesel locomotives to be used by industrial installations and ports. Locomotives of the new type schedule, which included capacities from 150 to 340 hp. have proved efficient and useful under heavy-duty operation. The use of standardized components and drive sub-assemblies contributed to lowering the production costs and it permitted a more efficient maintenance work as well as procurement of spare-parts. The constructive development of vehicles (illustration No. 2), in addition, meets the clients' wishes as to a variety of engine and drive designs.

Another type schedule includes noiseless (laufruhige) bogie-type locomotives (illustration No. 3) ranging from 450 to 800 hp. in capacity. Due to their simple design, easy operation, and negligible axial pressure, these locomotives are suited for shunting and medium-heavy line traffic, primarily and preferably for transportation facilities with light superstructure and with relatively small rail bend radii. The small

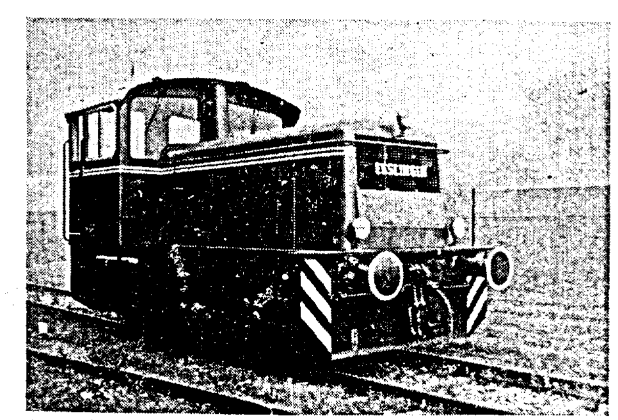


Illustration No. 2. Bi-axial Diesel locomotive of 150/340 hp capacity class.

and low front structures ensure a full and all-aroun visibility from the elevated cab. The spring system o the vehicle consists of steel springs or wear-and-tear resisting metal-rubber components which require n maintenance work.

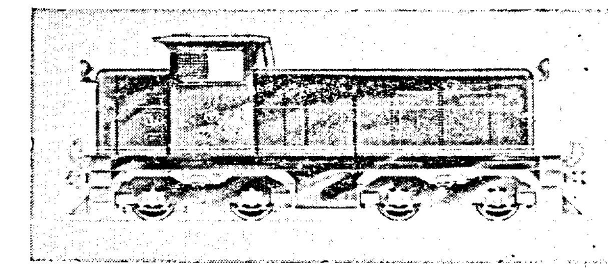


Illustration No. 3. Four-axled bogie-type Diesel locomotive of 450/800 capacity class.

The development of locomotive construction at th Machine Tool Plant in Esslingen has always beer handled in conjunction with the construction of RR cars of all types. There was a long but successful wa of constructive and ingenious development from th freight cars and coaches of the past century up to th modern motor coach with Diesel-engine or electri motor drive. Some of the last shipments of Diesel-hydraulic motor coaches were for Spain, Near East Turkey and Greece. Especially the Diesel moto coaches, destined for the Greek Peloponnesian Rail ways, (illustration No. 4), permitted a considerable improvement of the cruising speed and of travelling comfort as compared to the increased competition in the line traffic on highways.

Conforming to the change of times, the transportation facilities of large cities are also demanding thei due share on the modern development. Therefore,

Illustration No. 4. Three-unit motor coach train (1000 hp.) for Greece.

the streetcar trains, constructed by the Machine Tool Plant in Esslingen, became not only more efficient but also nicer in shape and more spacious. Only a few screws and rivets are still visible on welded car designs.

The ever increasing requirements for light structure call for a more accurate determination of the stress properties as well as of the dynamic and static strains.

A special department of the Machine Tool Plant in Esslingen is dealing with the computation of these high-grade undetermined systems of RR car and locomotive construction. By the aid of modern procedures—especially at elongation and vibration measurements—complicated designs are subjected on test stands to operation-like stresses in order to be able to check the thus obtained theoretic values also by practical tests.

Illustration No. 5. Tractor, constructed by the Machine Tool Plant in Esslingen, engaged in loading a mail train.

RAILLESS SPECIAL-PURPOSE VEHICLES

The loading of mail and baggage from the platform to the expedition halls is effected smoothly at modern RR station (illustration No. 5). Luggage elevators are superfluous. Electric and Diesel tractors ofhigh-climbing capability, as constructed by the Machine Tool Plant in Esslingen, transport loaded trailers in long trains over ramps and via underpasses.

Since long, the RR administrations are availing themselves of railless transportation facilities. Rather early, the engineers endeavoured to motorize also the vertical lifting on electric carts by means of lifting and crane superstructures. Based upon these beginnings, the forklift was designed. The lifting and stacking carts, designed by the Machine Tool Plant in Esslingen, are being used for various transportation ends at RR installations, e.g. RR repairshops and warehouses, where they are used for interplant transportation and at

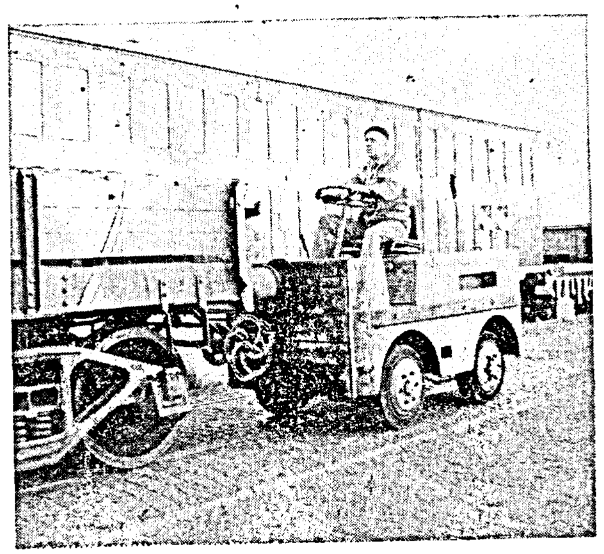


Illustration No. 6. Tractor utilized for shunting.

freight yards for the transhipment of various goods between RR cars and road vehicles. In addition, tractors may also be used, to a certain degree, for shunting (illustration No. 6). Consequently, in many instances heavy-duty shunting locomotives may be dispensed with and are thus made available for other duties. The possibility of achieving the nowadays strived for smooth transportation flow by one (1) man without loading ramps, also in the transhipment of goods on freight yards, will result in substantial operational advantages. (Illustration No. 7). The versatility in the expedition of transported goods accounts for the fact that at many transhipment yards certain transportation tasks, previously

Illustration No. 7. Forklift utilized for loading freight cars.

(Continued on page 19)

A Survey of Current practices of U. S. Makers of Diesel Locomotive Engines

By J. C. Rhoads

Railroad Locomotive Engine Section, Locomotive and Car Equipment Department
General Electric Company (U. S. A.)

DURING the past generation the world's railways have entered a major evolutionary period. One by one railroads have been changing over from steam locomotives to diesel electrics. The changeover is now complete in the United States and is already a well established trend in other countries.

The changeover to diesel-electric drive has been prompted by its greater efficiency, as well as the economic benefits that are derived from the much lower operating costs of the diesel-electric locomotive.

At the present time, the U. S. A. is still the largest manufacturer of locomotives for the railways of the world, although there have many signs of increasing activity in other countries.

The purpose of this article is to survey the current practices of U. S. diesel-electric locomotive manufacturers with regard to the design of diesel engines in terms of over-all locomotive design criteria. In addition, points of difference between U. S. A. and European practices are noted.

The V-engine configuration is popular among U. S. manufacturers because it gives the best space utilization and maintenance accessibility. The high percentage of V-engine applications for diesel locomotives leaves little doubt that this configuration has world-wide preference. Top cylinder accessibility is excellent and space utilization ideal. Generally, 8 1/2 or 9-inch bore diameters can be accomodated in a 6-foot cab width with a 45° V angle. Larger bores can be accommodated only with difficulty; smaller bores do not fully utilize the space. In this connection it is of interest to note that all three of the engines most used for locomotives have 45° V angles and bores in the 8 1/2—9-inch range.

Maximum horsepower per cylinder is desired in order to provide the minimum number of cylinders and other engine parts. Maximum horsepower per cylinder comes from the maximum bore diameter that can be accommodated in a given locomotive cab width in the V configuration. Based on U. S. practice, a 9-inch bore appears to be about the maximum obtainable in 4-stroke cycle engines, and an 8 1/2-inch bore in 2-stroke cycle engines. Horsepower per cylinder ranges from about 140 for 2-stroke engines to 165 for 4-stroke engines.

Maximum crankshaft rotational speed is important to minimize engine and transmission weight. Some engine design practice outside the U. S. includes speeds up to 1500 or 1600 rpm, but even at this higher rpm, the horsepower per cylinder is appreciably less than American practice, since the bore and stroke are less. American practice is to run 4-stroke cycle engines in the neighbourhood of 1000 rpm, and 2-stroke cycle engines at 800 or 835 rpm. Piston speeds are about equal to those of the so-called "quick running" engines mentioned above.

Ratings of engines by U. S. makers are based on long-term field experience rather than laboratory tests. Deratings due to ambient temperatures or high altitudes are made only for extreme conditions. Under more normal conditions of moderate altitudes and temperatures, the ratings are quite conservative. This rating practice results in longer life of the engine wearing parts.

Ratings generally are most dependent on thermal considerations; that is, deterioration of the hot parts such as pistons, liners, rings, valves, heads, manifolds, and turbo-superchargers. For a given output per cylinder, the 4-stroke engine exhaust temperature is several hundred degrees higher than that of the 2-stroke engine. The mean cycle temperature, however, is lower because each alternate stroke is a cooling stroke. For this reason, the 4-stroke engine operates cooler internally and has less trouble from thermal problems.

Engine ratings vary with ambient air temperature, altitude, fuel temperature, fuel heating value, and engine condition. All U. S. engines operate with fuel pumps measuring a given volume of fuel for each stroke. Condition of the fuel, therefore, has a greater effect on engine rating than any other of the above-mentioned factors. Heating value of the fuel varies with fuel density which, in turn, varies with fuel tank temperature. Proper engine output, therefore, must be carefully correlated with the condition of the fuel.

Turbo-supercharged engines maintain the air-fuel ratio with increased altitude so that engine smoke is not a problem. If the engine design will safely permit full output at high altitudes, greater ratings can safely be carried at sea level.

Two types of engine derating should be considered—inherent and controlled. Inherent derating follows a schedule where derating curves are plotted on turbo-supercharged engines and on non-turbo-supercharged engines. It is apparent that the turbo-supercharged engine is considerably better from this standpoint.

Power outputs are best measured by connecting the engine to a load absorbing device. Where electric drive is used, the generator can be readily connected to a water box. When power outputs are corrected for air and fuel conditions and for generator efficiency and auxiliary loads, gross output of the engine should be equal to the specified power of the unit. Operating time schedules are related closely to unit power outputs. Trends toward greater outputs per unit are to be expected as time goes on.

Locomotive manufacuturers in the U. S. rate horsepower in terms of the amount actually going into the transmission. This is known as *horsepower for traction* and differs from the European practice of rating in terms of the gross horsepower developed by the diesel engine. Gross horsepower ratings obscure the losses that come from auxiliary equipment such as radiator fans, air compressors and the like. Actual horsepower at the rail is obtained from horsepower for traction ratings by multiplying them by the efficiency of the transmission.

Engine reliability comes from conservative rating on the one hand and a minimum of control items on the other. Experience indicates that the fewer the components on a locomotive, the fewer the opportunities for failure. The United States concept of simplicity, as compared to the European viewpoint, is definitely in the direction of reliability.

Fuel and lubricant consumption should be kept at the lowest level for economy of operation. Fuel consumption is minimized when the diesel engine produces power with maximum efficiency over its operating range. Fuel rates in the range of 0.36 to 0.42 pounds per bhp-hr are obtainable. On engines of the same size, 4-stroke engines generally have five to ten percent better economy than 2-stroke engines. Also, oil control problems are simpler on 4-stroke engines since they have no inlet air ports to traverse with the piston rings. Conformable oil control rings can readily be used on 4-stroke engines—reducing the oil consumption to considerably less than one gallon of lubricating oil for each 100 gallons of fuel burned.

Although diesel engines can be shut off and started readily, the customary practice on U. S. railroads is to leave engines idle, particularly in cold weather, to keep the engines warm and to prevent coolant freezing. Engines used in the United States are capable of idling for appreciable periods without distress and require a minimum warmup when being put into operation. Locomotive cooling systems controlling temperature within close limits under both extended idling and running conditions greatly assist in obtaining long engine life.

ENGINE DESIGN DETAILS

Diesel engines used in locomotives require several design considerations that greatly affect operating results.

Pistons: Two types of pistons are currently favored by United States builders of locomotive-type diesel engines: iron and aluminum. Two builders use iron, whereas another builder uses aluminum. Iron is considered superior from the standpoint of both sturdiness and wear, although iron pistons are sometimes heavier and add to the engine reciprocating weight. In the two American 4-stroke engines, however, the one with the aluminum piston, although the piston itself is lighter, has slightly more reciprocating weight than the engine with the iron piston. Hence it does not follow that aluminum pistons always reduce reciprocating weight.

Aluminum pistons require iron top ring groove inserts but, even so, have lower life than iron pistons. Also, in the infrequent case of valve failures, an aluminum piston quite often disintegrates, resulting in considerable engine damage. In most cases, iron pistons remain intact.

Piston Rings: Properly designed and applied oil control rings minimize lubricating oil consumption.

Conformable type rings consisting of thin sections, backed up by a spring, are universal on U. S. automobile engines and are used by some locomotive diesel engine builders. These rings give minimum lubricating oil consumption, consistent with good top ring life.

Cylinder Liners: Two types of liners are used in the United States: unplated iron or chrome-plated iron. From the wear standpoint, the chrome-plated liner is considerably superior although its replacement cost is higher than plain iron. But per unit of service its over-all cost is probably lower. One major factor in liner and ring life is the liner thickness. The thinner the liner, the cooler its surface, and, as a consequence, the better the lubricating properties of the oil film.

Connecting Rod Arrangement: Two of the three principal U. S. locomotive types engine builders use connecting rods arranged for maximum rod bearing area. They are of either fork and blade or articulated design. The other builder uses side-by-side rods which greatly reduces the available rod bearing area. Both builders using large bearings on the crankshaft end of the rod use a bolted piston pin arrangement, giving a great increase in bearing area over the conventional piston pin arrangement. Generally the lower the bearing pressures, the longer the life and the greater the potential for future growth.

Main Frame: Two principal U. S. engines use a weldment for the main frame construction, while the third uses an alloy iron casting. Virtues of cast main frames are maximum stiffness for minimum weight since the metal can be placed most advantageously, maximum damping of vibratory strsses, and extreme resistance to fatigue crack development. However, in case of an engine wreck, repairs of the cast frame are somewhat more difficult.

Valves and Valve Trains: All three principal U. S. engines have 4-valve heads. The 2-stroke engine, however, operating at 835 rpm, must have valves actuated 835 times a minute. Although 4-stroke engines run at 1000 rpm, the valves operate on alternate strokes only, or 500 times a minute. Since the valves in all three engines the nearly the same size, the valve train stresses on the 2-stroke engine are more severe.

Bearing Material: All U. S. builders of locomotive-type diesel engines use steel backed copper-lead bearing shells. Steel backed aluminum bearings have been tried and some experience has been obtained. An advantage of aluminum bearings is minimum pin damage in case of bearing failures, although aluminum bearings seem to be sensitive to break-in and to dirt. A preference exists for copper-lead bearings, which require hardened crankpins and main bearing journals for optimum shaft and bearing life.

Turbo-supercharging: Optimum engine output and maximum engine efficiency are obtained by using turbosuperchargers. All three principal U. S. builders of locomotive-type engines use turbosuperchargers.

Without turbosuperchargers, more cylinders are required to obtain a given output. One complication in the use of turbosuperchargers on 2-stroke engine is engine starting and part-load operation. Separate, mechanically-driven blowers or mechanical connections to the turbosupercharger must be used on such engines, increasing the complexity of the system. Four-storke engines need no mechanical connection to the turbosupercharger which is coupled only by the exhaust system. Optimum engine manifolding with turbosuperchargers is obtained with outboard inlet manifolds leaving all of the space in the engine "V" for exhaust manifolds.

Generator Mounting: All three of the principal engine builders in the United States use electric drive on all of their production locomotives. Two of the three mount the generator rigidly to the engine frame both torsionally and transversely without the use of flexible couplings. The combined engine-generator set is then mounted as a unit on the locomotive platform. The other builder mounts the engine to the locomotive platform separately from the generator. A disk-type, flexible coupling is then used between the engine crankshaft and the generator armature. The coupling is rigid torsionally, but flexible angularly. The former method is preferable because: the engine-generator set is lighter and the alignment problem is simpler and unaffected by locomotive platform deflections.

With the V-design diesel-electric locomotive engine continuing its gain in world-wide acceptance, the future will see further refinements and efficiency improvements with emphasis on interchangeability with existing components. Improved technology in transmission design is expected to keep pace with engine improvements, yielding even more useful diesel locomotives for the furture.

These changes will enable railroads to haul larger loads at lower costs. Such savings will be of direct benefit to the economies of all growing countries.

The Evolution of the Railway in a Road

By An Engineering Correspondent

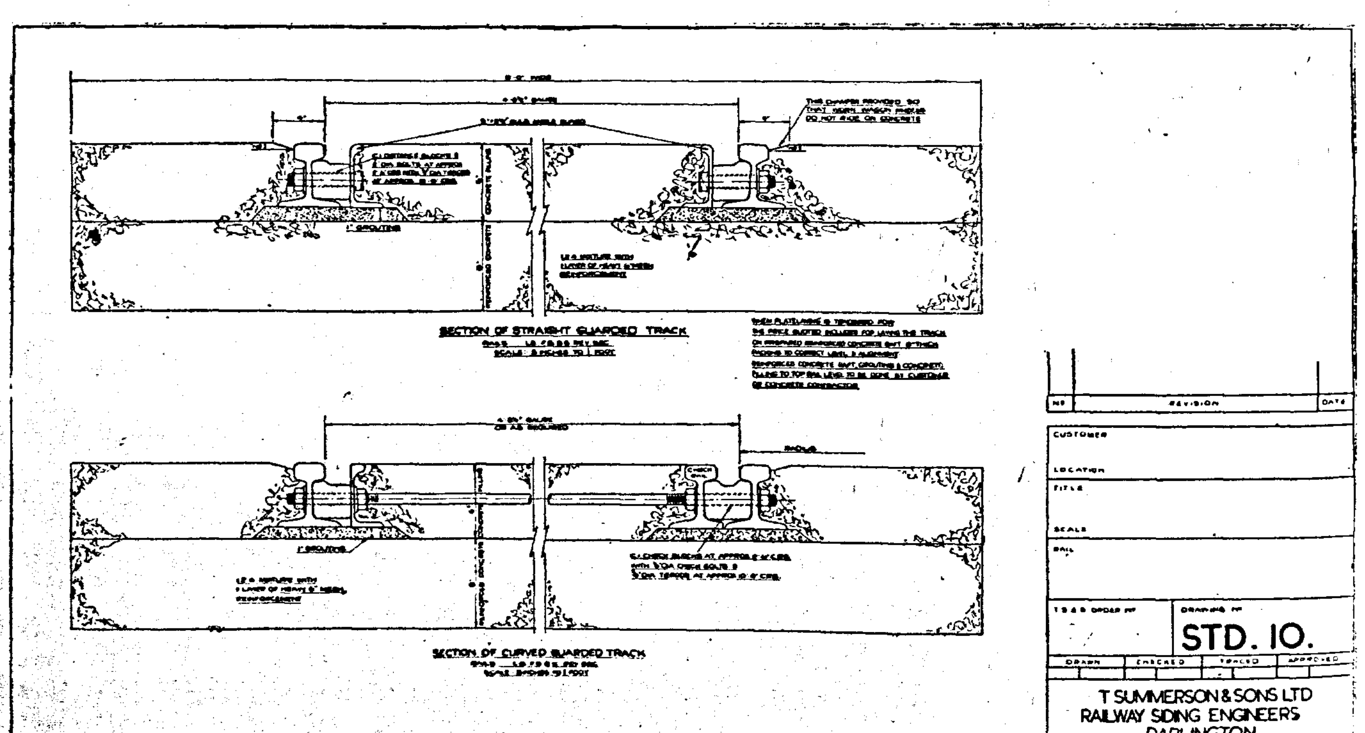
DUE to the growth of road transport many industries in Britain and on the Continent of Europe now receive some part of their raw materials, or despatch their finished products by road vehicles. This fact is specially accentuated in Docks and Harbours, and industrial sites where the quick inter-departmental handling of goods and products by means of small rubber tyred petrol trucks has necessitated the quays, or works yards being paved or being laced with roadways to carry this traffic.

These roadways are inevitably required to cross railway track systems and a design of railway track has evolved which caters for these needs.

The Railway must offer no obstruction to the road vehicle and is usually sunk into the roadway so that the road and rail top are at a common level. If the road is to be made of concrete then the timber sleepers and ballast must be eliminated as if the track is merely buried in concrete, the sleepers will quickly rot away and cause sinkage of the track.

The modern method applied to this problem is to lay a reinforced concrete raft of a thickness great enough to withstand the maximum load likely to be carried by the railway wagons. The top surface of this raft is at a level about 6″ below finished road and rail level. The Rails are then laid on this raft, packed to correct level and alignment by the use of steel packers of varying thickness, at intervals along the length, and cement grout pressed beneath the rails to form a continuous seat. The surface concrete is then poured to finish level with the rail top, a chase being formed to accommodate the wagon wheel flanges.

To prevent the edges of this concrete chase breaking away it is usual to fit a steel kerb made from Bulb Angles. This is bolted to the rail web and held the required distance away from the running edge of the rail by cast iron blocks which fit between the rail and bulb angle webs and are holed to take the Bolts. The Track is held to gauge by Tie Rods which are fitted through every fourth or fifth block and span the gauge.



Section of Straight and Curved Guarded Track in concrete.

GOLDEN RULES OF CONDUCT FOR RAILWAYMEN

1. Do you plan your work daily? Get the more essential things done first and do not neglect the important ones sidetracting them to the fag end of the day.

2. Do not express casually careless opinion. Never venture forth an opinion unless asked for it.

3. Remember that most of our mental worries come either from trying to fight life hard or from trying to run away from life. Do neither.

4. Learn to accept people as they are, love them, respect them, praise them, encourage them, differ with them, but above all, learn the priceless art of give and take.

5. Cry neither for the moon, nor over spilt milk.

6. Accept the things that you cannot change; have the courage to change the things that you can, and possess the wisdom to know the difference.

7. Do not drive too hard a bargain with yourself.

8. Accept life as it is—its wonders, changes, disappointments, frustrations etc., etc.

MIRRLEES IN TRACTION

By An Engineering Correspondent

[A description of this makers well known JT type of rail traction engine with an indication of its performance in line service on British Railways in the successful "Brush" type 2 diesel electric locomotive.]

INITIAL DESIGN CONCEPTION

THE original design parameters for the Mirrlees J and JV range of engines were laid down in 1947, the intention being two fold; to satisfy an immediate British Admiralty requirement and to meet the demand, as then understood, for a robust and reliable rail traction unit in the medium speed category.

At an early stage it was decided to adopt a bore of 9¾" and a stroke of 10½" and experience having shown that the most reliable traction engines are those that have undergone a lengthy period of continuous design development, the possibility of high pressure turbo charging was envisaged from the outset with the ultimate objective a B. M. E. P. of 200 p. s. i. at 1000 R. P. M.

EARLY APPLICATIONS

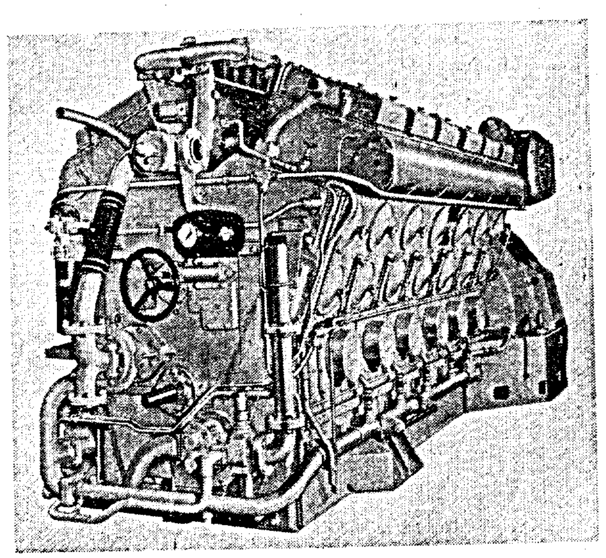
The prototype JV, a 16 cylinder engine was built in 1950 after which there followed a period of almost two years continuous development work under the observation of independent engineers during which time the engine achieved outstandingly high performance figures and in 1952 these engines were put into quantity production. At the same time a contract was placed by the Ceylon Government Railways with Brush Electrical Engineering Co. Ltd. for 25 locomotives incorporating the Mirrlees JVST12 engine and the first of these locomotives was commissioned early in 1953.

The three years of arduous operation in Ceylon during the period 1954—1957 yielded valuable service experience and made possible the introduction of many important refinements, the value of which has been borne out by the subsequent service experience obtained with a large fleet of similar locomotives on British Railways.

Among the features built into the rail traction version of these engines are the efficient locking of all nuts and the clipping of all pipes to withstand the effects of vibration and shock inseparable from this class of duty together with complete and easy access to all parts of the engine.

BRITISH RAILWAYS

The initial contract placed by the British Transport Commission with Brush Electrical Engineering Co. Ltd. in the autumn of 1955 for 20 locomotives powered by the JVST12 engine was completed at the end of 1958 and since that date repeat orders have brought the number of these engines (Fig. 1) supplied or on order for this customer alone to 226.



Fig/ 1
Mirrlees JVST12 Diesel Rail Traction Engine rated at 1365 H.P. at 900 R.P.M. coupled to a Brush Generator as supplied to Brush Electrical Engineering Co. Ltd., for installation in British Railways Type 11 Main Line Diesel Electric Locomotives.

The development towards higher output and higher speed as originally envisaged and referred to above, has been achieved without any sacrifice of reliability—the engines built for the Ceylon locomotives were rated at 1254 H.P. at 850 R. P. M. at N. T. P., the bult of those supplied in the locomotives for British Railways have a rating of 1365 H. P. at 900 R. P. M. whilst a number have been rated at 1600 H. P. at 950 R. P. M. This steady improvement in specific output has been achieved without recourse to cooling of the charge air on which considerable development work has taken place and which can be employed to further increase the power available always provided that the additional equipment can be accommodated within the limitations imposed by loading gauge and axle weight.

Engine Details

BEDPLATE AND SUSPENSION

The bedplate is an all welded structure (Fig. 2) with cast steel intercostals which embody the main bearing housings. The crankshaft assembly is carried in the bedplate, which is extended to carry the generator, and a wet type sump is incorporated.

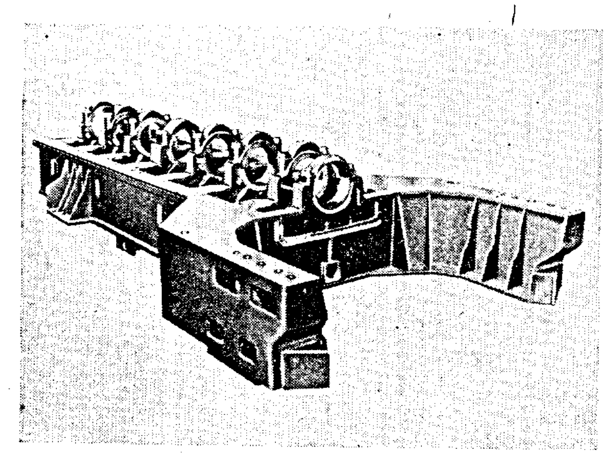


Fig. 2

CRANKSHAFT

The crankshaft (Fig. 3) is a carbon steel forging, machined all over, having hardened journals and pins; it runs in steel backed shell type bearings that are prefinished and require no hand scraping or finishing.

A torsional vibration damper of the viscous type, the accessory drive assembly (for lubricating oil and circulating water pumps) and the camshaft drive gear are all mounted on the crankshaft and an extension shaft drives the radiator fan.

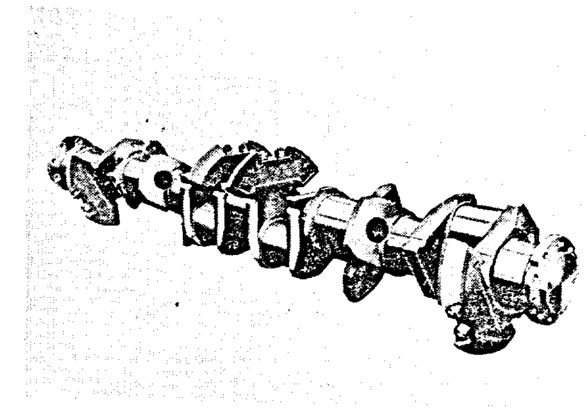


Fig. 3

CYLINDER HOUSING

The cylinder housing (Fig. 4) like the bedplate to which it is secured, is an all welded structure and houses the removable wet type cylinder liners. Quick release hand hole covers are fitted and the camshaft and fuel pump compartments which are separated from the crankshaft by a vapour tight deckplate and to the crank case doors are fitted BICERA type relief valves.

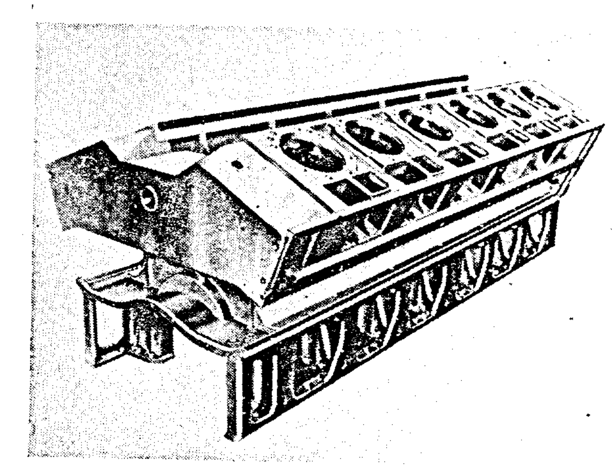


Fig. 4

CAMSHAFTS

The camshafts which are gear driven from the engine crankshaft consist of single lengths of carbon steel to which the alloy steel camsleeves are keyed. A bevel gear fitted to 'B' bank camshaft drives the engine governor.

CONNECTING RODS, SMALL AND LARGE END BEARINGS

The connecting rods are heat-treated carbon steel forgings (Fig. 5) and the small end bearings are phosphor bronze bushes pressed into the eye of the rod. The fully floating gudgeon pins are hardened alloy steel and are located endwise by circlips.

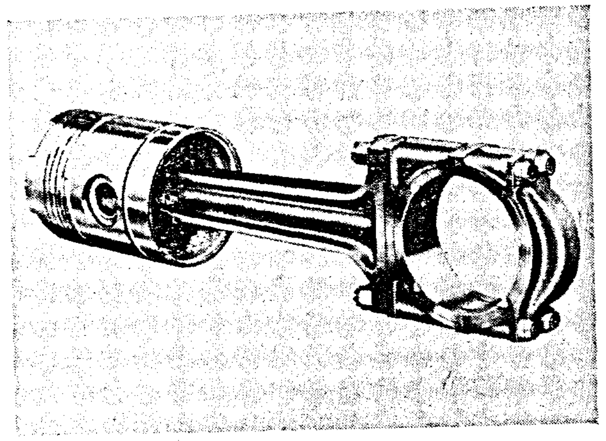


Fig. 5

The large end bearing housings are separate assemblies, which are bolted on to the palm face of the connecting rod; the bearings are steel backed shell type, copper lead lined.

PISTONS

The silicon alloy pistons have four compression rings and two scraper rings arranged one above and one below the gudgeon pin. A 'cocktail-shaker' ensures even distribution of the cooling oil over the inner surface of the piston.

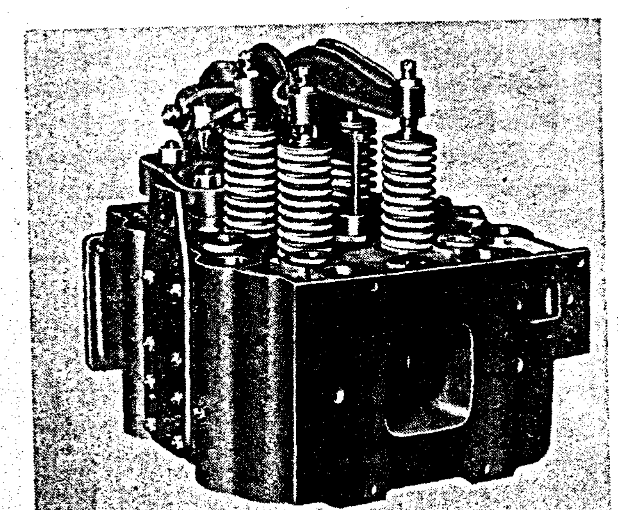


Fig. 6

CYLINDER HEADS

The cast iron 4 valve cylinder heads (Fig. 6) have well proportioned water passages to ensure adequate cooling, the water entering each head from the cylinder housing through two ferrules. Jumper pipes lead the water away from the highest part of the cylinder heads to the twin outlet header pipes.

Light easily detachable cylinder head covers are fitted.

VALVE GEAR

The four valves which are identical have an inner and an outer valve spring and seat on to alloy inserts which are shrunk into the cylinder head; cast iron valve guides are pressed in.

The rocker bracket which is mounted on each head carries the inlet valve rocker shaft in a pressed-in bushing. The inlet valves are operated by two rocker arms, which are secured to the splined ends of the rocker shaft by pinch bolts. One inlet rocker arm has an extention which is connected to the inlet push rod fork.

The exhaust rocker has two arms which operate the exhaust valves, one arm having an extension which is connected to the exhaust push rod fork. The exhaust rocker boss runs on the outside of the rocker shaft bushing.

Lubricating oil is supplied to a fitting on one of the rocker bracket lugs to feed the rocker shaft bushing and the push rod bushings through drilled oilways in the rocker shaft and roker arms. Pipes brazed to the arms feed oil to the tappets and valve stems.

VALVE TAPPETS

Hardened valve tappets, held in the ends of the rocker arms, bearing direct on to the ends of the valve stems.

CAM FOLLOWERS

The air inlet valves, exhaust valves and fuel pumps are operated by their respective cams, through roller type cam followers, which are held in the fork ends of guide levers that pivot about the cam follower fulcrum shaft.

FUEL PUMP TAPPETS

The fuel pumps are mounted on cast iron brackets bolted on to the cylinder housing. A short adjustable tappet rod, screwed into the cam follower fork end, actuates the fuel pump plunger through a guided plunger carried in the pump bracket.

GOVERNOR

A Woodward P. G. (pressure compensated) governor is fitted which regulates the engine speed at any position of the master controller, limits the torque output at any speed and matches the generator output to the engine output, thereby obviating the possibility of engine overload.

FUEL SYSTEM

A motor driven fuel transfer pump draws fuel from the main tank, through an in-line strainer and delivers it to the fuel service tank from which it is led to a Vokes fuel filter mounted at the control end of the engine. From here the fuel passes to the two injection pump supply manifolds.

Individual Bryce type injection pumps are supplied through flexible hose connections from the main fuel supply manifolds and deliver the fuel through solid drawn steel delivery pipes of equal length to the injector nozzle in each cylinder head.

An edge type filter is embodied in the nozzle holder feed pipe.

LUBRICATING OIL SYSTEM

A positive displacement, self-priming, gear type pump driven from the engine crankshaft draws oil from the sump, passes it through the filters and oil cooler and delivers it to the main lubricating oil gallery. From this gallery the main bearing are fed directly, the oil then passing to the big end bearings, small end bearings and pistons through drilled passages in the crankshaft and the connecting rod. A nozzle at the small end of the connecting rod directs oil on to the underside of the piston crown. Tappings off the main gallery feed oil to the camshafts, their, driving gears, the accessory drive gears, the rocker gear and the governor vertical drive shaft bushing.

A flow regulating valve is fitted to limit the quantity of oil entering the cooling system which thereby controls the pressure drop across the oil cooler; a pressure regulating valve limits the maximum pressure of the oil entering the engine system.

COOLING SYSTEM

The engine-driven circulating water pump draws water from the radiator and delivers it to the inlet manifolds running along each side of the engine. Branch pipes with flexible hose connections feed water into the cylinder jackets.

The heated water discharged from the engine into the two outlet manifolds passes to the top of the radiator via a thermostatically controlled by-pass valve.

ENGINE STARTING

The engine is started by the main generator which acts temporarily as a motor fed from the locomotive battery, an oil pressure switch ensuring that adequate lubricating oil pressure has been built up by the separate motor driven priming pump before the engine can be started.

PROTECTIVE FEATURES

The customary protective features against high water temperature and low lubricating oil pressure are fitted as also is an emergency overspeed shut down device.

SERVICE CONDITIONS

The majority of the locomotives powered by these engines are in service on the Great Eastern Lines of British Railways Eastern Region, where 668 steam locomotives are being replaced by 249 main line diesel locomotives based on four depots, a proportion of more than 2½ to 1.

Locomotives operating from the first of these motive power depots to become 100% diesel are accumulating 47,000 miles each week of which 60% is freight, 22% is passenger and 18% is parcel trains, empty stock working etc. The main burden of the train working at this depot, 40,000 miles each week, is carried by 25 Mirrlees engined Brush locomotives which are diagrammed 22 hours a day, six days a week.

A high utilisation factor is made possible by a high availability record to which every component contributes and in this respect the record of the Mirrlees engine has been exemplary.

IN YOUR OWN INTERESTS

HOW TO PURCHASE TICKETS

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

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

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

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

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

(Inserted in the interests of Travelling Public)

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CLEANLINESS LEADS TO HEALTH AND HAPPINESS

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

Cleanliness prevents disease; medicine only attempts to cure.

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

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