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THE INDIAN RAILWAY ENGINEER

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Railways and their Medical Departments

ONE of the important problems which the Railways have to face is to keep their staff fully employed as long as possible. Absenteeism on Railways quite often poses a serious problem as far as workshop and line staff is concerned, and many a rupee of the Railway is lost due to men being away from their work for long periods and yet getting paid ostensibly on medical leave.

Every big organisation whether it be in the private or public sector is in duty bound to look after the health of the people who work for it and by judicious medical treatment reduce to a minimum absenteeism due to sickness.

The Railways Medical Department can be separated into three Main Sections viz: Medicine, Surgery and Public Health, and it is essential that each of these should function at the top level of efficiency to avoid unnecessary frittering away of the railway's financial resources.

As in most departments a high level of efficiency can only prevail if the majority of staff is dedicated to its service, and works night and day to establish a reputation for efficiency.

Starting at the Administrative level, it is very necessary that the P. H. and H. O. should in addition to being a good medical man, should also be a man of broad vision and well read in his special science. It is he who generally sets the pace for improvements and expansions. The railways are usually a law into themselves and it is he who does all the planning to ensure future development on right lines. He must therefore be well read not only in his medicine and surgery but also in all that makes for advancement and modernisation in hospital techniques and public health matters.

The bulk of the medical work on railways is divided between medicine and surgery on the one side and public health on the other. Though in the early stages of his career a railway doctor has to work both as a physician and a minor surgeon, with the passing of years and in rising to higher grades he specialises in one branch or the other.

It is important that the physician should keep himself abreast of his subject by a vast amount of reading, because from day to day the medical science advances so rapidly. Undoubtedly he is kept up to date with his knowledge of drugs for various diseases by the various drug houses and pharmaceutical laboratories who send him their literature at regular intervals, like in all sciences the physician has to be constantly improving his diagnostic ability and this comes from sound common sense and observations of signs and symptoms and their application for the treatment of the disease. A railway physician has ample scope to practice and improve his skill because being in a field where senior men and specialists are not readily available he has to rely largely on himself, which is all to the good. It is said that we learn from our mistakes and this is nowhere better exemplified than in the case of a young railway doctor straight out of a college or a interimship in a hospital to take charge of a post as a medical assistant in a small railway district. He has this advantage that he is not kept too long in one district, but moved to others at regular intervals. As he attains seniority in service he is stationed at the larger and more important stations of the Railway and by this time he has gathered a fund of information

both of railway working and his own particular subject so that if he has any love and interest in his medicine he will have acquired the necessary experience to inspire confidence in his patients and make a name for himself.

The Surgeon on the other hand joins the Railway Medical Service with a high degree in Surgery and is usually attached to a hospital first as a junior surgeon and then Surgeon in Charge. At first his job is to undertake the minor operations and assist his senior in the operation theatre in the major ones. With a fair amount of practice and a vast amount of reading he develops the necessary skill to tackle most operations. Only in the case of brain or heart surgery will he have to call in the services of a specialist.

One of the most important functions of a Railway Surgeon is the saving of life and limb in a Railway accident. It is not unusually for railways to have major accidents either by derailments or collisions, and it is here that the surgeon can do a considerable amount of good work and by undertaking amputations of limbs to save lives etc.

The other major department of the medical services of a railway is the health department. The Assistant Medical Officer in addition to his minimum professional qualifications in medicine and surgery joins the service with a diploma in public health or is encouraged to acquire one at the earliest opportunity. It is his special function to be constantly vigilant to prevent an epidemic in his district. He has therefore to be constantly checking the water supply and the sanitation and the cleanliness of the railway colonies where a large number of workmen are concentrated. He has to devise ways and means of adequately disposing of the garbage and night soil.

His greatest role is displayed in meeting the sanitary conditions at fairs and melas where thousands and thousands of pilgrims have to be catered for a short period while the various ceremonies last. By the time he attends a few of these mass gatherings of humanity he becomes quite an expert and can be relied upon to take all the necessary precautions to prevent epidemics.

In all cases of health as well as medicine the knowledge and treatment of Tropical Diseases is very necessary and as far as possible railway doctors should be encouraged to take a course at the School of Tropical Medicine at Calcutta and elsewhere.

It would be in the interest of the railways to offer inducements to the medical and surgical staff to go abroad on study leave and acquire the latest knowledge technique and skill in their chosen profession. It is only by such encouragement that the railway medical services can be kept up to date.

Dentistry is a minor service on the railways and should be introduced where it does not exist, with nearly a lakh of railway servants scattered all over the railway the services of a dentist becomes a boon to many railway employees who for various reasons cannot leave their stations just to attend to their teeth.

With the rapid advance that is taking place in medicine and surgery, there is more and more scope for specialists, and therefore arrangements should be initiated in the railway medical

service that the patient has access to the specialist at railway cost. Just as in big public hospitals of cities and towns specialists give their services in an honorary capacity so too they should be attached as Honorary Specialists to Railway Hospitals.

Every railway should be provided with Emergency Medical Vans which are completely equipped with an operation theatre and all the paraphernalia required to attend to passengers who are the victims of a major railway accident, with such a van transferred to the scene of the accident at the quickest possible time, it may be the means of saving many lives and limbs.

Nearly as important as the medical service of a railway is its Nursing Services and every means should be taken to keep it at a high standard of efficiency. Well trained and experienced nurses only should be employed.

It is a function of the railway medical services to encourage First Aid among the staff and from First Aid to establish an Ambulance Division, and by inter-divisional competitions to keep it at a high state of efficiency.

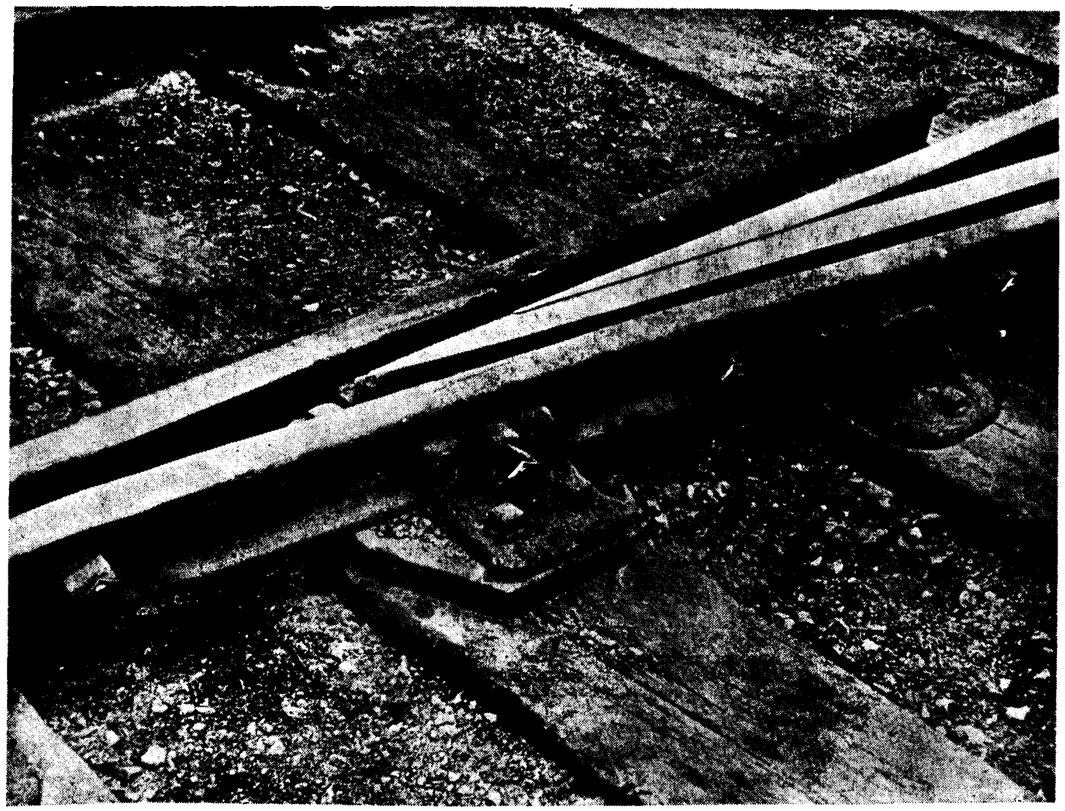
There is always room for improvement in the railway medical service, even the best, and the Administration should see to it that it functions at a high standard of efficiency always.

"PALNUT" SAFETY LOCK WASHERS

By An Engineering Correspondent

AS a method of preventing nuts from working loose, it may be said that the "Palnut" Safety Lock Washer is 100% effective. As it is described in "Kempe's Engineers Year Book "the "Palnut" is an example of the deforming type of anti-vibration lock washer. It consists of a single thread spring steel plate, of hexagon shape and the size of a standard nut. The formed sides are upturned to provide engagement with the spanner, and the hole is spirally formed to engage the bolt thread. Tightening by the spanner forces the inner section of the washer on to the bearing and upward and inward on to the bolt thread. The resulting pressure on the root of the bolt thread produces a secure vibration-proof locking action.

The "Palnut" Safety Lock Washer fits on top of the nut and, in consequence, is readily accessible for inspection, and other requirements. Being anti-vibratory this device is indispensable to all machinery and nuts subject to vibration. Another important factor in regard to this device is that a shorter bolt may be used than is normally fitted for alternative means of locking nuts.



Photograph by courtesy: British Railways (Western Region)

West Ealing "Palnut" Safety Lock Washers Crossing Bolts.

In the case of Split Pins, where it is necessary to drill the bolt the "Palnut" effects an economy not only in respect of labour charges but also by using the shorter bolt. Further saving is experienced, as once the "Palnut" is applied no further action is necessary.

Everything points to the recommendation of the "Palnut" as the one and only reliable method of preventing nuts from working loose.

When tested at the National Physical Laboratory, Engineering Department, Teddington, the "Palnut" did not fail, and the reproduction of the full scale report on these tests provides further evidence of the efficiency of this device. This reproduction is available on application to the manufacturers, together with other informative matter in regard to "Palnuts."

In all branches of Engineering, efficiency and economy are the two vital factors, and responsible Engineers everywhere are only going to employ equipment ensuring these two standards of perfection.

Where the "Palnut" is not fitted the problem of securing nuts and preventing them from working loose is one that is engaging much time and expense. The wide application of "Palnuts" is fully demonstrated in the photographs, and whether for the purpose of securing nuts on Locomotives, Carriages and Wagons, Signalling Apparatus, Stretcher Bar Bolts or other Railway Applications especially as regards Track Work, the result is one hundred per cent assured. Saving in labour costs and reduction in price for the purchase of bolts, no more routine inspection on the track, as once the "Palnut" is fitted the more vibration the tighter the "Palnut" grips.

Evidence of the satisfaction enjoyed by the many users of the "Palnut" Safety Lock Washer is to be seen from the examples illustrated, and with this in mind the Manufacturers would be only too pleased to furnish any information together with sample "Palnuts" for testing to any interested Engineer.

Manufacture of Diesel Railcars in India

The Deputy Minister of Railways, Shri Shah Nawaz Khan, told Shri N. R. Muniswamy and Shri Ajit Singh Sarhadi during question hour in the Lok Sabha that the question of the manufacture of diesel railcar in the Integral Coach Factory, Perambur, was under consideration, but no formal order had yet been placed.

Shri Shah Nawaz Khan said that the tentative proposals for the Third Five Year Plan of the Railways envisaged procurement of 197 diesel rail cars as under :—

67 broad gauge at the estimated cost	Rs. 6.4 lakhs per unit
120 meter gauge at the estimated cost per unit	Rs. 3.8 lakhs and
10 narrow gauge cars at the estimated cost of	Rs. 2.5 lakhs per unit

He said that it was proposed to manufacture all these rail cars in the Integral Coach Factory, Perambur.

Asked as to what preliminary steps had been taken to go ahead with the manufacture of such rail cars, the Deputy Minister said that the designs to suit indigenous manufacture were under preparation.

Shri Shah Nawaz Khan replied in the negative to a question whether all components were to be manufactured by the Integral Coach Factory.

* * *

CONSUMPTION OF COAL BY RAILWAYS DURING 1959-60

The quantity of coal consumed during 1959—60 by the Railways for loco purposes was 13.47 million tons as against 12.92 million tons during 1958—59, said the Deputy Minister of Railways, Shri Shah Nawaz Khan, in reply to a question by Shri M. Valiula in the Rajya Sabha.

The Deputy Minister said that the Railways were not using diesel traction more and more with a view to saving coal. The main object of dieselisation was to improve the line capacity on sections where saturation had been reached or was expected to be reached with steam traction and as a prelude to electrification.

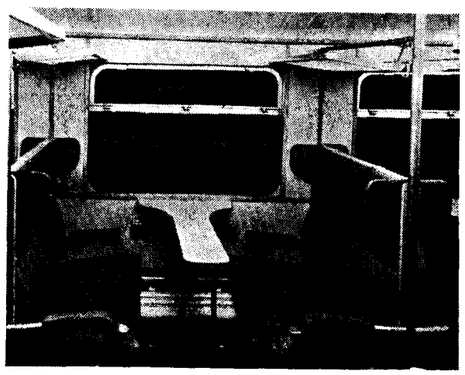
Articulated Double-deck train to solve traffic problems

THE VEB Waggonbau Gorlitz — German Democratic Republic — exhibited at the Leipzig Spring Fair 1958 as a reconstruction an articulated 5-car double-deck semi-train with bufett car, which attracted the interest of all exports being a first-class manufacture. This new unit is characterized among others by an enormously increased economy in operation. It is possible to make up trains according to presented needs and demands. The car length is chosen most favourably in proportion to the capacity, making it possible to convey a considerable number of passengers. The utilization of a special light-weight construction resulted in a seat weight of 200 kgs. never attained before by international standard.

A capacity of 640 seats in seat order 2+2 was taken as basis for the semi train, the train being equipped without electric heating.

Proceeding from the results of the meanwhile carried through clear tests and wishes presented by clients, the articulated double-deck train has been further accomplished in serial construction and has been provided among others beside the former low-pressure steam heating also with an electric heating 1000 volts. The travel comfort being even remarkable before has been increased, the semi train now having 620 seats in favour of higher convenience.

These trains are mainly used in the tourist and commuter service of the GDR, i.e. according to need as 5-car semi train or as 10-car train. A special bufett car at the end of the train or in the middle (in the latter case it is called an articulated 11-car double-deck train) with its up-to-date kitchen and bufett installations secures the gastronomical needs of the traveller. The 5-car train consists of 2 end and 2 middle cars of double deck construction, as well as of 4 intermediate sections of one-storey construction which serve as entrance vestibules. On the whole 6 two-axle bogies without axle holder take up the superstructure. The separate cars are connected articulatorily and the transition from one car to the other is not particularly conspicuous from the outside. In the interior of the car the transition is fluent. Upper



and lower deck are large areas with together 124 seats each car. The double-seats have high back rests and head cheeks and are soft and upholstered. 1200 mm windows and the tube lamp lighting render best light conditions by day and night. The brake system laid

out for 120 km/h speed A loudspeaker installation permits the transmission of broadcast programs and other serviceable informations.

In addition to the aforementioned the following *particulars of the semi train of the present construction series* are interesting :

Length over buffer	104 300 mm
Length of each end car over front walls	21 275 mm
Length of each intermediate car	16 550 mm
Length of each intermediate section	2 350 mm
External car width	2 870 mm
Height of car from rail top to top of roof sheet	4 650 mm
Foot height over rail top : upper deck	2 391 mm
lower deck	371 mm
intermediate section	1 185 mm
Wheelbase of bogies	2 500 mm
Shortest curve radius in operating installations	100 mm
in open line	150 mm

The above described articulated double-deck train has also roused great interest abroad and will increasingly be exported in the next years. At the Leipzig Spring Fair 1960 the VEB Waggonbau Gorlitz will show such a semi-train again.

A Chain of Hydropower Stations on the Angara River

Engineering preliminaries have been started for the construction of a hydropower station at Ust-Ilim on the Angara river in Siberia.

With a design capacity of 4.5 million kilowatts (as against the 2 million kilowatts of the Grand Coulee Dam, the largest water power development outside the Soviet Union), the station will be built 250 kilometers down from Bratsk where the Ilim river meets the Angara. The river at that spot is not wider than 800 metres, while the bed and banks are of strong rock providing an excellent foundation for the power plant.

The design drawn up by Moscow engineers envisages the installation of the world's largest turbine-generator sets, each rated at 500,000—600,000 kilowatts.

The project will take from four to five years to complete. Its output will be pooled into the mammoth Siberian power grid to boost above all the expansion of non-ferrous metallurgy.

The Ust-Ilim hydropower station is a third link in the Angara chain of water power developments. Already operational is the Irkutsk station (660,000 kilowatts), and the Bratsk station (4.5 million kilowatts) is under construction. Plans are afoot to build several more of them on the Angara. Their aggregate power output will be upwards of 10 million kilowatts.

At present, the Soviet Union is the second biggest power producer in the world. In nine months of this year electricity production in the Soviet Union amounted to 187,000 million kilowatt hours.

* * *

GLOSSARY OF TERMS FOR ELECTRICAL CABLES AND CONDUCTORS

The Indian Standards Institution has just published IS : 1591—1960 Glossary of Terms for Electrical Cables and Conductors. With the progressive formulation of Indian Standard Specifications on many types of cables and conductors, the need for following uniform definitions in all the standards was felt. With a view to facilitating this and to avoiding repetition of definitions of terms in each standard, these have been reviewed and brought under one cover. While drafting this standard, the definitions recommended by the International Electrotechnical Commission (IEC) have also been taken into consideration.

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.

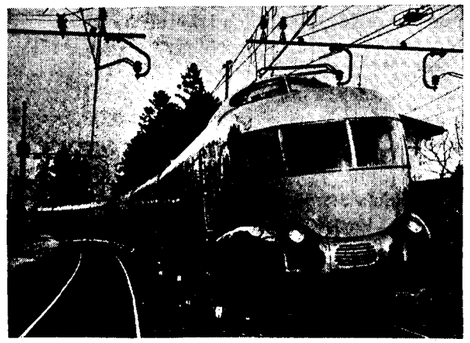
— Safer operation.

— 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.

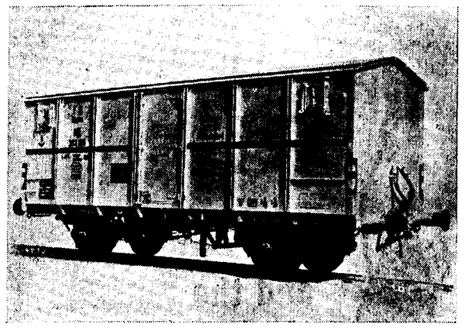
And the payloads to which, under particular emergency conditions, we have seen many cars subjected, point up the fact that the second problem, too, has been successfully solved.

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.

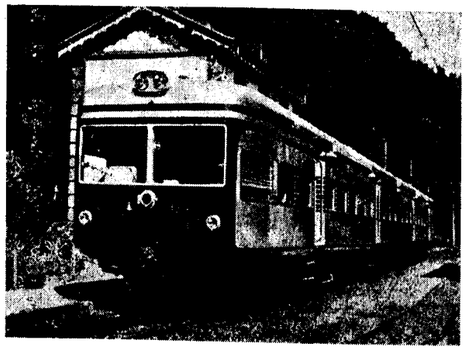
Type "P" stainless steel sleeping car manufactured by ANSALDO for Compagnie Internationale des Wagons-Lits equipped with RIV Tr 233 spherical roller bearing axle-boxes.

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.

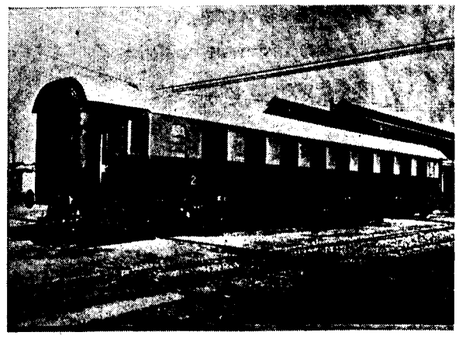
This summary information will serve as an introduction to the development of our thesis about the magnitude of RIV's contribution to the solution of the problem. A brief description of the range of products brought out by RIV for railway applications will serve the purpose of underlining that contribution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



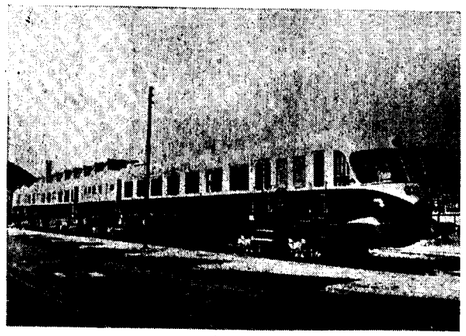
British-form refrigerator car type "Hgb" series 390,000 of the Italian State Railways, with RIV Tr 191 taper roller bearing axle-boxes.



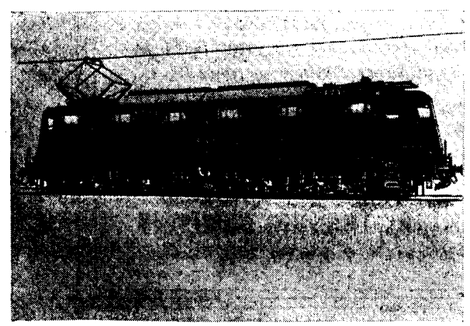
FIAT railcar set for the Indian Railways with axle-boxes, traction motors and transmission gear equipped with RIV antifriction bearings.



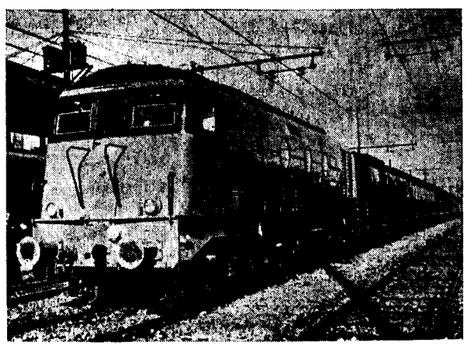
Italian State Railways 2nd class passenger coach, manufactured by BREDA, equipped with RIV Tr 196 cylindrical roller bearing axle-boxes (journal dia. 130 mm).



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



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



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

ROLLER BEARING AXLE-BOXES

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

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

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

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

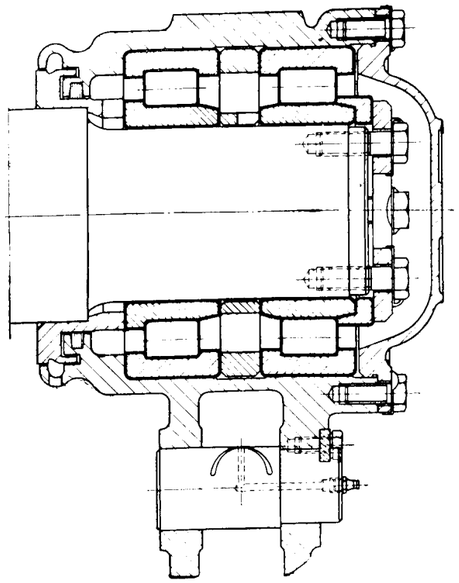


Fig. 1. Axle-box with two cylindrical roller bearings.

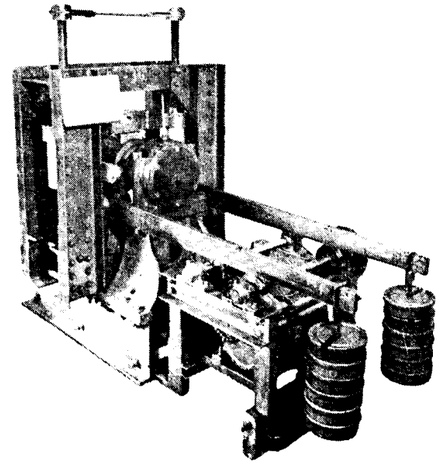


Fig. 2. Machine for testing railway axle-boxes under load.

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

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

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

Bearing calculation—which is, of course, always predicated on service conditions—is an easy matter, because the total radial load is equally shared by the two bearings, whilst the 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.

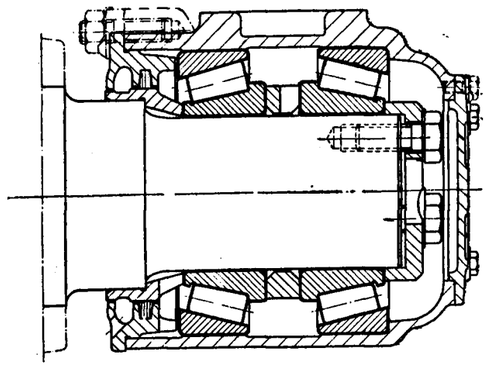


Fig. 3. Axle-box with two taper roller bearings.

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.

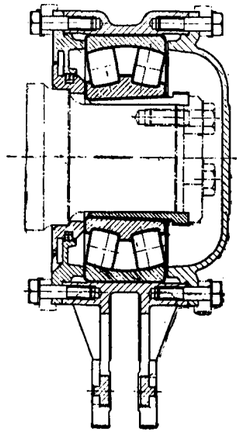


Fig. 4. Axle-box with one self-aligning bearing.

This design of axle-box has been used on many rail-cars 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*).

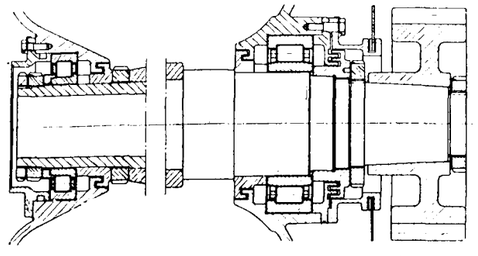


Fig. 5. Traction motor equipped with cylindrical roller bearings.

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.

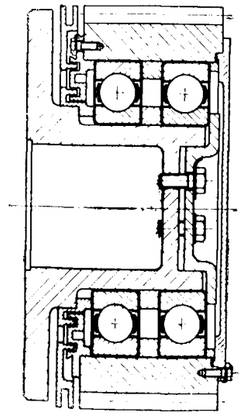


Fig. 6. Reduction gear for locomotive.

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 transmis-

sion 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.

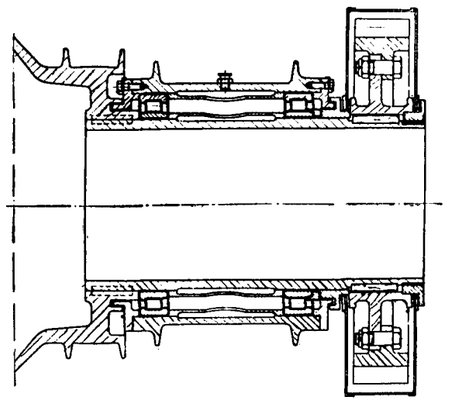


Fig. 7. Roller Bearings fitted on hollow axle of electric rail car

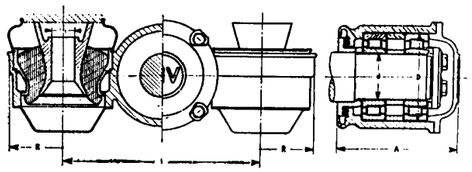


Fig. 8. Rubber springs fitted to a railway axle-box

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

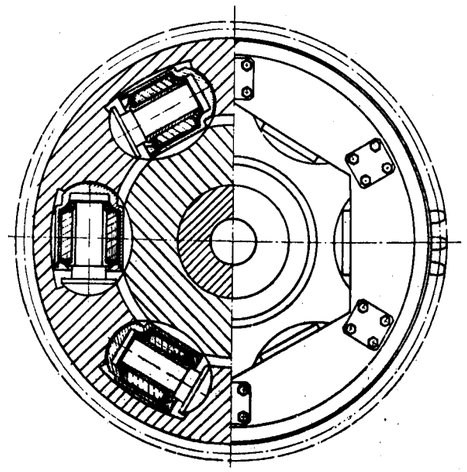


Fig. 9. Silentbloc flexible transmission.

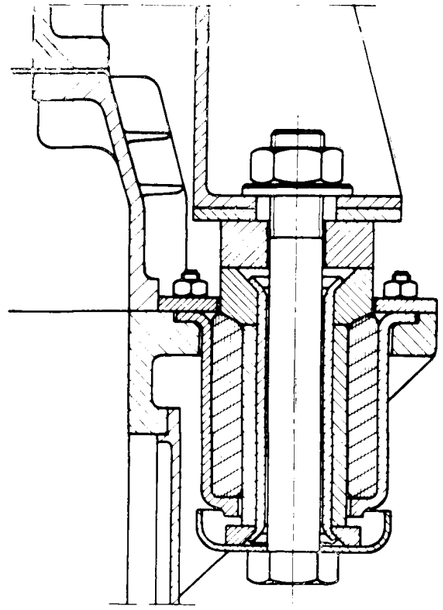


Fig. 10. Motor suspension equipped with antivibration mountings.

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.

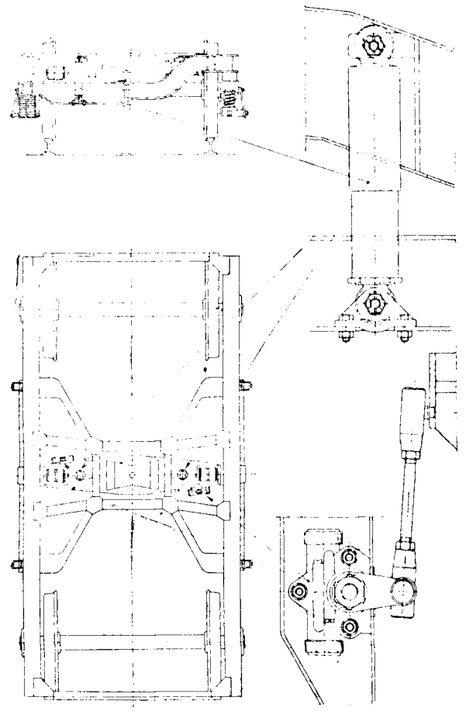


Fig. 11. Shock absorber arrangement on rail car bogie.

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.

Design and Manufacture of Oxygen Cutting Machines

By An Engineering Correspondent

HANCOCK & Co. (Engineers) Ltd. of Croydon, England have been designing and manufacturing oxygen cutting machines for over 40 years and the first photograph (Fig. 1) shows a profile cutting machine built in 1921. This machine operated from oxy-coal gas and was driven by a clockwork motor drawing a serrated wheel which was steered over the pencil line on a drawing twice the size of the job required; this gave the machine a high degree of accuracy but it also required skilled labour to operate it.

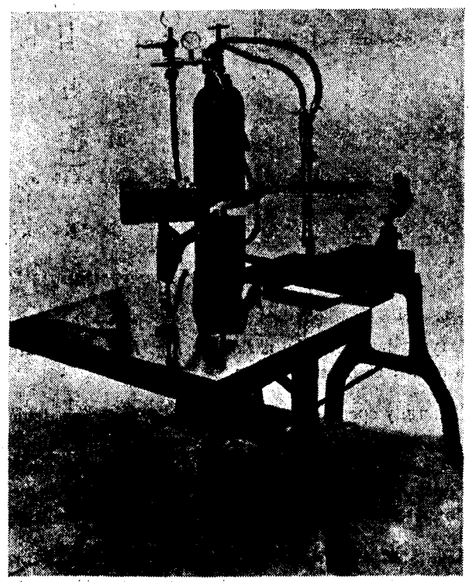


Fig. 1.

The second photograph (Fig. 2) shows the latest electronically controlled machine following a pencil line or a drawing the same size as the required cut out. This machine is fully automatic and allowance can be made on it for the width of cut so that one template of the correct size can be used on varying thicknesses. The dual carriage machines of this type vary in size from 40" square upto 10 ft. wide by 20, 30 or more feet long. One advantage to this type of machine is that a number of burners can be placed side by side along the burner bar thereby increasing the production of the machine on smaller jobs, whilst at the same time the same machine using one burner only can produce large jobs, thus the versatility of the machine is increased whilst the capital cost, floor space, and number of operators is kept to a minimum.

As can be seen in the photograph, the machine is of box type construction with a fabricated bottom carriage running on precisioned ground rils. On top of this is mounted the top carriage which has an aluminium casting on the smaller machines, and

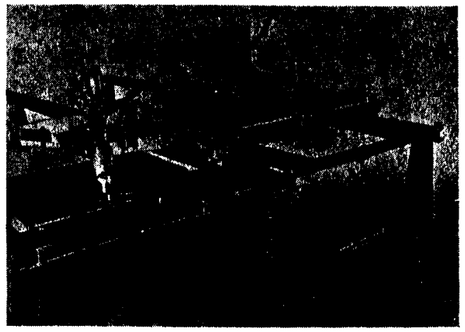


Fig. 2.

Fig. 3.

fabricated on the larger machines. Built into the top carriage are all the electrical controls, such as rectifiers for use with the magnet, and all switches are dual controlled at either end of the machine. For reasons of safety the electrically operated gas solenoid valves are mounted in the open in a recess at the back of the machine. One switch controls the fuel gas and preheat oxygen and the second switch controls the cutting oxygen, this valve is specially designed so that when it is switched off the oxygen in the pipe between the burner and the valve itself is exhausted to atmosphere giving an instant shut-off of cutting oxygen at the burner. Fig. No. 3 shows the Hancomatic Machine itself without the electronic control. In this case the roller drive which prevents any contact with the drawing when the electronic control is being used, has been removed and the standard tracer head which has five interchangeable drive heads is fitted in its place. This tracer head

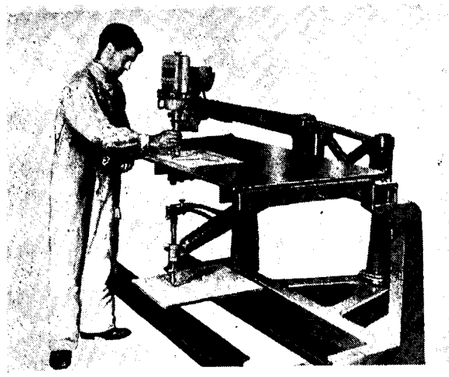


Fig. 4.

which is also used on the small Hancomaster Machine (Fig. 4) enables steel, wood or plain drawing templates to be used on the machine, circles and straight lines are cut automatically without the necessity of either templates or straight edges. All slides on the machine are fitted with slipper plates to enable any slight wear to be taken up so that the machine during the course of a lifetime can easily be kept in first-class condition as the running surfaces are hardened and ground, all ball races are grease packed and fitted with dust covers. To increase the versatility of the machine further, it is possible to fit a three burner compound head for flame planing for any type of double bevel and nose preparation, for single burner work a compact electronically controlled automatic height device will maintain the burner at a set distance above the plate.

For the smaller type of profiling work, the Hancomaster Machine shown in Fig. 4 is very popular. This cannot be fitted with the electronically controlled head but the standard tracer head with the various drives can be used. The main advantage of this machine is that the floor space requirements is very small as the work is directly underneath the template support arm. The main feature of this

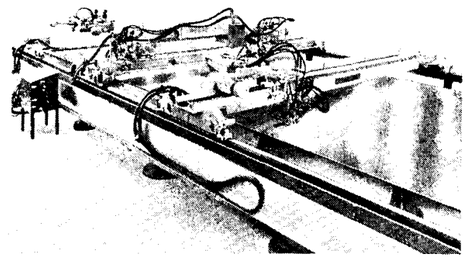


Fig. 5.

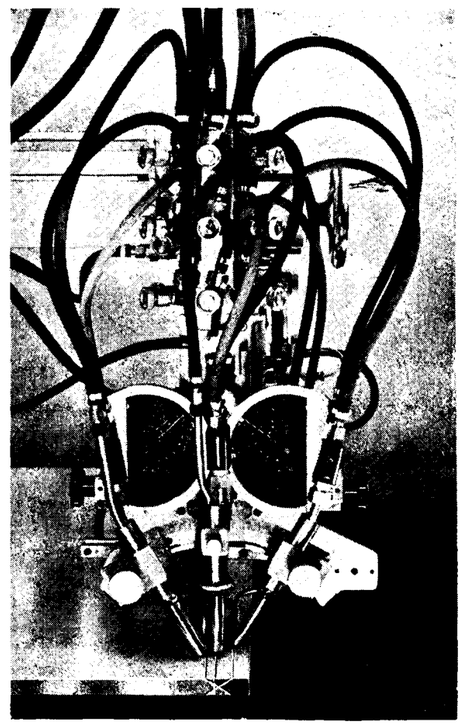


Fig. 6.

machines as with all other Hancock Machines is the robustness of construction. This is essentially to eliminate vibration and to obtain good cutting.

Flame planing machines (Fig 5) are widely used in the ship-building industry and in various other engineering industries where any large rectangular plates are required with double bevel and nose weld preparation for subsequent welding operations. These machines are capable of taking plates approximately 12 ft. × 40 ft. and cutting all four sides simultaneously. The machine has many automatic controls which means that only one operator is required to control the whole machine, the correct depth of bevels is easily obtained by setting the burners and reading off the depth of bevel from dials fitted on the machine (Fig. 6). The burners fitted on to this machine as on all other machines are of the latest antiflashback construction and have proved themselves over a period of time.

The foregoing is a very brief resume of some of the standard range of machines whilst at the same time many specialised machines have been built. One such machine which is believed to be the largest in the world and has over 1000 sq. ft. of cutting area was installed in a steel works for cutting 5" stainless steel slabs. Since this machine was installed it has cut on the average of 3 miles of cutting per month without any breakdown due to failure of the equipment. Many special machines have been built for the construction of atomic power stations. One such machine was designed and built to produce double bevel and nose preparation on circular holes which were parallel to the vertical axis of a 70 ft. diameter sphere. This machine was so constructed that it was easily positioned over any particular part of the sphere as in each sphere over 200 holes have to be cut.

Hancock & Company have specialised in the manufacture of oxygen cutting machine, and with their standard range of machines and experience from special types of machines they feel confident that there is no cutting problem which they could not tackle.

The Insulated Rail Joint in Railway Safety

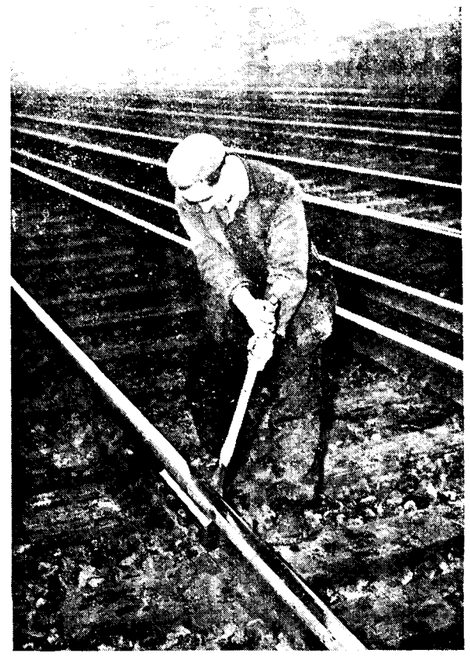
By An Engineering Correspondent

ALL who are concerned in railway operation realise that the prompt running of trains depends upon fundamental safety and reliability. One of the chief factors in the maintenance of railway safety is a reliable signalling system. Indeed, the gratitude of the travelling public for the fine safety record of our railways is very largely due to the ingenuity and skill of inventors and designers of railway signalling equipment.

The logical way to prevent accidents is to ensure that two trains occupy the same sections of line only when it is safe for them to do so. Such is the primary task of the Signal Engineer. His responsibility is to prevent the possibility of a signalman setting up traffic routes and clearing signals which would bring trains into collision.

When the increasing complexity of track layouts and the desire for speeding up traffic movements compelled the operation of points and signals from a central position, the need for controlling the operator's actions was immediately apparent. Study of the confidence of signalmen as they go about their work may raise the question of the necessity for preventing the movement of a wrong lever, but even the most experienced of them would demand the retention of "interlocking". This term is applied to the machanism, either mechanical or electrical, which ensures that levers are moved in correct sequence and that no movement is made which would permit two trains to converge on a common portion of track.

The basis of all modern signalling is the "track circuit" which detects the presence of a train or vehicle on a particular section of line. The rails forming the track circuit are bonded together electrically and insulated from neighbouring sections of line. The length of a track circuit may vary from one rail length to a number of miles and depends upon the function it has to perform in relation to the form of signalling for that locality. A small electric potential is applied at one end of the track circuit and a relay connected at the other. The purpose of the relay is to detect the presence of current and will, therefore, be prevented from responding if this current is short-circuited by a vehicle on the track. Contacts are fitted in the relay mechanism, in both energised and de-energised conditions, and are used in the control circuits for signal and point operation and interlocking. The train thus contributes towards its own protection.



A solid insulating joint in the track.

Insulation of early track circuits depended upon fishplates made entirely of natural timber. However, with the increase of axle loads and traffic, this insulation had to be replaced by a more robust fishplate made of steel, which was insulated from the rail by thin sheets of fibre with bushes of similar material to insulate the steel bolts. While this type of joint was mechanically very strong, it's use resulted in frequent electric failure of the insulation. This failure de-energised the track-circuit relay, producing the same effect as a train in the insulated section, and therefore brought into play the safety controls which the Signal Engineer had been so careful to provide. Certain facilities are sometimes installed to enable the

signalman to over-ride the track-circuit interlocking, but this introduces the human element which unfortunately, has not proved infallible. In either case, whether emergency release facilities are provided or not, traffic is delayed until the maintenance staff can reach the site and find the offending piece of insulation. As the insulating components are mainly hidden within the rail joint, tracing a fault can often take a long time with consequential further delays to rail traffic.

Every effort was made by the Signal Engineer and his staff to keep these track-circuit failures to a minimum by frequent renewal of the insulation but this inevitably increased cost, particularly since the cost of labour and access to track must be included.

Fibre insulated joints have been even more highly developed by North American engineers, but despite this, electrical failures are frequent. Moreover, cost of the joint is proportionately high.

On European Continental Railways several experiments with insulating coatings have been tried, the most promising of which appears to be a steel fishplate with a rubber coating applied by vulcanisation. This fishplate provides good insulation but has the disadvantage of high initial cost.

The development of a new form of insulating adhesive may again enable modified steel fishplates to be bonded to the rail and, if a solution can be found to the present criticisms, a new type of insulating rail joint may appear. This may one day be the answer to the problem, but there are a great number of difficulties yet to be overcome.

Insulating joint, as supplied by Permali Ltd., England.

It may now be asked: have plastics anything to offer in providing a suitable insulating fishplate? For example, glass fibre impregnated with resin offers the possibility of great mechanical strength coupled with excellent insulating qualities. Unfortunately, however, it falls down on the grounds of cost and rather poor resistance to abrasion. Other plastics cannot so far be considered because of their low co-efficient of elasticity and lack of fibrous reinforcement, producing sudden breakage; or an uneconomic price, or both.

The fishplate inspection department of Permali Ltd.

As so often happens, therefore, a partial return to original forms has brought about the most significant development in the material used for insulating rail joints. After all, material timber is an excellent material, having fair mechanical strength and electrical resistance if maintained in a dry state, but with the disadvantage that alternate wetting and drying deteriorates the fibres and so weakens the material. Moisture in the cells of the wood structure also reduces its electrical resistance to a dangerously low level.

In the 1930's, scientists began to consider the best methods of improving this plentiful natural commodity in order to provide an electrical insulator having a high degree of mechanical strength, together with resistance to moisture, and they approached the problem by way of impregnation and densification. It was found that perfect impregnation with synthetic resins could not be achieved cheaply in a solid block of wood, so thin veneers were used. As a result, the impregnating material reaches every tiny cavity in the wood, thus sealing it against the absorption of moisture, and this is followed by densification which improves the insulators mechanical strength.

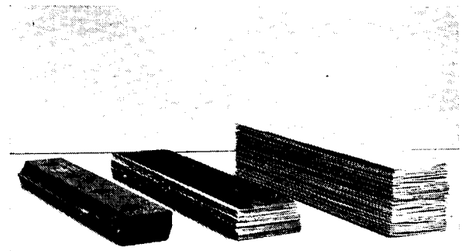
This specialised process was first carried out by Permali Ltd. who today operate the most modern factory of its kind in Europe. Beech veneers are impregnated under vacuum with a phenolic type synthetic resin, after which the application of heat and pressure fuse together stacks of these resin-laden veneers into what is, in effect, a solid block of resin reinforced by densified wood fibres. The result is an extremely strong relatively light and homogeneous material which is non-hygroscopic, dimensionally stable, weather resistant and termite-proof.

With this material available, the development of the densified wooden fishplate was an obvious step. It removed all fears of electrical failure in rail joints and after extreme trials, was accepted by track engineers as a fishplate capable of carrying the heaviest axle loads.

The three pieces of insulation in the solid insulating rail joint replace at least nine in the fibre insulated steel type; but more important than this is the fact that it CANNOT FAIL ELECTRICALLY. Therefore, the Permanent Way Engineer, although he would naturally prefer a fishplate which equalled the rail in life, now concedes the outstanding mechanical strenght of the densified wood fishplate, and values it for gradual indications of mechanical weakening over terms of months, after giving years of reliable service. This last fact is of great importance in that the permanent way ganger can replace a joint at his own convenience and during a traffic lull.

The solid insulating fishplate is simple to install and no preparation of the rail ends is necessary. In fact one man can complete the installation in a minute or so. Joints for rails of different ages or profiles, such as Bull-head to flat-bottom, new or worn, large to small, are easily provided for by densified laminated wood.

In addition, densified laminated woods of varying qualities and resin content are now available. One type, for example, has a low proportion of resin but slightly enhanced mechanical strength. It suffers a little from lack of resin by having a higher moisture absorption than the vacuum impregnated type, so that



A fishplate and equivalent stack of resin impregnated veneers before and after densification.

the latter should be used in climates where rainfall is abundant and extra protection is required to exclude moisture. In these circumstances, full impregnation safeguards the fishplate, even if totally submerged in water.

The solid insulating fishplates need no special maintenance, other than normal attention to rail joints. Even so, it should be remembered that until an insulating fishplate is invented with exactly the same mechanical strength as an uninsulated steel fishplate, a certain amount of care is necessary during installation and subsequent maintenance to ensure satisfactory life. The joint sleepers must be firmly tamped and all fastenings kept tight. When maintenance is poor, the solid insulating fishplate will always given better service than all other types and can never fail electrically even under the worst possible conditions, thus maintaining the "safety factor," so essential to the well being of all who travel by rail.

PIONEER ALL-ELECTRIC LOCO STILL GOING STRONG

When we were young, as a matter of fact before a lot of us were born, a General Electric (USA) locomotive was hauling freight trains on Brazil's Paulista Railroad. And it's still going strong today, nearly a half century later.

The locomotive, which went into service in Brazil, in 1921, was the first ever made by General Electric for a Latin American railroad. One of 12 units, the historic "first" was an all-electric locomotive running on 3,000 volts direct current supplied by overhead wires. Three years after these locomotives were made, G-E developed the first practical diesel-electrics. Since then, several hundred diesel-electrics, bearing G-E name plates, have gone into action in Latin America. Altogether, G-E has supplied over 1,000 locomotives for Latin American railroads. Together, they would develop enough horsepower to haul a fully loaded train long enough to stretch from Venezuela to Tierra del Fuego (Chile and Argentina).

The Development of Roller Bearing Axleboxes for Railway Vehicles

At a conference dealing with roller bearing axleboxes held on 4th and 5th March 1959 at **SKF** *Gothenburg and* **SKF** *Katrineholm, and attended by railway engineers from Finland, Norway and Sweden, Mr. Viktor Synek gave a short lecture with the above title. This article is an English translation of a more detailed version of this lecture.*

IN 1918 **SKF** started an investigation into bearing applications which were subjected to heavy shock loads, and a detailed study of the problems involved led to the design of the spherical roller bearing—a type which has subsequently become of outstanding importance to machines in general and to railway vehicles in particular. A great deal has been published about spherical roller bearing axleboxes, but a summary of their development may nevertheless be of interest. Spherical roller bearing axleboxes have also had a decisive influence on the development of other types of roller bearing axlebox, particularly cylindrical roller bearing axleboxes, and these are also discussed in this article.

Two designs of spherical roller bearing axlebox, which differ considerably in design and principle of operation, have undergone parallel development—axleboxes with two spherical roller bearings (twin bearing design) and axleboxes with one spherical roller bearing (self-aligning axleboxes).

The twin bearing design of axlebox can support a bending moment in any plane passing through the centre-line of the axle, and in this respect there is basically no difference between its properties and those of roller bearing axleboxes of alternative design or of plain bearing axleboxes.

The self-aligning axlebox with one spherical roller bearing has special properties. With this design the angular freedom of movement of the spherical roller bearing is deliberately utilized either to prevent cornering of the box in the guides or to promote smooth running of the vehicle.

The differences in characteristics and design of these two types of axlebox make it necessary to deal separately with their development. It is natural that individual stages of development should overlap, and some simplification of the presentation is necessary in order to give emphasis to essential features. In the following pages, therefore, only axleboxes for passenger coaches with axle loads of 15 tons and goods wagons with axle loads of up to 20 tons are dealt with.

AXLEBOXES WITH TWO SPHERICAL ROLLER BEARINGS

The axlebox shown in Fig. 1, with one spherical roller bearing at the outer position and one cylindrical roller bearing at the inner position, may be regarded as the predecessor of axleboxes with two spherical roller bearings. It was very widely used and therefore occupies an important place in the development of roller bearing axleboxes. The cylindrical roller bearing only carried radial load, whilst the spherical roller bearing carried both radial and thrust loads.

Axleboxes of this design were first fitted to bogie wagons on the Swedish State Railways in 1922, and in the following years came to be used in relatively large numbers in many countries, especially for express passenger coaches.

Both bearing inner rings had an interference fit on the journal and some difficulties were experienced in machining the journals within the specified tolerances,

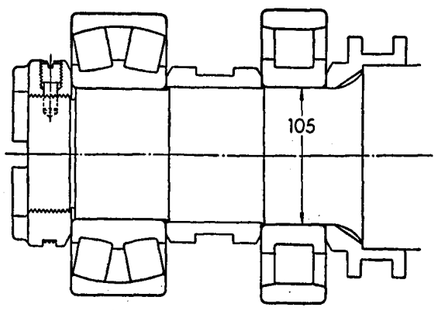


Fig. 1. Axle bearing arrangement in 1922.

especially in countries where facilities for grinding the journals were not available and there was insufficient experience in machining to limits which were very close compared with plain bearing practice. It was also necessary to conform to regulations for periodic inspection of the journals for fatigue cracks. This entailed removal of the bearings at each inspection, which took a comparatively long time with the methods of dismounting then in use.

Withdrawal sleeves had come into use as far back as 1920 and good results had already been obtained with them in axleboxes with one spherical roller bearing. The advantages that these sleeves offered were that they permitted wider limits for the journal diameter and they facilitated the dismounting of the bearing. It

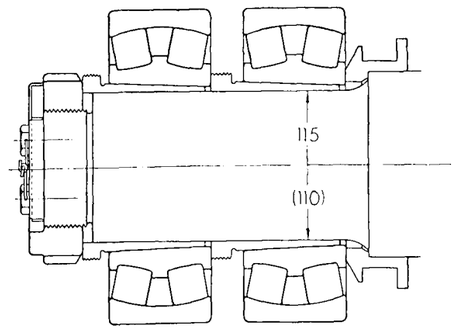


Fig. 2. Axle bearing arrangement in 1926. Bearing dimensions: 120×240×80 mm.

was therefore a logical step to use these sleeves in conjunction with two spherical roller bearings of the same size in twin bearing boxes. Some railway administrations were reluctant however, to change from the design with one spherical roller bearing and one cylindrical roller bearing because this type of axlebox had proved very reliable. Certain types of vehicle were being fitted with this type of axlebox in the 1930's and many of them are still in service today.

When the design incorporating two spherical roller bearings mounted on withdrawal sleeves was first introduced only bearings of medium series were available. The dimensions of the bearing considered suitable for standard vehicles in high speed traffic was 110×240×80 mm and the withdrawal sleeve had a bore of 100 mm. It soon became obvious however, that the carrying capacity of the bearings could not be fully utilized, the deciding factor being the carrying capacity of the journal, and as far back as 1926 a special "railway bearing" was designed having dimensions of 120×240×80 mm and approximately the same carrying capacity. The withdrawal sleeve for this bearing had a bore of 110 mm. This bearing has been widely used not only for express passenger coaches but also for special goods wagons; in Germany it has been used even for large goods wagons with an axle load of 20 tons. These axleboxes were not really intended for such heavy axle loads, nevertheless the bearings proved extremely reliable even under these conditions giving convincing proof of the high carrying capacity of spherical roller bearings. In 1931 however, there were a number of cases of fractured journals, especially on the large goods wagons just mentioned, and it became necessary to use a more robust journal. Investigations showed that after a period fatigue fractures developed due to grooving of the journal, at the end of the inner withdrawal sleeve. In Germany the withdrawal sleeve for the inner bearing was dropped and the bearing mounted direct on a tapered seating, whilst in Sweden the difficulty was overcome by the introduction by **SKF** of a thin-section withdrawal sleeve with a bore of 115 mm, which reduced the stresses in the journal by 12%, Fig. 2. This design proved satisfactory, at least as far as bogie passenger vehicles were concerned, and no more fractured journals occurred. It was realized however, that the journals still prevented the carrying capacity of the bearings from being used to the full. Experience with the spherical roller bearing in other industries had, meantime, shown that the bearing rings could be of thinner section (especially the outer ring) without adversely affecting the reliability of the bearing. These considerations led to the introduction in 1934 of a spherical roller bearing with dimensions of 130×240×80 mm for axleboxes. Although the section height was reduced below that of the bearing with the

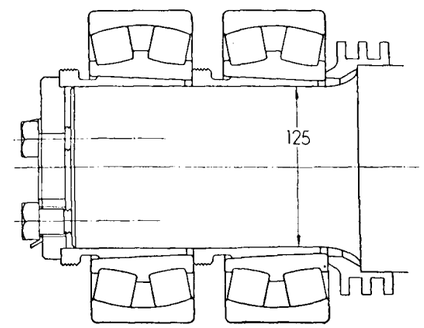


Fig. 3. Axle bearing arrangement in 1934. Bearing dimensions: 130×240×80 mm.

same outside diameter which it superseded, a somewhat higher carrying capacity was obtained by better utilization of the available section height. The withdrawal sleeve for this bearing initially had a bore of 120 mm. which was later increased to 125 mm. This diameter of journal was suitable for all loads for which the bearings themselves could be used, Fig. 3.

During the first 30 years of their existence no essential changes took place in the internal design of spherical roller bearings, because they fullfilled all

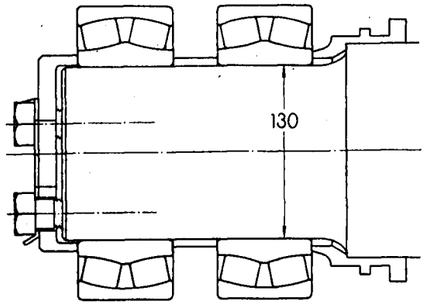


Fig. 4. Axle bearing arrangement incorporating spherical roller bearings. U.I.C. 130 mm journal. Bearing dimensions: 130×220×73 mm.

requirements made of them. It was not until the years 1948—1950 that **SKF** began to consider the possibility of redesigning the bearings to increase their carrying capacity. One of the reasons for starting these investigations was a general desire to reduce the dimensions of roller bearings for axleboxes, although not at the expense of reliability or life. During the second World War work was started on roller bearing axleboxes for standard 4-wheel goods wagons and for these comparatively low-priced vehicles it is important to design inexpensive axleboxes. The investigations led to the design of a spherical roller bearing which differs essentially in internal construction from that originally introduced in 1920.*

For goods wagons with axle loads of up to 20 tons and passenger coaches with axle loads of up to 15 tons, spherical roller bearings with dimensions 135×220×73 mm. were developed, Fig. 4 Despite the reduction in section height to only 45 mm. a bearing of this type has a higher carrying capacity than the larger bearing previously used for the same axle loads. The axle

* See Ball Bearing Journal No. 4/1957.

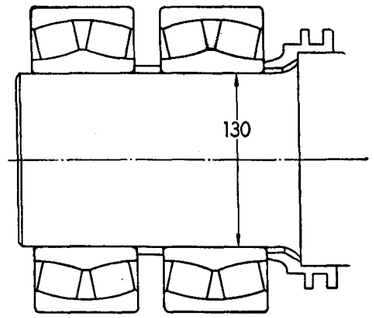


Fig. 5. Axle bearing arrangement incorporating spherical roller bearings. U.I.C. 130 mm. journal. Bearing dimensions: 130×230×80 mm.

journal shown in Fig. 4 has been standardized by U.I.C.

The reasons which led in the initial stages of development to the use of bearings mounted on withdrawal sleeves did not apply to the same extent after the War. There is no longer any uncertainty regarding the correct fit to be used for inner rings mounted direct on the journal and manufacturers have no difficulty in keeping to the close tolerances required on journal diameters. The proved reliability of the bearings and the robust journals have made frequent inspection unnecessary; also facilities are now available in many railway workshops for supersonic crack detection without removal of the bearings. As a result a less expensive design with direct mounted bearings is more widely used. Improved methods of mounting (for example by heating the bearings electrically) and of

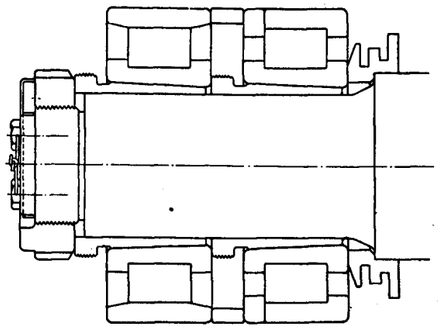


Fig. 6. Axle bearing arrangement incorporating cylindrical roller bearings. Used from 1927. Bearing dimensions: 120×240×80 mm.

dismounting (by means of oil injection) have also contributed to this change.

Certain railway administrations, however, are already committed to the use of bearings on withdrawal sleeves and prefer to continue with this practice, with its well-established advantages. **SKF** therefore manufacture bearings which only differ from that shown in Fig. 4 in that the inner ring is of thinner section and has a taper bore. Bearings of this type with withdrawal sleeves can be fitted on the same 130 mm. diameter journal.

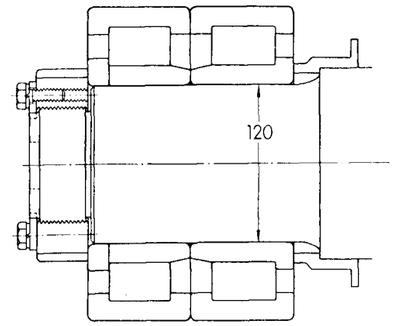


Fig. 7. Axle bearing arrangement incorporating cylindrical roller bearings. U.I.C. 120 mm journal. Bearing dimensions: 120×240×80 mm.

From Fig. 4 it will be seen that the bearing span is comparatively large, which is advantageous to the load distribution on the two bearings. When deciding the length dimension for this U.I.C. journal it was intended that it should also be used for particularly heavy vehicles, for example, certain types of motor coach which require bearings of higher carrying capacity. Standardized spherical roller bearings with dimensions of 130×240×80 mm. may be selected in such cases. They are shown in Fig. 5.

AXLEBOXES WITH CYLINDRICAL ROLLER BEARINGS

In parallel with the development of twin spherical roller bearing axleboxes, cylindrical roller bearing axleboxes have also been developed in a number of countries. Early tests showed that cylindrical roller bearings were suitable for railway applications and this was also proved by the results obtained with axleboxes of the type shown in Fig. 1.

In the United Kingdom these boxes have been established for suburban electric multiple unit stock, but only radial loads are carried by cylindrical roller bearings—a ball bearing or a thrust pad being used for carrying the thrust loads; in other countries, particularly Germany, designs have been developed where the radial and thrust loads are carried by the cylindrical roller bearings. The thrust loads are taken on the flanges of the bearing against which the end faces of the rollers slide and it has been shown in practice that the thrust loads which occur when negotiating bends etc. can be carried by the cylindrical roller bearing without any damage due to sliding friction, provided that the side faces of the rollers are executed with great care and a first class lubricant is used. The working conditions of railway rolling stock are favourable to the bearings since the thrust loads are usually of short duration and under no thrust load, or fluctuating thrust load, the lubricant is able to get between the flange and the roller ends. On the other hand, cylindrical roller bearings are sensitive to continuous thrust loads which may occur, for example, if the bearings are mounted in vehicles where the axleboxes can be cross-located.

As mentioned earlier, after 1926 spherical roller bearings with dimensions 120×240×80 mm. came to be used in all types of railway rolling stock and these bearings gave very satisfactory results. This performance in Germany was also very good if the subsequent journal breakages experienced on large goods wagons are disregarded. Because of the structure of the German rolling bearing industry however, trials had been carried out at quite an early stage with cylindrical roller bearings having the same boundary dimensions as the spherical roller bearings and using the same method of securing them on the journal, see Fig. 6.

The cylindrical roller bearings shown in Fig. 6 did not fulfil expectations for various reasons, including the fact that securing the inner rings by means of withdrawal sleeves was not suitable for this type of bearing. The design shown is, however, the predecessor of the axlebox used in Germany today, see Fig. 7. The boundary dimensions laid down for spherical roller bearings in 1926 were retained, but the bore is cylindrical. The bearings are mounted side by side on a 120 mm. journal, partly to reduce costs by dispensing with the distance collar and partly to obtain a short axle journal which, according to the U.I.C. specification, must be suitable for an axle load of 20 tons. The end of the journal is threaded and the nut and method of locking is similar to that previously

used for spherical roller bearings. In addition to the 130 mm. journal, the journal shown in Fig. 7 has also been standardized by the U.I.C.

It might perhaps be thought that the 130 mm. journal would be better for spherical roller bearing and that the 120 mm. journal would be better for cylindrical roller bearings, but this is not so. The 130 mm. journal is a general purpose journal on which all types of roller bearing can be mounted without difficulty. Fig. 8 shows cylindrical roller bearings on the 130 mm. journal. Their outside diameter and width are the same as for the bearings in Fig. 7. Their carrying capacity is also the same, the reduction in the section height from 60 mm. to 55 mm. being obtained solely at the expense of the ring thickness.

Fig. 9 shows spherical roller bearings mounted on the U.I.C. 120 mm. journal. Despite the smaller size of these bearings, their carrying capacity is only about 10% less than that of the spherical roller bearings shown in Fig. 4 and they conform to U.I.C. requirements in respect of carrying capacity and life.

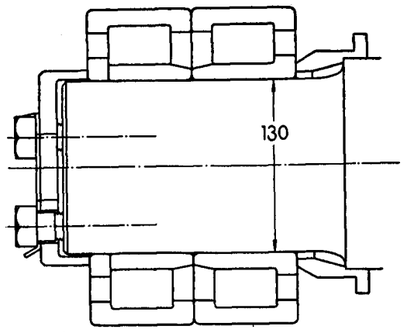


Fig. 8. Axle bearing arrangement incorporating cylindrical roller bearings. U.I.C. 130 mm journal. Bearing dimensions : 120×240×80 mm.

DEVELOPMENT OF AXLE JOURNALS

A glance at the axle journals illustrated shows that not only has the diameter increased to 130 mm. over the years but that the method of securing the bearings on the journal has also undergone development.

Figs. 1 and 2 show that initially the end of the journal was threaded and a robust nut used to locate the bearings. To begin with, as shown in Fig. 1, the nut was locked by means of a set screw, but this method was soon discarded because frequent inspection of the journal and remounting of the bearings often made it necessary to drill new holes for the screw. The use of a key secured to the journal end by two set screws as shown in Fig. 2 was then introduced. Although the nut used with this method of locking is expensive, the method has given good results and is still being used today.

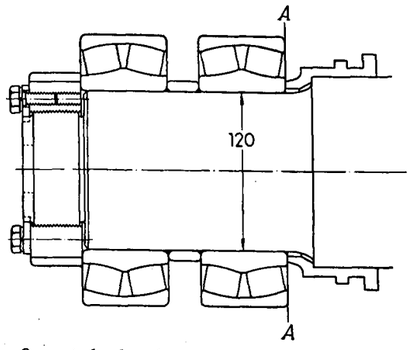


Fig. 9. Axle bearing arrangement incorporating spherical roller bearings. U.I.C. 120 mm. journal. Bearing dimensions : 120×205×68 mm.

In cases where roller bearing axleboxes were used to modernize old vehicles it was often found that the axle journals were too short to be threaded and an end plate was then used secured to the journal with three screws, Fig. 3. This method of securing the bearings proved to be advantageous and it came to be adopted in increasing numbers as far back as the 1930's, largely because it was cheaper than using a threaded journal and nut. The axle journal shown in Figs. 4 and 8, which has been standardized by U. I. C. is fitted with an end plate.

At this point it may be appropriate to consider in greater detail some of the requirements made of nuts and end plates. In spherical roller bearing axleboxes, because of the tight fit of the inner rings, the thrust shock loads occurring during operation are transmitted from the bearings direct to the journal. These loads are not such as to cause displacement of the bearing inner rings, even if there is no nut or end plate. As the thrust loads from the axlebox body are usually transmitted to the inner bearing, the fit of both bearings would have to be overcome to achieve displacement of the inner rings, and experience shows that this does not occur. In recent years there has been a

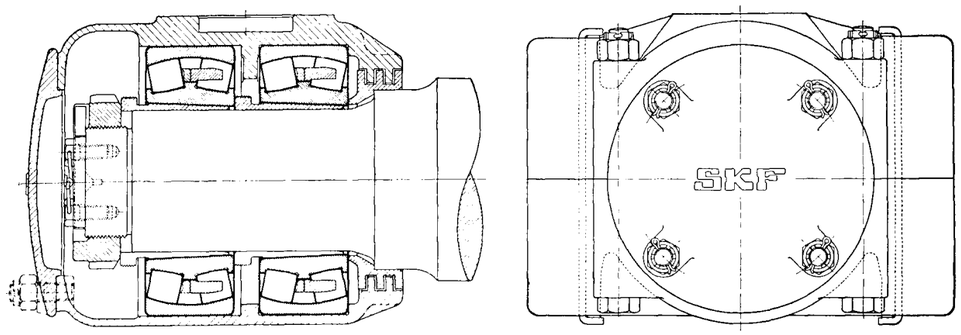


Fig. 10. Axlebox with spherical roller bearings of type shown in Fig. 3. Split box.

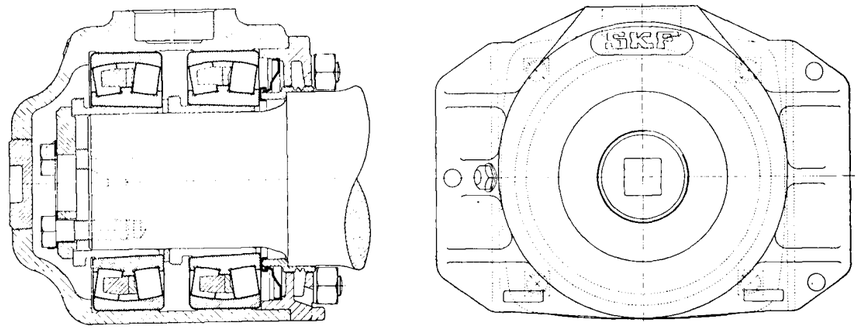


Fig. 11. Spherical roller bearing axlebox for goods wagons. Solid box.

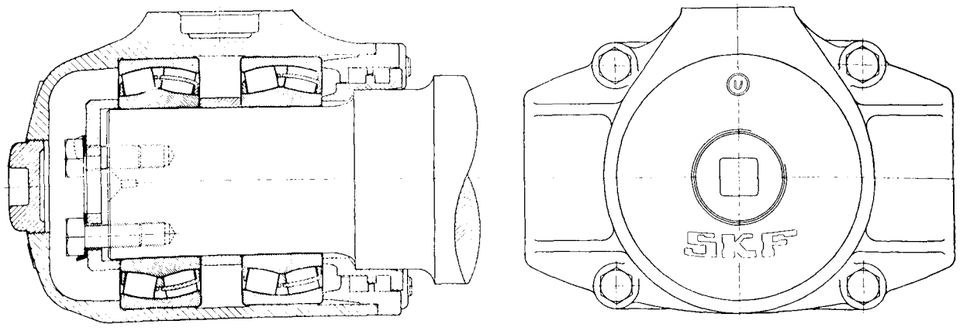


Fig. 12. Goods wagon axlebox with spherical roller bearings of type shown in Fig. 4. U.I.C. 130 mm. journal.

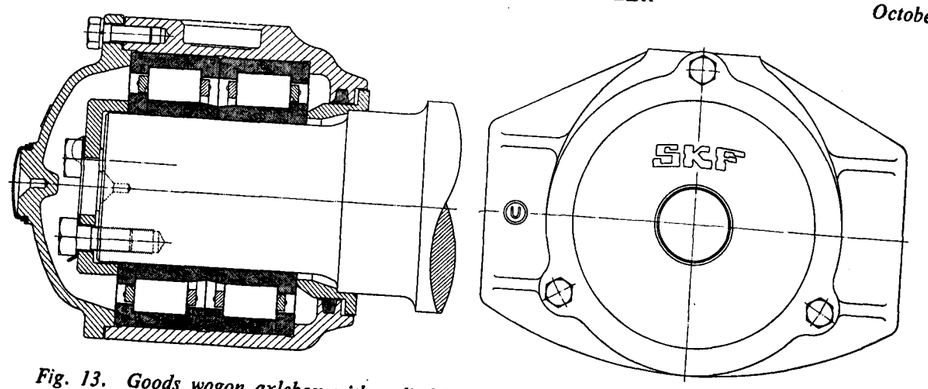


Fig. 13. Goods wagon axlebox with cylindrical roller bearings. U.I.C. 130 mm. journal.

move towards dispensing completely with the axial securing of spherical roller bearings with cylindrical bore, Fig. 5, although so far only in cases where the axlebox is guided by flanges in both directions or at the inner flange only. A factor which has contributed to this arrangement is that even in the very unlikely case where the inner rings of both bearings have loosened on the journal—either due to bearing damage or to unsatisfactory machining of the journal which has been overlooked during inspection—the axlebox will remain in position on the journal because the box is suitably checked in the frame. The use of a securing device on the journal end would serve no useful purpose in such circumstances.

It is obvious that dispensing with nuts and end plates not only reduces initial costs but that work in connection with mounting and dismounting of bearings is also considerably reduced.

In the case of spherical roller bearings on withdrawal sleeves, the securing device at the end of the journal should never be dispensed with.

In axleboxes with cylindrical roller bearings of the usual design, Figs. 7 and 8, the outwardly directed thrust loads act undiminished on the securing components at the end of the journal, and these are therefore not only necessary—they must be of appropriate strength.

The U.I.C. 130 mm. journal, Figs. 4 and 8, has an end plate secured by three robust screws (7/8″). Although this journal was developed in connection with spherical roller bearings, the robust end securing device was selected so that the journal could be used generally, especially also for cylindrical roller bearings.

DEVELOPMENT OF AXLEBOX BODIES

During the first twenty years or so after the introduction of spherical roller bearings for railway vehicles the axleboxes were of twin bearing design, and, with few exceptions, of split type. This design was selected not only because it was absolutely necessary for spherical roller bearings, but also because it offered great advantages during the development period, some of which are still applicable today.

Fig. 10 shows an example of an axlebox of this type with spherical roller bearings. The box is split horizontally and the two halves held together by four bolts.

As mentioned earlier frequent inspection of the bearings and the journal used to be necessary. The dismantling and removal of the split box could be done more rapidly and with less effort than in the case of a one-piece casting, since removing and mounting the axlebox only entailed lifting each half separately and not the whole box. This latter factor still retains its importance, and split boxes are still often preferred, especially for large bearings, because they are easier to handle—despite the fact that they are more expensive.

The experience gained in the course of time has shown the superiority of roller bearing axleboxes over plain bearing axleboxes. One of the results of this was that shortly before the outbreak of the Second World War various railway administrations began to take an interest in these axleboxes for standard goods wagons.

Increased demands were being made on goods wagon stock, especially as regards running speeds, and the time was therefore opportune for the design of a suitable goods wagon axlebox.

Frequent inspection of the roller bearings could not be entertained for this type of wagon and experience showed that in any case it was no longer necessary. As, in addition, the cost of the bearings for these relatively low-priced wagons had to be as low as possible, the use of solid axleboxes was obvious. Fig. 11 shows the axlebox designed at that time for a 125 mm. diameter journal. It will be seen that the box has a solid back cover, and after the bearings are mounted on the journal the box body is pushed over the bearings and the cover bolted up. These axleboxes came into use about 1940 and a very large number of them were fitted during the ensuing years.

Fig. 12 shows a more recent goods wagon axlebox having a solid body conforming to dimensions laid down by U.I,C. The roller bearings are shown in Fig. 4. To facilitate mounting and dismounting the back cover is secured to the body by four bolts which are accessible from the front of the box.

Split axleboxes have only rarely been used for cylindrical roller bearings, the usual design of box being shown in Fig. 13. The axlebox is to U. I. C. dimensions and fitted with the bearings shown in Fig. 8. The method of securing cylindrical roller bearings makes it necessary to have a box with a front cover.

The development of axlebox bodies has not been limited to design only; very important developments have taken place as regards material.

Cast steel was originally considered the only material suitable for axlebox bodies, and in cases where it was possible to give the box a simple form, and where the boxes were mass produced, steel forgings started to be used. Steel castings and forgings are still used today for many boxes.

At about the same time as the introduction of roller bearing axleboxes for two-axle goods wagons, types of alloyed cast iron with good strength properties were introduced. It was soon recognised that these cast irons offered an excellent and inexpensive material for axleboxes which, because of their shape and application, are subjected to normal stresses. In the last 20 years a very large number of goods wagon axleboxes—and to a lesser extent passenger coach axleboxes—with high tensile, copper alloy cast-iron bodies have been supplied and have given satisfactory service.

For axlebox castings, which, due to their shape and the loads they have to carry, are subjected to heavy tensile and bending stresses, or which have to meet special safety requirements, spheroidal graphite cast iron has become a serious competitor of cast steel in recent years.

Spheroidal graphite cast iron cannot be regarded as cast iron or as a kind of steel, although its mechanical properties are very similar to those of steel. In many respects spheroidal graphite cast iron is even superior to cast steel as a material for axlebox bodies. It is tough, corrosion resistant, wear resistant and easy to machine.

The strict specifications laid down by railway administrations in regard to the selection of materials for mechanical components, where great reliability is an obvious requirement, do, of course, make it difficult to change over from a well-known material to a new one whose properties differ from those specified. Despite this, spheroidal graphite cast iron will undoubtedly be used more and more for axlebox bodies on passenger coaches, motor coaches and locomotives as it not only fulfils the technical requirements but also shows advantages from the point of view of manufacturing costs.

COMPARISON OF TWIN SPHERICAL ROLLER BEARING AXLEBOXES AND CYLINDRICAL BEARING AXLEBOXES

When comparing axleboxes of different design the life and running properties of the bearings are of major importance, but certain other factors such as the method of mounting and dismounting the bearings, the work involved during bearing inspection, etc. must also be taken into consideration. Some of these latter factors will be considered first.

In a spherical roller bearing axlebox both bearings are identical; they are self-contained, i. e. each bearing forms a unit. In the case of cylindrical roller bearing axleboxes the inner rings of both bearings are different and the bearings are not self-contained units.

Mounting of the two types of bearing is carried out differently. With a spherical roller bearing axlebox the bearings are mounted on the journal, the end plate (where required) is fitted and the bearings

lubricated and then the axlebox body pushed over the bearings. With a cylindrical roller bearing axlebox the loose inner rings are first mounted on the journal in the correct order; the outer rings and roller sets are then fitted in the box body, the free space

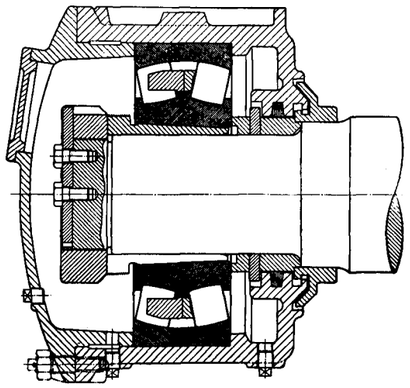


Fig. 14. Self-aligning axlebox dated 1921.

between the rollers filled with the grease and the box then pushed over the inner rings. The weight which has to be lifted in this case is greater than for a spherical roller bearing axlebox because, with the exception of the inner rings, the two bearings are in the box body, whereas with the spherical roller bearing box the bearings are on the journal. Fitting of the box body must be carried out more carefully with cylindrical roller bearings as other wise the rollers may easily score the inner rings if the axlebox is not lined up properly. Damage of this kind is not possible with spherical roller bearings.

Another essential difference is that in the case of cylindrical roller bearings the nut or end plate must be removed in order to withdraw the alxebox for inspection of the bearings. With spherical roller bearings this is not necessary.

It is easier to inspect the inner rings of cylindrical roller bearings, since with spherical roller bearings it is necessary to remove some of the rollers before the inner ring tracks are visible. On the other hand, the outer ring track of the spherical roller bearing can be inspected quite easily by swivelling the outer ring.

Both spherical roller bearings and cylindrical roller bearings meet the requirements of the railways with regard to long lubricating intervals and low working temperatures. In the case of very high train speeds it is theoretically possible that cylindrical roller bearings are slightly better in this respect, but as the matter appears to have no practical significance actual temperature recordings in service with a view to confirming the theory or otherwise, have not been carried out.

Care must be taken in the selection of lubricants for both types of bearing, and greases are available which will give good performance over long periods of service.

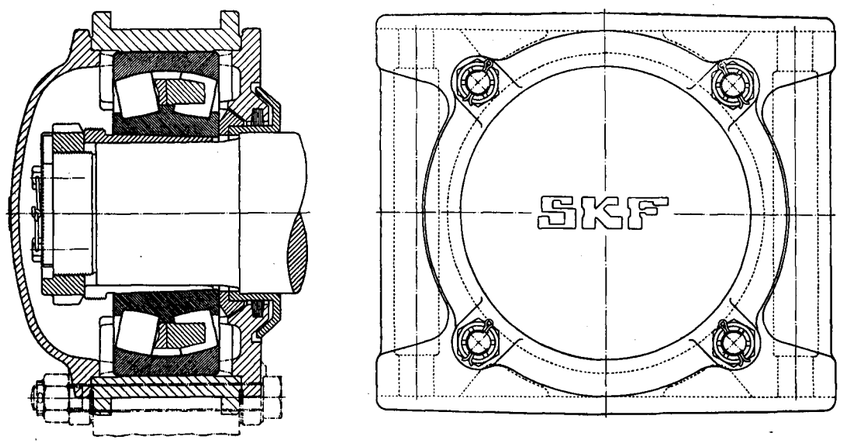


Fig. 15. Axlebox for diamond bogies. Old design.

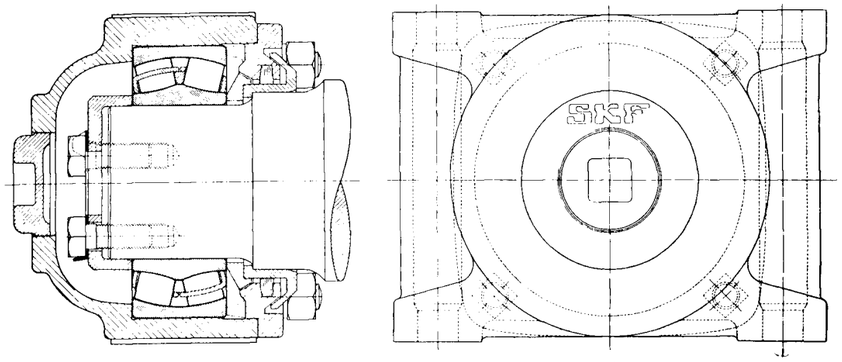


Fig. 16. Axlebox for diamond bogies. Modern design.

SELF-ALIGNING AXLEBOXES

The first roller bearing axleboxes to be widely used on railway rolling stock had only one spherical roller bearing per box, the design being shown in Fig. 14. This box was introduced in 1921 with bearing 22332 K with a modified, extra thick inner ring. This was the first occasion on which withdrawal sleeves were used. The vehicles were bogie wagons with an axle load of 15 tons, which were run at speeds of up to 75 m. p. h. These axleboxes gave satisfaction until, about 25 years after the roller bearings had been fitted, the wagons were scrapped. This alone gave ample proof of the importance of self-aligning axleboxes.—In the case of self-aligning axleboxes the axle journal is short and no problems are encountered with regard to journal diameter comparable with those which have been met with twin bearing designs.

In vehicles with diamond bogies the body of the axlebox is rigidly bolted to the bogie frame. Deflection of the frame must be taken into account and it cannot be assumed that the boxes on the same axle have the same centre line. The self-aligning feature of spherical roller bearings was therefore regarded as an important advantage for this type of bogie right from the outset. Figs. 15 and 16 show two stages of the development of this type of box.

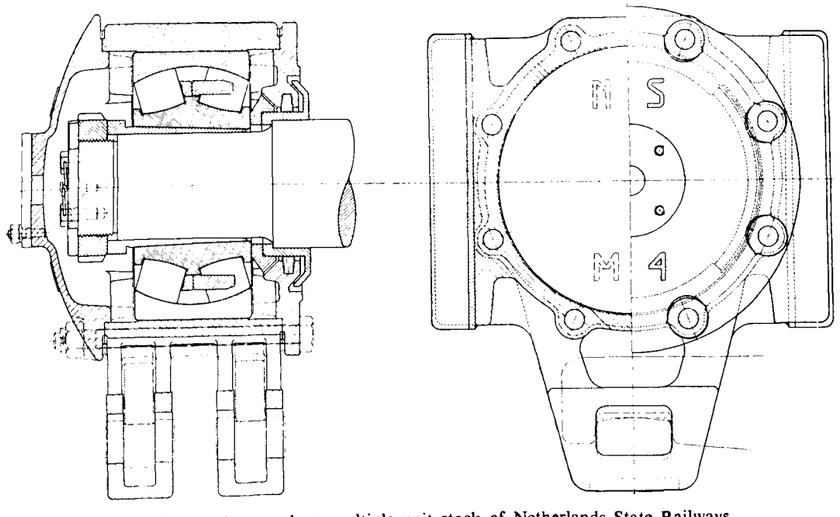


Fig. 17. Axlebox used on multiple unit stock of Netherlands State Railways.

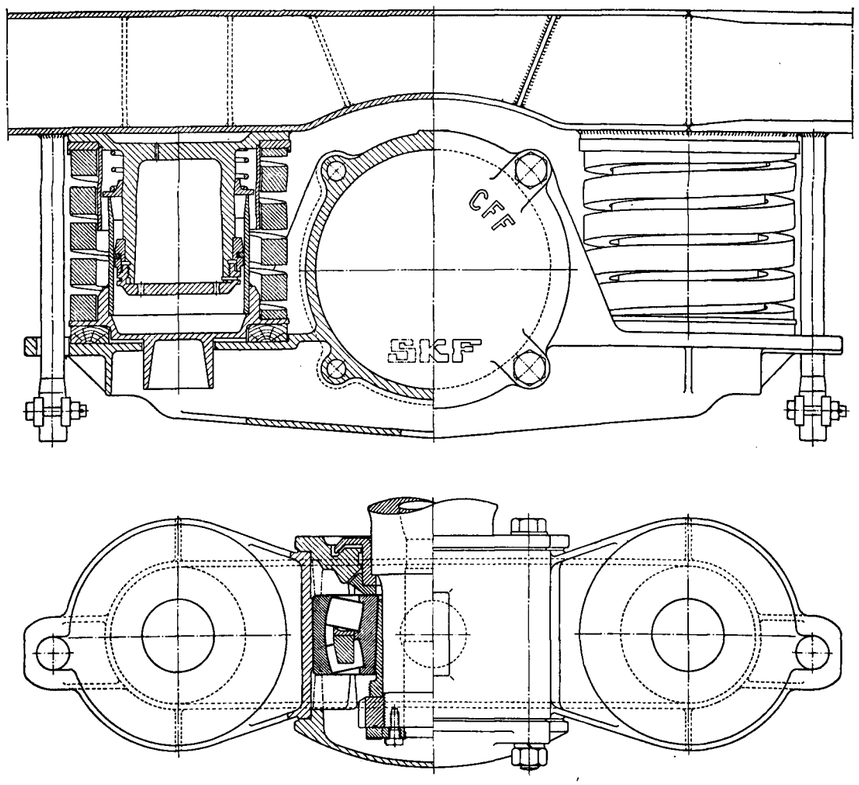


Fig. 18. Schlieren bogie axlebox.

In the initial designs bearings mounted on withdrawal sleeves were used almost exclusively, Fig. 15, but in recent years development has taken place along similar lines to that of twin bearing boxes and there is a preference for bearings with cylindrical bore as shown in Fig. 16.

It was general practice for a long time to secure the bearing on the journal by means of a nut and locking key, but this method is gradually being superseded by the simpler end plate. With the direct mounted design of the type shown in Fig. 16 it has been possible in some cases to dispense with the locking device entirely, as with the twin bearing design of box, since the thrust loads arising during operation are not sufficient to displace the bearing inner ring on the journal. Since the box itself is rigidly bolted in the frame the question of lateral location of the box body does not arise.

It has been mentioned earlier in this article that the new design of spherical roller bearing has made it possible to reduce the overall dimensions of axleboxes, and this important feature has resulted in an increase in the use of self-aligning axleboxes.

The special properties of axleboxes having only one spherical roller bearing have encouraged rolling stock designers to produce bogie designs in which these properties can be utilized to the full. Two examples are shown here. Fig. 17 shows the axlebox used for electric multiple unit stock of the Netherlands State Railways. This design was introduced during the 1930's and a very large number of these axleboxes are in service. Fig. 18 shows the axlebox for Schlieren bogies which are being widely used nowadays because of their excellent running characteristics.

Both these axleboxes are designed for underslung

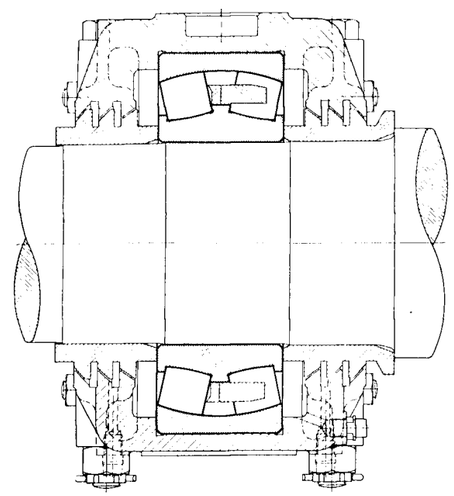


Fig. 19. Trailing truck axlebox for inside journal. Horizontally split box.

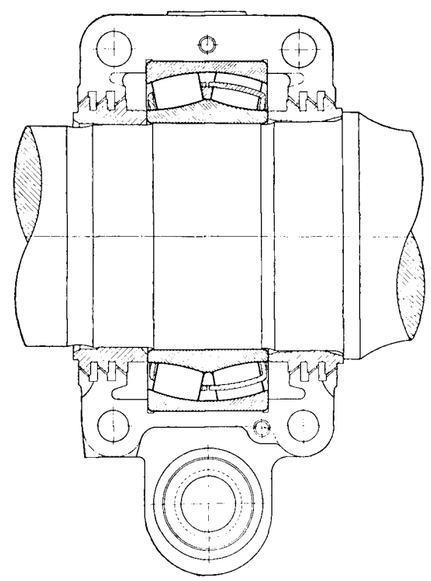


Fig. 20. Axlebox for the driving and coupled axles of steam locomotives. Vertically split box.

spring suspension and the axlebox therefore remains in stable equilibrium even if the guidance of the box in the frame is disregarded.

Self-aligning axleboxes are also often used with top spring loading. In these designs, however, good lateral guidance of the box in the frame is necessary.

All the examples mentioned so far deal with axleboxes fitted outside the wheels, but special mention should be made of inside boxes which are commonly used on locomotives. Whilst the static axle load in the case of a locomotive is much the same as for any other railway vehicle, for technical reasons the axle diameter at the bearing seating is considerably larger than the journal diameter for an axlebox fitted outside the wheel. Because of this one spherical roller bearing per journal, often from a light series, is sufficient, and axleboxes with only one spherical roller bearing for fitting to inside journals have therefore generally been selected.

Bearings mounted on withdrawal sleeves have only been used very occasionally for inside journal

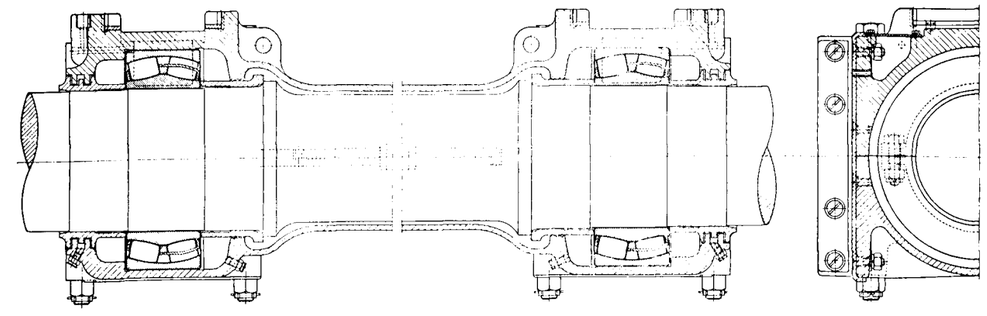


Fig. 21. Cannon type axlebox for coupled axles of steam locomotives.

axleboxes. The reason for this is that the main advantage of the withdrawal sleeve—ease of dismounting of the bearing—cannot be utilized because it is necessary to press off the wheel before removing the bearing.

Figs. 19 and 20 show two typical designs of axlebox for inside journals. Fig. 19 shows a box which was developed many years ago for the trailing axles of steam locomotives, whilst Fig. 20 shows a more modern design for the driving and coupled axles of steam locomotives.

Although self-aligning axleboxes for outside journals are always of solid type, axleboxes on inside journals are usually of split design to simplify bearing inspection. The trailing truck box shown in Fig. 19 is split horizontally and the two halves are held together by bolts. The driving and coupled-axle box in Fig. 20, on the other hand, is split vertically. Compared with the horizontally split box this latter design has a number of advantages. It is comparatively narrow, which has a favourable effect on the required width of frame gap; the bolts which hold the two halves of the box together are not subjected to any undue stresses even in applications designed for underslung spring suspensions; finally, when the box is dismantled it is not necessary to remove the liners.

It has already been mentioned that self-aligning axleboxes intended for top spring loading require good lateral guidance in the frame. This arrangement is therefore not suitable for coupled axles which must have a certain amount of axial float. In these cases cannon type axleboxes are used, Fig. 21, which also incorporate only one spherical roller bearing per journal. The use of cannon type axleboxes is not confined to floating coupled axles however, and they are also often used on non-floating axles.

Self-aligning boxes with underslung springs are characterized by their self-righting properties, and if lateral freedom of the axle is necessary in relation to the frame the self-aligning feature of the spherical roller bearing can be utilized.

B.U.T. MANAGEMENT CHANGES

B. U. T. announce that Mr. Ronald Ellis, B.Sc. Tech. (Hons.), A. M. I. Mech. E., M. I. Loco. E., Assoc. Inst. T., will relinquish his executive duties as General Manager of the Company on 15th October, 1960. Mr. Ellis will, however, be appointed to the Board of Directors in order that his advice and guidance in the field of rail traction and trolleybuses will be continuously available to British United Traction Limited.

Mr. F. G. Headen, the present Secretary of the Company will take over Mr. Ellis's executive duties as Manager.

Mr. J. D. Slater, A. C. A., has also been nominated to the B. U. T. Board of Directors.

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RAILWAY GIANTS AT WORK

More than 150 fully loaded freight cars are frequently strung out behind the powerful gas turbine electric locomotives built by the General Electric Company (U. S. A.) for the Union Pacific Railroad.

At times, the 8500 horsepower giants actually haul their strings of cars up a relatively steep grade crossing the continental Divide in the western part of the United States.

Almost as long as a fifteen-storey building is high, the G–E gas turbine electric locomotives are the biggest thing of their kind ever built anywhere in the world. Fully loaded, the locomotive and tender weigh 1,170,000 pounds.

The 18 other units built in the past 2 years have already accumulated over two million miles of service at altitudes up to 8,000 feet. Twelve additional units are being completed at the rate of one a month.

The gas turbine power plants in these locomotives are similar in principle to jet engines. The main difference is that, in a locomotive, the turbine is connected through reduction gears to electric generators which supply power to the driving motors on the axles. In a jet engine, the expanding gases are allowed to push their way out the rear, giving the plane a forward thrust.

Building and Development of Electric Locomotives in Czechoslovakia

By An Engineering Correspondent

THE advancement in technics and the new price ratios of the sources of energy has led during the past few years in the whole world to a fundamental change in railway traction.

Steam traction has been replaced in most cases by diesel traction, but on heavily loaded lines by electrical traction almost exclusively as it is, in comparison with diesel traction, more economical in spite of considerable capital expenditure.

The well-known Skoda Works has also contributed its share to the application of electrical traction. In its locomotive works, which has built since its foundation in 1920 over four thousand locomotives for fifteen countries, electric locomotives have been built already since 1928. After 1945, a special Electric Locomotive Department was established. The Skoda Bo' Bo' electric locomotive is still at the top of world technics as regards the power of each of its traction motors for 3,000 Volt d. c., which is 586 kW.

About 380 of these locomotives have been built in several variants and production of them for this country and for export continues in increasing numbers since the complete stoppage of the production of steam locomotives in the Skoda Works in the first half of 1958. In a short time these electric locomotives will be supplied to Poland. At the same time large deliveries continue to the U.S.S.R.

The different variants of this locomotive have maximum speeds of 90, 120 or 140 km p.h. and weight 80, 84 or 88 tons. The individual variants differ also somewhat in their mechanical part, particularly in the arrangement of the boggies and springing and in the transmission of the torque from the motors to the axles. This type of electric locomotives has become the backbone of the electrification of the Czechoslovak State Railways and at the same time the only express train locomotive of the Soviet Railways.

At present a new reinforced traction motor is being tested, which will make possible either higher speeds with the Bo 'Bo' express train type, or the transport of heavier trains with goods train type locomotives.

Long-term testing of four slightly different prototypes of a six-axle Co 'Co' locomotives, which is derived from the four-axle locomotive on the sectional principle, are actually in progress. These will be built as from 1962, according to the wishes of the customers, either with six motors of 708 kW each with elastic suspension or—for the special requirements of the Czechoslovak State Railways—with simplified nose suspended motors of 500 kW.

For the requirements of a. c. 25 Volt electrification with industrial frequency a Bo 'Bo' main line locomotive of 3,000 kW is being developed, in which serious interest has already been shown by several countries. A test track and a prototype locomotive will be in operation in the first half of 1961. To prevent as far as possible initial difficulties, usual with new machines, the well-proven, reliable elements of the d.c. locomotive have been incorporated in the mechanical and electrical parts of the a. c. locomotive.

In the open cast mine locomotive branch the locomotive works of the Skoda Works are also prominent. About 250 of their six-axle 150 tons locomotives of 1,560 kW at 1,500 Volts d.c. are in operation in different areas of the U.S.S.R., further scores in China, Bulgaria, etc. Their reconstruction is being prepared with a simultaneous substantial increase of power and weight to ensure that the new locomotives will satisfy the increased requirements resulting from the greater depths and capacity of these mines.

The production of this type of locomotives has been transferred a short time ago to a new modern locomotive factory, which delivered at the end of 1959 its first locomotive. At present the new factory has already realized its first export deliveries.

For open cast mines of medium size, the Skoda Locomotive Works build narrow gauge four-axle locomotives weighing 64 tons with a rated output of 520 kW at 1,500 Volts d.c. One hundred locomotives of this type have contributed substantially to the

electrification of Czechoslovak mines. These locomotives have proved so successful that they will be built, following orders in hand, for several years without substantial changes.

In addition the Skoda Works build, as required, small numbers of special locomotives such as two or four-axle battery shunters, two-axle trolley line shunters for 600 Volts d.c. and locomotives for coke works.

For the extensive production of suburban electric units, which is being prepared, the Skoda Works produce complete electrical equipment, which has proved successful during the past months on prototype units.

Owing to the extent and range of their production of electric locomotives, both works building Skoda locomotives are among the largest, if not the largest, builders of electric locomotives in the world. Their yearly production is substantially larger than the produetion of a number of other world renowned firms, which have been for many years without competition in this line. The actual stage of advancement is an encouragement to the Skoda Works to continue the production and development of reliable and economic Skoda electric locomotives.

1000 HP Diesel Hydraulic Locomotive with TWIN DISC Converter

By An Engineering Correspondent

AMONG the many 1000 HP Diesel locomotive models ordered for or operating in Europe, the new NUOVE REGGIANE locomotive features a new hydro-mechanical transmission, which is described in this article.

DIMENSIONS AND PARTICULARS OF THE LOCOMOTIVE ARE

— Axle rotation	B—B
— Weight in service order	48.600 Kg
— Wheelbase	1435 mm
— Overall length	13000 mm
— Overall width	3000 mm
— Overall height	4020 mm
— Bogie pivot pitch	6760 mm
— Bogie Wheelbase	3000 mm
— Wheel diameter (new)	1000 mm
— Minimum curve	80 m
— Fuel tank capacity	1700 litres
— Maximum speed :	
freight service	54 km/hr.
passenger service	82 km/hr.
— Starting tractive effort at 33 per cent adhesion, passenger service	16.200 kg.

ENGINE

Power comes from a Nuove Reggiane/M. A. N. Diesel engine model L 12 V 17.5/21 B, supercharged, twelve cylinders, four strokes. The engine is set to give a top-output of 920 HP at 1400 RPM, the continuous rating being 825 HP at 1300 RPM.

Cylinders are 175 mm by 210 mm. The fuel consumption at continuous full load is 172 gr/CVh. The weight of the dry engine is 3060 kg.

TRANSMISSION

The drive from the engine is taken through a flexible coupling and a short cardan shaft to a TWIN DISC three-stage torque converter type IF-16000. The output shaft of the TWIN DISC converter is connected by a flexible coupling to a two-speed power-shift transmission manufactured by Nuove Reggiane, Reggio (Emilia), Italy.

Both the Twin Disc converter and the tow-speed transmission are carried on a sub-frame, elastically mounted on the under-frame.

Reversing gears are contained in the two-speed power-shift transmission. The transmission has two output flanges, from which cardan shafts lead forwards and backwards to the alternate-speed gearbox mounted on the bogie frame.

Cardan shafts transmit the power from this gearbox to each axle drive. Reaction torque is taken from each axle drive through an arm and rubber bushes to the bogie frame. The two alternate-speed gearboxes and the four axle drives are manufactured by Nuove Reggiane.

(A) TWIN DISC CONVERTER

The well-known Twin Disc torque converter has three basic components (see Fig. !) : the impeller, the turbine and the stator or housing of the converter. The impeller is driven at engine speed by the engine. The turbine is made up of three rings of blades and is connected to the output shaft. The stator or housing contains two sets of blades. The multiple-stage turbine blading enables the torque-speed range to become infinitely and automatically variable within a wide range of high efficiency. Due to the multiple-stage turbine blading it was possible to obtain the listed performance only with two speeds. In passenger service, 600 HP are available on the wheels from about 20 km/h to 82 km/h, taking into account a reasonable mechanical efficiency. Between 13 km/h and 54 km/h 600 HP are available on the wheels in freight service. Fig. 2 reproduces the speed-tractive effort curve of the Nuove Reggiane unit.

A small auxiliary fluid or charging pump, engine driven, is a gear-type pump and is required to maintain the basic fluid pressure within the converter, which is constantly filled with fluid.

A separate heat exchanger is provided to cool the converter fluid. The difference in fluid pressure at the converter outlet and inlet points is sufficient to

circulate the converter fluid through the pipes and heat exchanger. Through a bleed line extending from the highest point of the converter fluid cooling circuit, a small amount of fluid constantly bleeds back to the fluid tank replacing the fluid taken out by the charging pump.

(B) TWO-SPEED POWER SHIFT TRANSMISSION

The diagrammatic section reproduced in Fig. 3 show how the gears and clutches of the two speed power-shift transmission are arranged.

Seven gears, two friction clutches and two dog clutches provide for the two speeds and the reversing gears.

High and low speed are obtained through two Twin Disc air actuated friction clutches, type PO 318; such a clutch is reproduced in Fig. 4. Air is introduced into the shaft at the right free end, through a double DEUBLIN rotating union. Through piping, the air is introduced from the shaft to quick release valves mounted on the clutches. The air under pressure, about 9 kg/cm², first closes the valves and then enters the diaphragme chamber. This, in turn, forces the diaphragme and pressure plate forward. At the same time, the plate separator moves forward compressing the release springs. Engagement takes place in less than a second. Disengagement is the reverse procedure. When the inlet air pressure is reduced, the first 0, 1 kg/cm² reduction opens the quick release valves and exhausts all the air. Clutch release takes place in less than one second.

The two Twin Disc PO clutches are mounted outside the gearbox housing and thus easy to service; large passage, provided in the clutch, assures adequate air-cooling for all components. No adjustment is ever required to maintain proper pressure on the friction discs.

The following table gives the gear wheels in mesh, in each speed as well as in each direction of power flow; see also Fig. 3:

Forward : F engaged

— low speed : C_1 engaged C_2 disengaged $\frac{a}{b} \times \frac{e}{g} \times \frac{g}{f}$

— high speed : C_1 disengaged C_2 engaged $\frac{d}{e} \times \frac{e}{g} \times \frac{g}{f}$

Reverse : R engaged

— low speed : C_1 engaged C_2 disengaged $\frac{a}{b} \times \frac{b}{c}$

— high speed : C_1 disengaged C_2 engaged $\frac{d}{e} \times \frac{b}{c}$

All gears and bearings are pressure lubricated and a lubricating oil cooler is provided.

The reverse gears can be operated at standstill only. Actually, the gearshifts are fully automatic without any action of the driver. The control mechanism of the transmission has to control the gearshift automatically, as a function of the input and output speed of the converter. Then only, the shift will occur at the same efficiency, whatever the load.

Therefore the main component of the transmission control mechanism is the Twin Disc speed ratio governor driven by belts from the input and output sides of the converter. At the proper moment, oil under pressure is directed to control valves, which control inlet and/vr exhaust of air in the Twin Disc clutches.

The total weight of this 1000 HP hydraulic transmission, consisting of the Twin Disc three-stage torque converter and the two speed powershift transmission, including reversing gears, is but 5890 kg.

(C) ALTERNATE-SPEED GEARBOX AND AXLE DRIVES

Four gears and two dog clutches provide for two speeds, namely freight service and passenger service. The gearbox of conventional design can be operated when the locomotive is at a standstill only. The output shaft has two flanges from which cardan shafts go forward and backward to the axle drives, also of conventional design.

THE DIESEL ENGINE PISTON

By *J. E. Robinson, M.I.Mech.E., M.I.Mar.E., A.M.B.I.M.

THE most suitable piston material has yet to be determined but, broadly speaking, either some form of cast iron alloy or, alternatively, an aluminium alloy is employed. Each of these materials have their advantages and disadvantages, and the choice is largely dependent upon the duty which the engine will have to perform. In the case of aluminium alloys, the low weight and good heat conductivity are the desirable factors, whereas in the case of cast iron the lower co-efficient of expansion coupled with strength at elevated temperatures makes it attractive for lower speed engines.

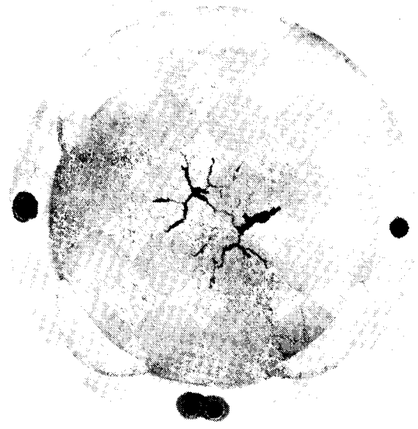


Fig. 1.

Due to the higher co-efficient of expansion of the aluminium alloys, greater piston clearances are necessary which in turn may give rise to piston noise or slap, and in extreme cases cavitation erosion or water side attack on wet cylinder liners may thus be caused. Under adverse conditions ring groove wear also occurs at a higher rate than when cast iron pistons are employed. On the other hand, the cast iron alloys give rise to higher reciprocating weights imposing increased loads on the bearing, connecting rods and piston pins and, consequently, cannot as yet be employed on engines having the higher rotational speeds.

When S. G. Iron is used instead of ordinary high grade cast iron considerable reduction in weight is achieved by means of the lighter sections which can be used so that, the total weight of the assembly should not greatly exceed that of the aluminium alloy piston. In addition, the ring groove wear experienced with S. G. Iron pistons is lower than on aluminium alloy and will enable the higher speeds and ratings to be obtained on lower grade fuels, and this will allow a simple design to be employed.

As previously mentioned, one of the greatest disadvantages of the alloy piston is the relatively high wear characteristics of the ring grooves, which reach serious proportions when the engine operates is dusty climatic conditions or when low grade fuels are employed. In order to obviate this factor, pistons are made in which an austenitic iron insert is cast into the upper piston body for carrying the top compression ring. The austenitic iron ring reduces the top ring groove wear, and it has been found in service—under these conditions—that wear of the lower ring grooves is negligible.

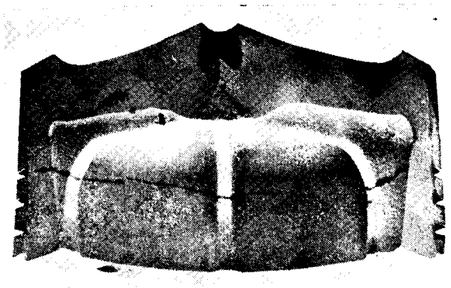


Fig. 2.

The two main problems in the design of a suitable piston crown are to conduct the heat from the combustion chamber to the piston wall and, to transfer the thrust of the gas load to the piston bosses and thence via the pin to the connecting rod. Heat

* An extract from a paper by J. E. Robinson presented to the Diesel Engineers and Users Association.

transfer is obtained by the circulation of air and oil on the underside of the crown and, this can be considerably improved by the avoidance of webs or ribs, which restrict the air flow and cause stagnant pockets. In fact, undercrown supporting webs are really unnecessary in uncooled pistons as the crown section, which is adequate for efficient heat flow, is usually rigid enough in itself to take the gas loads.

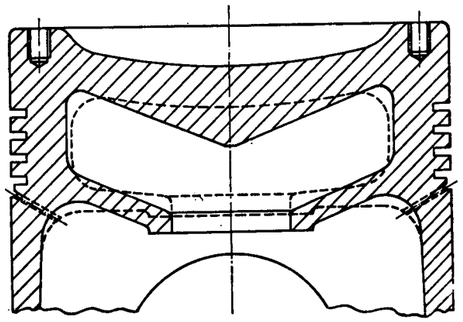
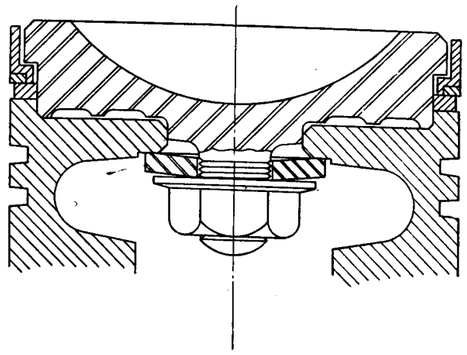


Fig. 3.

The two main forms of crown failure in medium to large cast iron pistons are shown in Figs. 1 and 2; Fig. 1 illustrates a typical case of "star" cracks in the piston crown and Fig. 2 shows a circumferential crack round one of the ring grooves. After careful analysis it has always been found that the star cracking is caused by the piston material being subjected to extremely high temperatures, and investigation to date has proved that the high temperature has been caused by some fault in the combustion system, i. e. either a fault in the air or fuel supply leading to excessive loads being carried by one cylinder.

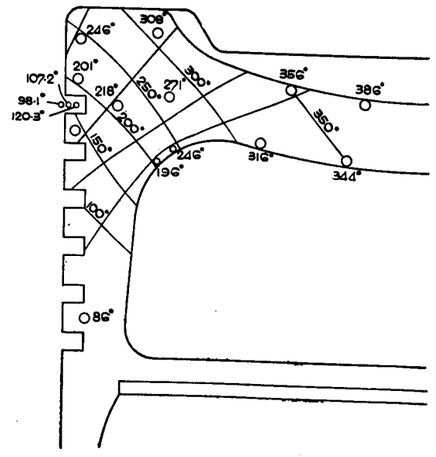
The type, of failure shown in Fig. 2 was fully investigated by Fitzgeorge and Pope, who deduced it was caused by the fatiguing action of the repeated combustion pressures combined with the tensile stresses occurring as a result of the temperature gradients in the piston wall.

Investigations carried out by the author's Company into a number of cast iron piston designs have shown that the safety factor of the stresses on the inside wall is often less than unity and, consequently, all cast iron pistons now designed have a safety factor of not less than 1.5 : 1. Reference to Fig. 3 will show how little modification is required to a piston to overcome



PISTON WITH STEEL CROWN AND FITTED WITH TOP COMPOSITE FIRE RING.

Fig. 4.



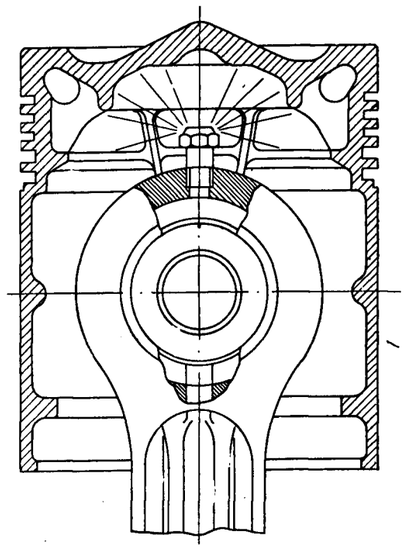
PISTON TEMPERATURE SURVEY.

Fig. 5.

this form of failure. The original section is shown as a full line and gave a stress range safety factor of 0.97 whereas the modified design, shown in dotted lines, increased the safety factor to 1.5. From the description of the stresses involved, it will be seen that in pistons which have ribs extending from the

crown to the wall, each web acts as a stress raiser and, reference back to Fig. 2 will show that the cracks here commence on the inside of each rib.

The same type of failures are sometimes seen in alloy pistons, but in this case the star cracking is usually replaced by crown burning caused by faulty combustion. There is little the piston designer can do about this problem, except in those engines which are subjected to consistent high localised temperatures and which warrant the fitting of a steel insert. These conditions are met in a number of high output Uniflow Two-Stroke engines and, Fig. 4 shows a crown section of a design employed for this duty.



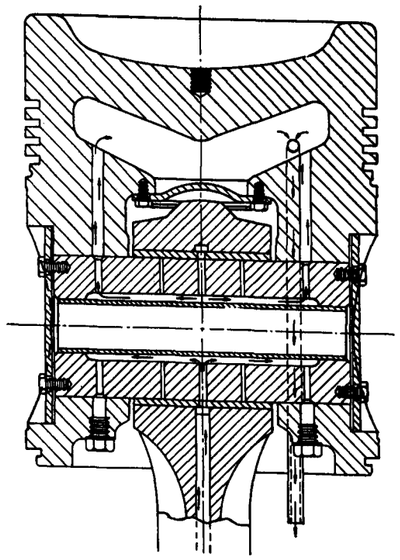
UNDER CROWN COOLED BY OIL JET.

Fig. 6.

Piston breakage as such is seldom met with in an aluminium piston of modern design, which uses adequate scantlings to withstand the high loads, and the occasional failures which do occur can mostly be traced to hydraulic action or flaws in the material which have escaped detection during manufacture.

Heat is transferred directly from the lands of the piston to the cylinder and it will be seen from the temperature survey shown in Fig. 5 that there is a pronounced temperature drop down the top land. This is clear indication that heat is being dissipated by the land to the cylinder and is of the utmost importance since the operating temperature of the top piston ring often sets the limit to the output which the engine can satisfactorily maintain. By increasing the land depth, the top ring is moved into a cooler zone and, generally speaking, it is now usual to design this depth to about 1/5th of the piston diameter.

In considering the dimensions of the lower lands, it is necessary to deal with the mechanical rather than



OIL COOLED PISTON.

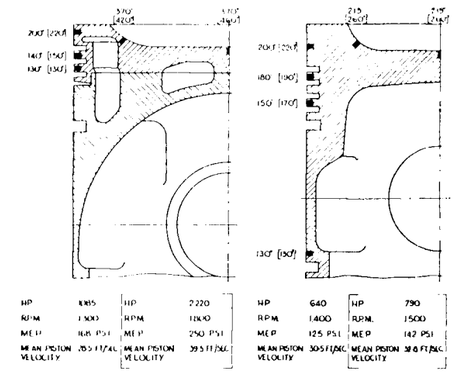
Fig. 7.

the thermal design. Weakness in land section results in part or all of the land fracturing at the root, and the majority of failures which have occurred are in those cases, where the pistons were designed originally for low B. M. E. P. ratings and, where the engine has subsequently been developed to give higher outputs.

With the higher B. M. E. P.'s obtainable more attention is being paid to the actual temperatures of

the piston crown and ring belt and, greater consideration is now having to be given to the subject of piston cooling on engines of all sizes.

In the simplest form of piston, crown cooling oil is supplied via the crankshaft to the large end bearing, from thence up a drilled passage in the connecting rod and after lubricating the small end the oil is allowed to escape through a nozzle in the top of the con-rod to impinge on the underside of the crown. Such a piston is shown in Fig. 6. This system is mainly used in high and medium speed engines and suffers from the disadvantage that it tends to become inadequate when the engine is running at a heavy load and low speed. On larger or more highly rated engines an improved arrangement is employed, in which the oil leaving the gudgeon pin bearing is circulated through passages between the gudgeon pin bosses in the piston via drilled passages up to the crown and then returned to the crankcase through drain pipes, as shown in Fig. 7. With the advent of even higher ratings, more complex systems are employed in order to increase the rate of circulation and to obtain a greater degree of cooling behind the piston rings. Such a system is shown in Fig. 8, illustrating the Maybach engine, in which it will be seen that passages are provided in the piston crown behind the ring belt through which oil is circulated. It is of particular interest to note the comparison of piston temperatures taken between the cooled and uncooled piston shown, together with the relative operating B. M. E. P.'s. Particularly significant is the



COMPARISON OF COOLED AND UNCOOLED PISTON

Fig. 8.

very large temperature difference between the piston crown and ring belt of the cooled piston.

With the advent of higher speeds and B. M. E. P.'s it is to be expected that the piston will become still more complex with provision for improved cooling of the ring belt and, possibly some provision for piston crown insulation. This development may well mean a renewed interest in Cast Iron as the future piston material, particularly as the casting technique for S. G. Iron develops.

COATED ABRASIVE, GLUE BOND

The Indian Standards Institution has prepared a revised draft of IS : 715—1957 Specification for Coated Abrasives, Glue Bond at the request of some of the manufacturers.

This standard covers the requirements for coated abrasives in the form of sheets, rolls, belts, discs and converted shapes; with paper, cloth or combination backing. It was originally issued in 1957 and the main modifications incorporated in the revised draft are:

(1) Metricization of the standard
(2) Recasting of the table for "Allowable Limits for the Sizing of Abrasive Grains".

The draft standard will be put in wide circulation to all interests concerned for eliciting technical comments. The comments received will be taken into consideration before the draft is finalized. Copies of the draft standard are available, free on request, from the office of the Indian Standards Institution, 'Manak Bhavan', 9, Mathura Road, New Delhi-1 and from its Branch Offices located at Bombay, Calcutta and Madras.

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KIEV UNDERGROUND RAILWAY OPENED

The Kiev underground railway, the third in the USSR, was put into operation with services on the first line of over six kilometres, linking four districts of the city.

All the six stations of the new line were built from plans by the best Ukrainian architects and decorated with white and rose marble, coloured granite and Ukrainian mojolika. A second line is currently under construction in the Ukrainian capital.

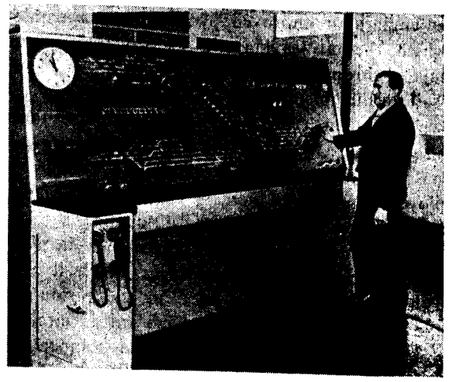
The Geographical system for the control of Train movements

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

IN the very early days of railways movement was slow and even after steam traction was introduced extreme caution had to be observed. This condition applied equally to railway signalling when considerable time had to be taken to ensure that points were properly set for train reception. Today, these operations can be affected swiftly and accurately, by the movement of a push button or switch.

Railways had been in operation some 45 years before the first signal box was constructed. The points were of crude construction and hand signals, exhibited by the men working the points, were used to work the trains. At large stations there were many points and several men had to move over a considerably distance. In bad weather the work was performed with risk. Gregory Hutton, Chief Engineer of the then London & Croydon Railway, thought of a way of eliminating this unsatisfactory state of affairs by moving the point switches by rodding attached to the tails of levers assembled together in a frame. He also arranged for the signals to be wire worked from levers in the same frame. The next step was to protect the operator from the weather and a shelter was built over the lever frame and it is possible that the term "Box" arose from this development. In India, "cabin" is generally used and "tower" on American railways. The first installation was set up at Bricklayers Arms Junction in 1846.

The success of this experiment led to many other lever frames being constructed and in due course lever interlocking was invented which prevents wrong levers being manipulated perhaps leading to conflicting and dangerous movements. Facing point locks were introduced, worked from levers in the signal box, and these were made to function in conjunction with locking bars so that points could not be unlocked while a train was passing over them. In the course of years lever frames, interlocking, and signal and point connections developed to near perfection and this may be considered as the completion of the first stage in the story of signalling and interlocking. Signalmen could operate points and signals within their control in comfort, interlocking prevented them from making wrong lever movements, locking bars made operation of point switches impossible while a train was passing over them and detectors ensured that points were correctly set and locked before signals could be lowered. The levers of a mechanical frame are of considerable size, about four feet high, and this



Route Relay Interlocking panel in Temple Mills West signalbox, British Railways, Eastern Region.

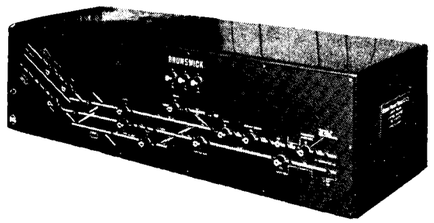
(Photograph by courtesy of British Rlys., Eastern Region)

is necessary in order to multiply the signalman's physical effort and develop sufficient force to drive the point rodding and point switches. At a large station, in order to set up a route for a train, often a dozen or more levers have to be worked. This takes time and also the expenditure of considerable energy. At the end of a signalman's spell of duty, the speed of lever operations must decrease.

The disadvantage was soon appreciated by George Westinghouse, the inventor of the air brake, who turned the principle of this invention to the operation of railway points and signals by compressed air and the first installation of this kind was brought into use in 1884. Since the lever frame was then only necessary for controlling the agency working the points and signals, miniature levers only were required and from this stage developed the power signal frame as used today. The first power frame to

appear in Great Britain was put down at Granary Junction, Bishopgate, on the former Great Eastern Railway and this installation dates from January 15th, 1899.

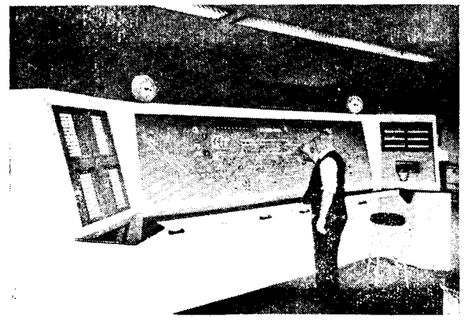
Miniature levers for power frames have been manufactured in various styles. The first frame made by Westinghouse has the handles fixed at right angles to the contact shaft with a knob at the end giving the appearance of a large clock key. The frame at Granary Junction is of this type. In another type of power frame the contact shaft does not rotate but moves backwards and forwards being operated by a moulded handle. The size of this type of power frame is reduced by staggering the position of the operating handles every other one being fixed underneath the shaft instead of above it. Generally other types of frames have miniature levers which are replicas in shape and operation of the full size mechanical levers.



Type 'NX' Route Relay Interlocking panel in Brunswick signalbox, British Railways, L.M. Region. Installed in February 1937 this was the first instance of geographical route setting in the world.

The introduction of power signalling not only permitted many points and signals to be operated in a very short time but also extended the distance over which they could be worked. Mechanical operation of points is strictly limited but with power operation there is no restriction. It is not necessary to be able to observe these units from the signal box for the position of all trains is indicated on an illuminated diagram, signal and point positions are electrically repeated on the power frame and electrical interlocking circuits prevent point operation while trains are passing over them or signals being prematurely operated before routes are clear. Earlier power frames were fitted with mechanical interlocking between their levers but later, in larger installations, electrical interlocking was introduced.

Although the miniature levers of a power frame require hardly any effort for operation, the constructional details of the various connections for working circuit controllers, attachments for electric locks, framework and casing is very considerable. About 1920, in order to dispense with this elaborate construction, the railways of the U. S. A. adopted a switch panel arrangement wherein signals and points were controlled from miniature switches mounted on the illuminated diagram. In these installations the



Type 'NX' Route Relay Interlocking panel at Faversham signalbox, British Railways, Southern Region. Brought into use June 1959.

(Photograph by courtesy of British Rlys., Southern Region.)

miniature switches controlled relays which operated points and signals and also provided the necessary interlocking features. From that date the use of panel interlocking in that country has progressed rapidly.

Great Britain has always been conservative in making any change in safety appliances for railways and except for the London Underground Railways, where power frames were introduced almost from their inception, at the beginning of the century, the main line railways were reluctant to adopt them except for a few isolated cases. The extensive electrification of the then Southern Railway brought the introduction of power signalling as a collateral development. With the exception to the London Transport Railways, this system now has more power frames in operation than any other region. The first panel interlockings were introduced on the former London & North Eastern Railway in 1933, at Goole Bridge and later in the year at Thirsk. These panels had individual switches for the operation of points and signals.

Power frames reduce the number of lever operations essential for the setting up of a route. In mechanical operation more lever movements have to be carried out. Before point positions can be changed they have to be unlocked and then re-locked by working the facing point lock lever. There are also many additional signals per route which are used for securing the route ahead of the approaching train. In power signalling fewer signals are necessary because the routes are locked through the agency of track and other circuits. The signalman therefore has less levers to operate and these without physical exertion. He is not, however, relieved from the responsibility of thinking out his various movements and which levers have to be operated for a particular route and which levers require other levers to be operated first in order to release them. In a busy signal box the expenditure of mental energy for this part of the work is considerable and this led to the development of route setting on the geographical principle, a system developed in the U. S. A. in the nineteen thirties by S. N. Wight of the General Railway Signal Company who also invented the first Centralised Traffic Control system for railways. This is called the 'NX' system. The technical press is today the medium for advertisements displaying the advantages of the geographical method of route setting and some of these systems are supplied by countries outside the Commonwealth. It is necessary to point out that Britain was the first country in the world to install geographical signalling called the "NX" system and this installation was brought into use in February 1937 at Brunswick on the then Cheshire Lines Joint Committee. The same system was installed at Girard Junction, Pennsylvania, U. S. A. in September of the same year and quickly followed by many other installations of identical type.

The geographical method of route setting eliminates all mental strain and concentration. The routes are set up by the operation of buttons or knobs at the entrance and exit ends of the desired route, as depicted on the panel, and not by the operations of individual miniature levers controlling points and signals. Generally operation of one or two switches is necessary for setting up a complete route which, in a power frame, would require the movement of many levers. The working of points and signals and the interlocking with conflicting routes is all accomplished by relay interlocking. All track circuits are electrically repeated on the control panel together with signal aspects.

Apart from rapidity in operation, the geographical method of route setting is readily understood by new signalmen. With mechanical and power operation new men took several weeks to "Learn the box". The geographical way has a switch at the signal position and a button at the part of the track layout where the signal reads to and operation of these two units sets all the necessary points and clears the signals.

The modernisation plan for British Railways includes a very large programme for power signalling and in this route relay interlocking panels form a very prominent part some 145 of these now being in operation or are under construction. In some installations the control switches have been placed on a console underneath the illuminated track diagram and control desks with push buttons have been developed for the latest signal boxes on the railways of London Transport. No doubt these variations may be considered more suitable in their particular application but the advantages claimed by the geographical route setting method is the absolute simplicity in selecting the required route and the minimum operation necessary in setting it up.: Removal of the control units from their geographical position on the panel reinstates the visual connection between these units and the panel or diagram and this condition existed between power frame and illuminated diagram and was the source of mental fatigue in a busy signal box.

PLATFORM WEIGHING MACHINES

The Indian Standard Specification for Platform Weighing Machines (IS: 1435–1960) is the latest addition to a series of Indian Standards on commercial weights and instruments being prepared by ISI at the instance of the Standing Metric Committee, Government of India. Standards covering general requirements for weighing instruments and specifications for counter machines, beam scale, weigh-bridge, crane weighing machines, steelyards, etc., have already been published.

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.

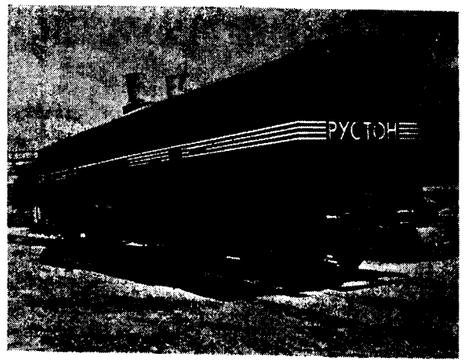
The centre-section of the wagon contains the heart of the power station. Here the Ruston TA gas turbine (1) is installed, together with the alternator (2) that it drives. The gas turbine weighs about 6 tons (less than one-tenth the complete station) and occupies just over one-fifth the wagon's total 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 :

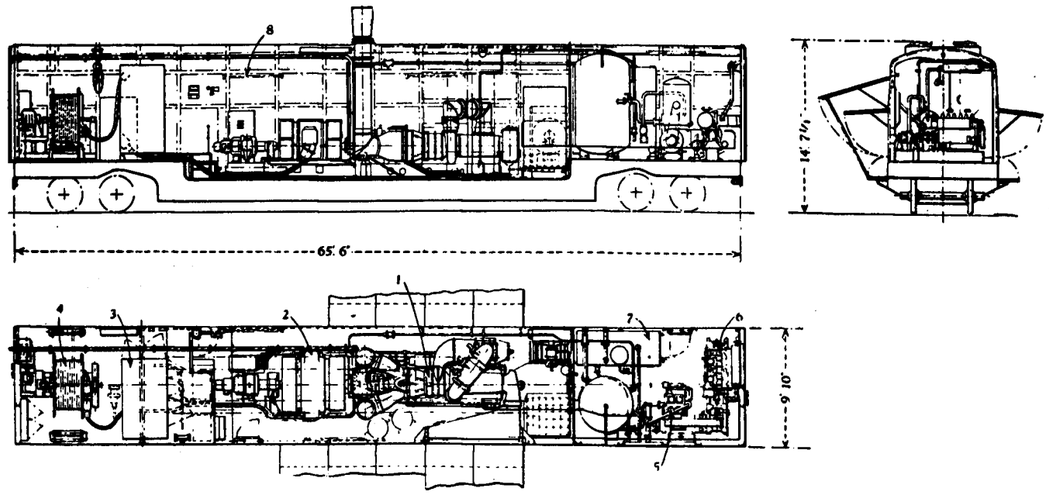
THE TA GAS TURBINE

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.

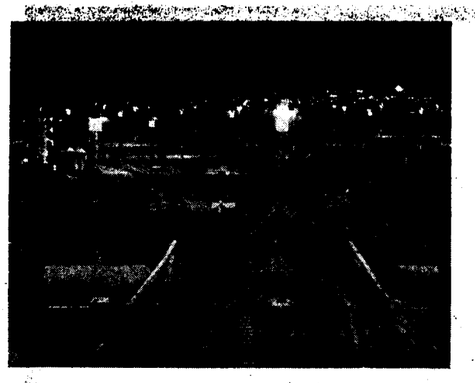
The automatic voltage regulator (by Brown Boveri) can maintain the voltage within plus or minus 0.75 per cent.

(Courtesy: Engineering)

Automatic Control at Margam Marshalling Yard

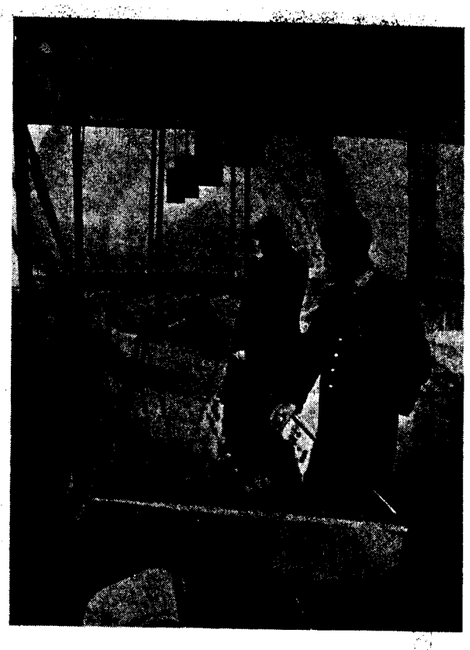
Computer techniques are used in this installation to derive voltages corresponding to the retarder pressures required for checking the speed of wagons running off the hump, and the release from the retarders is governed similarly as the sidings fill up, with provision for injecting certain modifying factors.

A NEW railway marshalling yard covering 170 acres of what was formerly a tract of sand dunes at Margam (Glamorganshire) was officially opened on April 11 by Mr. K. W. C. grand, member of the British Transport Commission. The yard, one of the major work in the modernisation programme of the Western Region, British Railways, is on the east side of Port Talbot and was designed in close co-operation with the Steel Company of Wales, to whom fifteen sidings have been allocated. In all there are twelve reception sidings, fifty double-ended sorting sidings, ten single-ended holding sidings, and seven single-ended tranship and cripple sidings. The extent of the sorting sidings is seen in the accompanying night view from near the hump summit, with the control tower visible on the left.



Sorting sidings at Margam seen from near the hump summit.

Margam yard is stated to be more fully automatic in operation than any similar installation in Europe. Computer control is applied both to primary and secondary retarders. The system provides a voltage analogue of required exit speed from the secondary retarders, and compares this with a voltage analogue of actual speed, the error voltage then controlling the retarder pressure. The main contractor for the signalling and control equipment and retarders was A.E.I.-G.R.S., Ltd. (formerly Metropolitan-Vickers-G.R.S., Ltd.). Improved procedures introduced in this installation begin with the punched tape programming for operating the sorting siding points. The tape is produced in the traffic office at the control tower on a reperforating teleprinter, from information transmitted by portable radio telephone by the shunter who divides arriving trains into cuts according to the wagon destinations. When a train is about to be humped, the corresponding tape is fed into a tape reader. Operation of a push-button on the control room panel (seen in the second illustration) starts the tape, which initiates control signals for setting the points as necessary to direct the cuts into the appropriate sidings. The control signals, in the form of destination codes, pass in succession through an



Signalling and humping control panel in control tower operating room.

indication store, where four destinations at a time are displayed to the operator, and then through a series of relay stores, one for each track circuit. They are not accepted by a store associated with an occupied track circuit so that there is no interference with the control of the points for a preceding cut.

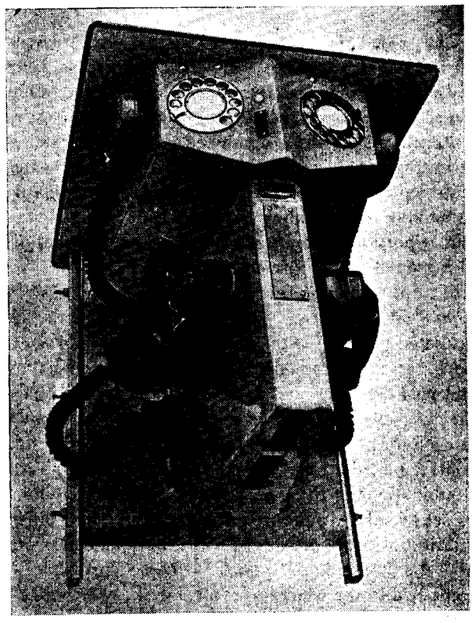
The driver of the locomotive propelling the train over the hump has a continuous indication in his cab of the humping instructions ("hump normal," "hump slow," or "stop"). This is a light signal with horizontal and inclined rows of lamps, and is operated by an alternating current in the rails with alternative frequencies of the order of several hundred cycles. One or other frequencies, according to the indication required, is superimposed on the normal d.c. track circuit and is picked up inductively. Absence of code is arranged to signal "stop." Any change of aspect is accompanied by an audible warning.

The automatic control of the electro-pneumatic retarders takes account of standage space in the sidings as well as weight, speed and "rollability" of wagons, and provision is made for manual biasing of wagon release speeds from the retarders to allow for the effects of strong adverse or following winds, and for the slightly higher pressures required when rails are wet.

Measurement of "rollability" is effected by two pairs of inductive wheel detectors operating at supersonic frequency, preceding each retarder. The signal from each pair is used to operate a high-speed binary counter giving a count inversely proportional to the speed of the cut. As the distance between the pairs of detectors and the gradient are known, the count is computed electronically to produce a voltage representing the rolling resistance of the cut. This voltage is transformed into a digital code and passed forward to the release speed computer.

Other inputs to the release speed computer are derived from voltages proportional to distance-to-run and curvature, the latter being constant for each siding and selected automatically when the route is set up. Distance-to-run is taken from a standage store for each siding, consisting of a potentiometer controlled by the state of the siding track circuits. As wagons enter the siding, the potentiometer is stepped by an amount corresponding to the length of each cut. The output voltage is thus reduced as the siding fills up.

Actual speed of wagons approaching retarders is measured by v.h.f. equipment utilising the Doppler frequency-shift effect, and a proportional voltage is produced. This measured-speed voltage and the required exit-speed voltage, together with information from a weight detector preceding each primary retarder, are then fed to the pressure computer, which produces a voltage output defining the pressure required in the retarder cylinders to remove the excess energy from the cut. At the retarder this voltage is compared with



Pull-out drawer of control panel, housing telephone and microphone equipment.

that from a pressure transducer mounted on the air manifold, providing the means to operate the inlet and exhaust air valves so as to maintain the pressure in the cylinders equal to that demanded.

Primary retarders are controlled similarly to the secondaries except that distance-to-run is not involved at this stage. The weight-deducting device preceding these retarders consists of a group of micro-switches which are mounted in a short length of slotted rail.

The control panel in the control tower is in two portions, that on the right operating the signalling of the reception sidings and associated tracks on the entry-exit route setting system, while the left-hand portion controls all equipment associated with humping

operations. Each retarder has two switches. One switch has an automatic position and three manual positions for selecting retarder pressures by hand if necessary; the other has a "computer" position for fully automatic control of release speeds, as described earlier, and five manual positions, enabling present speeds to be selected. Provision is also made for manual operation of points as an alternative to the normal route-storage system.

The panel is a "Domino" panel constructed on the "Integra" system, for which the British licensee and manufacturer is Henry Williams, Ltd., Tolpits Lane, Watford. It is built up of units 40 mm. square arranged to form a combined track diagram and operating panel with push-button or rotary switches and repeater lamps. Certain units are "blanks," containing no operating elements but being engraved with a portion of the track diagram so that continuity of presentation is preserved where no controls or indication are required. Units and "blanks" are supported in a grid. Each unit comprises a lower insulated portion with the contact pins and connections, an upper moulded part carrying the optical parts and push-buttons, and a cover plate forming part of the panel diagram. Twelve contact points are provided in each unit, enabling up to twelve lamps or six single-contact push-buttons to be accommodated, or various combinations of these accessories. All lamp bulbs are of clear glass, the required colours for different indications being provided in the inorganic glass optics of the "Domino" unit. These principles are embodied in the Margam control desk, which also has certain special features, including the pull-out drawers (one of which is illustrated) containing dial telephones and microphones for v.h.f. radio or loudspeaker communication with shunting locomotives and various parts of the yard. The radio equipment was supplied by Pye Telecommunications, Ltd., and the sixty-line automatic telephone exchange, which also gives access to the main railway trunk network, by the Reliance Telephone Company, Ltd.

Main lighting in the yard is provided by 216 Benjamin "Duoflux" floodlights with 1000W filament lamps, mounted 55 ft. above ground level on tubular steel tower with triangular bases having 2 ft. 6 in. sides, on square bases with 1 ft. 6 in. sides, according to the space available between tracks. Lights distribution from the "Duoflux" fittings is controlled so that the main illumination is directed towards movement along the yard while shunting and glare is avoided. The lighting is controlled from two mimic diagram consoles supplied by The General Electric Company, Ltd.

The whole scheme has been developed and directed by Mr. M. G. R. Smith, M. I. C. E., Chief Civil Engineer, and Mr. A. A. A. Cardani, A.M.I.E.E., M.I.R. S.E., Signal Engineer, Western Region.

In addition to those named in the text, the following contractors were responsible for work as shown.

PRINCIPAL CONTRACTORS

Main contractor (earthworks, permanent way, bridgework, drainage, fencing, amenity blocks), Sir Robert MacAlpine (South Wales), Ltd.; control tower, John Morgan, Ltd.; earthworks and permanent way, Robert M. Douglas, Ltd.; main electrical contractor, British Insulated Callender's Cables, Ltd.; signalling cables, British Insulated Callender's Construction Company, Ltd.; internal electrical installation in control tower and yard buildings, Lee Beesley and Co., Ltd.

[Courtesy: THE ENGINEER]

UTILISATION OF WORLD BANK LOAN BY INDIAN RAILWAYS

The Deputy Minister of Railways, Shri Shah Nawaz Khan told the Lok Sabha during question hour that a fresh loan of $ 70 million had recently been negotiated with the International Bank for Reconstruction and Development to finance the acquisition from abroad of diesel and electric locomotives, rolling stock spare parts and other railway materials and equipment and services connected therewith.

Asked to state the extent to which the Railway administration had been able to utilise the sum of $ 50 million made available to it by the Bank, Shri Shah Nawaz Khan replied that the loan had been fully utilised. The railway equipment acquired for the value of $ 50 million had been fully utilised for the railway's modernisation and development programme.

The Deputy Minister gave this information in reply to a question by Shri Narayan Das and three other members.

RAILWAY WEED CONTROL

By Peter de Jong, B. A. (Hons.) Oxon.,
Technical Manager, Tata-Fison (Pte) Ltd.

THERE are 35,000 miles of railway track in India, traversing a wide variety of soil and climate areas; from dry desert lands to sub-tropical jungles—from steaming coastal plains to rain-washed and snow-covered hills, more than 6,000 feet above sea level. Under these conditions, where rainfalls may vary from less than 10 to over 200 inches annually, the Maintenance Engineers of the Indian Railways are facing an equally wide and diverse range of problems of weed control on railway tracks.

The main objects of hard ballast are to provide a firm foundation, uninfluenced by fluctuations of pressures, wind, rain, vegetation and burrowing animals. Plant life will establish itself in almost any situation, however, initially inhospitable and although clean stone ballast presents such an environment it is by no means immune and slowly accumulating residues of air and rain-borne mineral and vegetable particles provide progressively growing pockets, in which plant seeds may establish themselves.

Although these earliest plant pockets may be of little size and importance, they aid in the collection of air-borne dust deposits and this, together with their own dead remains, gives rise to an increasing build-up over the years. Maintenance of neglected tracks becomes increasingly difficult and eventually there may be obstruction of ancillary moving gear and a friction-reducing contamination of the rails. Heavy weed infestation on the shoulders reduces stability and weed growth in the cesses creates fire hazards as well as mechanical interference with signalling and other Services.

In India because, in spite of its size and population, the relative amount of railway track is small, and because labour availability is large, hand-weeding of tracks is still a practical and economic possibility. In Europe and in the United States of America, where chemical control has had its longest and most advanced usage, hand-weeding is now only used in circumstances where no suitable chemical exists. Hoeing in the cesses may surely provide immediate control of annual weeds but by creating a tilth it increases fertility thus encouraging quick re-infestation and on many perennial weeds it acts in fact as a stimulant.

For many years, particularly in the United States, herbicides of a rather crude type and applied in large dosages have been in general use. Amongst these a number of different crude oils have been used, applied to the track at rates of 100 gallons or more per acre, but such treatments are economic only near to cheap sources of supply. Compounds of arsenic have been used, but this material being highly toxic to animals has caused heavy stock losses in the United States where straying animals and spray drift contamination of neighbouring grazing land have given rise to many cases of poisoning. Compounds of Boron have been used widely but Borates are soluble and easily leached from the soil under conditions of moderate rainfall, so their general effect is not persistent. Chlorates, too, are used and have been the herbicide in major use on British railways in the recent past. Chlorate solutions in water are inevitably highly conducting and may cause direct electrical trouble as a result of shorting and, as their action is corrosive on metals, they may also give rise to indirect electrical and mechanical troubles. Their use on electrically operated railways with conductor rails is even more undesirable. Even borates, though much less corrosive, have undesirable electrical conductivity, and these, together with the potential fire hazard resulting from the drying of chlorates on vegetation, create considerable obstacles to the use of such materials.

In recent years many new and important organic chemical herbicides have been developed and these have all been tried on railways in the United States of America and in Europe. The disadvantage of these materials is great, particularly in intensively farmed areas, where the risk of down-wind drift of fine spray may lead to serious damage in susceptible crops adjacent to railway tracks. Already liable for considerable compensation for fire damage, railways are naturally not anxious to incur any additional risk and these materials are, therefore, generally unpopular.

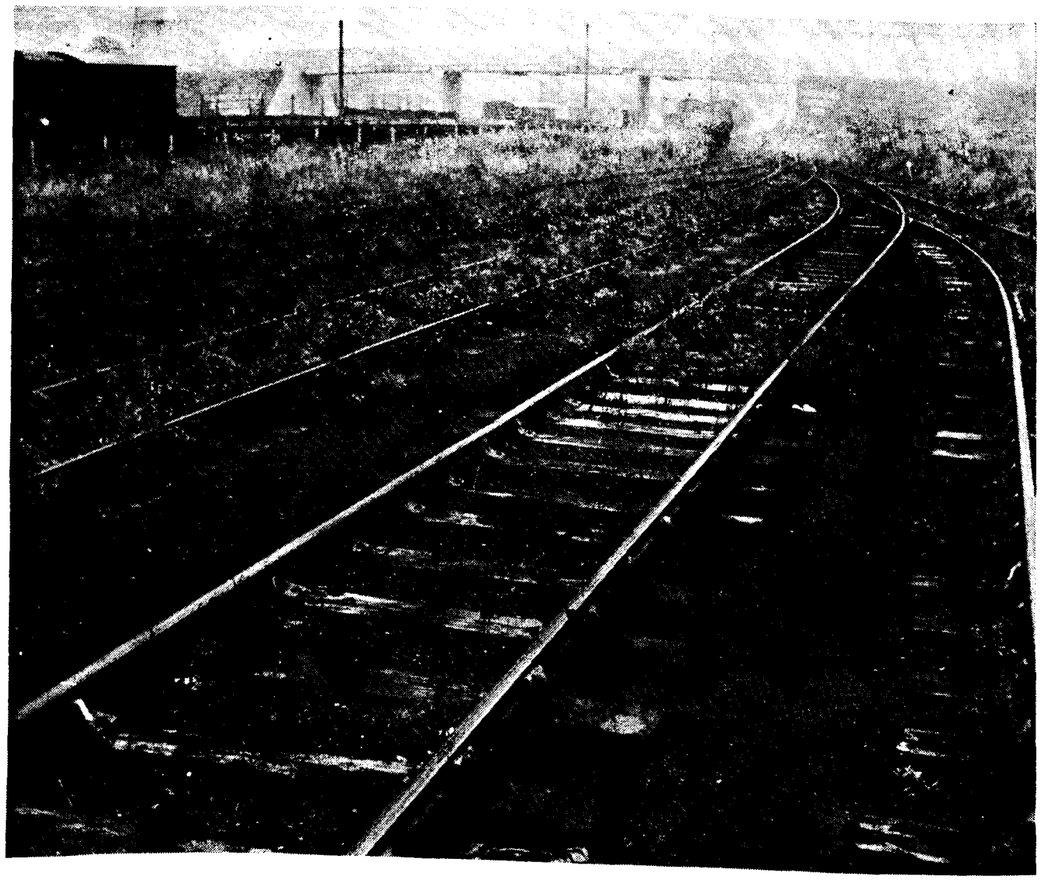
The technique of weed control on railway tracks is

to preserve a desert rather than destroy a jungle and the more quickly and cheaply that this operation may be carried out and the less frequently it is required, the more efficient will be the maintenance of weed-free tracks. Chemical weed control measures based on slow acting materials with a high degree of persistence are the obvious answer to this problem and search for a suitable railway herbicide has shown, in recent years, the major advantages of formulations based on a new organic herbicide called SIMAZIN.

Simazin has a very low water solubility and acts mainly through the roots of plants. There is little foliage action, thereby creating negligible effects in cases of unavoidable drift of spray on to adjoining crops and the low solubility, combined with unusual resistance to bacterial decomposition, results in keeping it effective in the soil for a considerable time. A year-long effectiveness can generally be expected and in certain cases the residual effect may even be longer.

Within the last two or three years a number of trials have been carried out in England by Fisons Pest Control Limited in conjunction with the British Railways and Simazin has been sprayed commercially on more than 1,000 miles of track in 1959.

Of value both on hard stone as well as ash-ballast, applied at a standard dosage rate of 5 lb. of active Simazin per acre, a high degree of control is obtained, which may be maintained by subsequent annual applications of 4 lb. of active material per acre.



Photograph by courtesy: Fisons Pest Control Ltd., U.K.

Weed infested railway tracks—Foreground treated with Simazin.

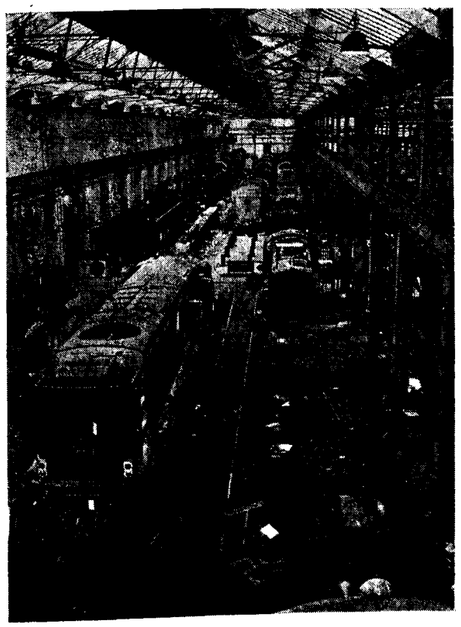
As I have already pointed out there is at present very little scope for chemical weed control on railway tracks in India due to the ready availability of labour for hand weeding. Surely, however, the time is not far distant when, with the increasing industrialisation of the country and the present upward trend in wage rates, hand-weeding, even in India, will prove to be difficult to organize and expensive to sustain. Under such conditions chemical weed control on railway tracks will come into its own and it would be prudent to investigate, in these early stages, the suitability of various herbicides for this purpose.

Crude oil formulations and oils fortified with phenolic distillates are likely to be available only in limited quantities and areas and will probably not be economic except at points near to sources of supply. Arsenical compounds will have even greater hazards in their use than in Western countries, for the incidence of straying cattle is much greater in India and in areas where low literacy rates expose the population to greater dangers of poisons than in more developed countries, the use of such highly poisonous chemicals could hardly be advised.

The problems of weed control are admittedly diverse, dependent as they are on widely varying soil and climatic factors. One can generalise in saying that it is usually in the growing season before the monsoons, in the hothouse atmosphere of high humidity and temperature, that weed growth develops with enormous rapidity. Under such conditions the borates and the chlorates, because of their high solubility would have only transient effect and it is particularly for conditions such as these that Simazin formulations are best suited. Applied before the start of the monsoon showers Simazin will remain active in the soil throughout the growing season, exerting a marked controlling effect over initial weed populations. Trials will be required to establish optimum dosage rates and correct timing of applications, which in themselves would be dependent on local climatic conditions and weed populations, but there would seem to be a strong case for investigations of this nature early in the history of chemical weed control on railway tracks in India.

For those drier areas where the weed problem is based mainly on the rapid appearance of ephemerals, a related formulation based on Atrazine, which has the same properties of Simazin but is rather more soluble and quicker acting, seems to be worth investigation.

British Diesel Electric Locos for East African Railways



Diesel electric locomotives for the East African Railways and Harbours Administration under construction at the Darlington, England, works of Robert Stephenson and Hawthorns, a member of the English Electric group. Two of the order for 10 have already left by sea for Mombasa aboard the Kenilworth Castle. Two more will be shipped every month until the order is completed.

The order, believed to be worth nearly £1 million, was obtained against strong foreign competition, as tenders were invited from 30 concerns in 11 countries. The 97½-ton locomotives, with a maximum output of 1,840 h. p., will be able to haul 700 tons at 45 m. p. h. on level tracks and at more than 15 m. p. h. on steep gradients at altitudes over 9,000 feet. They will also be required to operate over light rails and to do this they are fitted with a special wheel arrangement of one free and three powered axles on each bogie.

The company of Robert Stephenson and Hawthorns, Ltd., can trace its locomotive-building history back to 1825, when the famous Locomotion Number One, the first loco for use on a public railway, was built. It is claimed that their Darlington works are now among the most up-to-date in Britain.

New Signalling for Britain's Railways

Advanced Techniques for the big Electrification Scheme

By C. F. D. Venning
Chief Signal Engineer, Westinghouse
Brake and Signal Company Ltd., London.

THE signalling industry of Britain has recently expanded its technical, manufacturing and installation capacity to meet the increased demand by British Railways, as well as to maintain exports to many parts of the world.

Much research and development has taken place in the last few years to meet the requirements of Alternating Current electrification. The main line electrification of British Railways will be single phase 25 kV 50 cycle and 6.25 kV in certain suburban areas. Some of the existing 1,500V Direct Current lines will be converted to 50 cycle. London Transport Executive and Southern Region will retain D. C. traction using conductor rails, and the Southern Region electrification is being considerably extended as part of the modernisation plan.

In accordance with modern practice, colour light signals are used, usually of the multi-unit types, the need for which is accentuated in electrified areas with overhead catenary, involving supporting structures and large insulators. Signals are controlled in the conventional manner by track circuits, and it is in this particular field that development has taken place.

In most instances, interlockings are operated by power, controlled from a panel on the relay interlocking principle. In certain smaller interlockings, mechanical point operation has been retained, the signals and outlying points being worked by power from small control panels fitted above the mechanical interlocking lever frames.

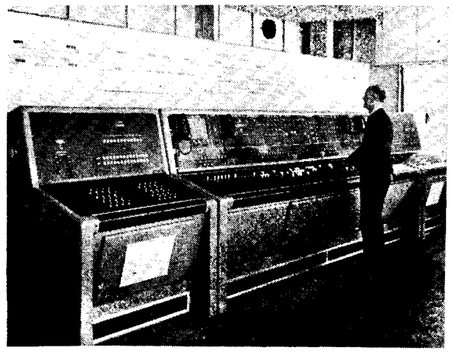
FALSE ENERGISATION IMMUNITY

In A. C. traction areas the track circuits are mainly of the single rail D. C. type, in which one rail is allocated for traction return current, and suitable track circuit relays and feed equipment, immunised against false operation by traction current, have been developed. By modifying the magnetic circuit of a D. C. neutral relay to include copper slugs and a magnetic shunt, the track relays are made completely immune against false energisation by A. C.

Some double rail track circuits have been used with miniature impedance bonds, A. C. 75 cycle current being supplied to the rails by means of static frequency converters. At the relay end is a frequency discriminating filter which rejects any 50 cycle and its harmonics, and feeds a standard D. C. track relay through a metal rectifier.

Advanced signalling techniques are being introduced to British Railways with the electrification schemes now in progress. This is a typical searchlight signal, route indicator and subsidiary signal system on the newly electrified Eastern Region station at Claeton-on-Sea, Essex. The equipment is a product of The Siemens and General Electric Railway Signal Company Ltd., Wembley, Middlesex, England.

In those sections where 1,500V D. C. traction is in use, and is to be converted to 50 cycle A. C., or where there are extraneous D. C. currents from adjacent running lines, 83⅓ cycle A. C. track circuits are used. Where existing 50 cycle signalling equipment is in use, it is being converted and re-adjusted for use from the new 83⅓ cycle A. C. which is supplied to sections of line from separate automatically controlled motor alternators located at convenient places.



A typical control desk and illuminated diagram with "Westronic" remote control (a product of the Westinghouse Brake and Signal Company Ltd., London) now being installed on the railways of Britain with the progress of the electrification scheme. It is at Sandbach, Cheshire, on the London Midland Region.

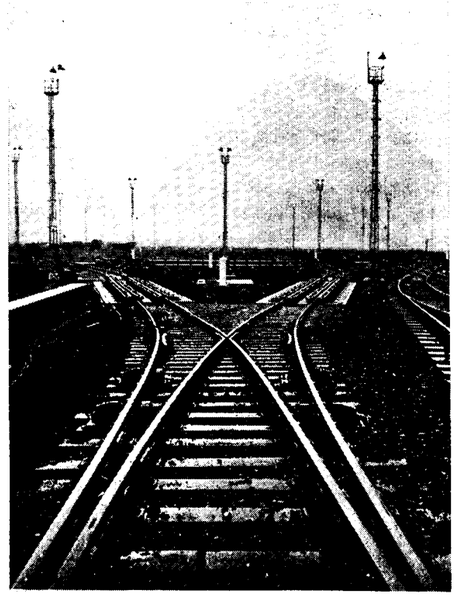
In A. C. 50 cycle traction area line circuits are mainly D. C. Here again, special A. C. immune line relays of somewhat similar construction to the track circuit relays have been developed. Line circuits are liable to interference owing to the proximity of the catenary. In some instances it has been necessary to repeat the line circuits at intervals, using repeater relays to ensure that the induced voltage will not approach a figure which might affect the proper working of the equipment, or be dangerous to men working in the apparatus cases or relay rooms.

QUICK CHANGE-OVER

In the 1,500 D. C. traction conversion areas, D. C. line circuits are obviously not permissible while D. C. traction is still in use, and arrangements have been made so that a quick changeover can be effected during the period the existing traction is being superseded by the A. C. traction.

The present trend is towards miniaturisation of control equipment, and in practically all instances plug-in relays, many of which are now of the miniature type are used. These have similar characteristics to the larger types used hitherto and meet the specifications of British Railways. A far greater number of relays can obviously be located in the same space as that previously used, resulting in smaller signal box buildings. Pre-wiring of signal-box relay racks and outside location housings has been carried out to a very large extent, resulting in a high standard of workmanship, the units being tested before dispatch to the sites.

There are a large number of power interlockings, varying from those having only a few routes to many having between 150 and 500 routes, while at least one has more than 1,000 routes. These are controlled on the route relay interlocking principle from control



Completely automatic signalling and control methods are being introduced to Britain's railways with the modernisation scheme now in progress. This is the Hump Yard at Margam in South Wales on the Western Region. The electrical control system has been provided by Associated Electrical Industries Ltd., London.

panels in central signal boxes, and many cover a large area of control.

Opportunity has been taken to control outlying interlockings, junctions and ground frames from the central control panel, using the recently-developed remote control systems effectively providing control of large areas of track from one central point. As determined by the economics of each instance, either direct wire or electronic systems employing only two wires have been used.

HIGH-SPEED REMOTE CONTROL

One system which has been used extensively is a transistorised high-speed remote control and indication system, providing a means of high-speed transmission by carrier frequencies, of control information from a central control point (signal box) to a remote interlocking (field location), and simultaneously the transmission of indication information back from the field location to the signal box. One installation has a capacity of more than 700 controls and 1,000 indications, while another installation controls a remote junction handling a very intensive suburban service of trains.

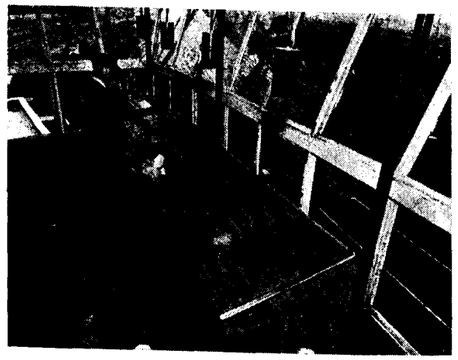
Much development has also been put into the design of control panels, the most recent of which are of the smaller type, the overall dimensions being reduced considerably from those used in the past. These panels retain all the conventional route set and other indications, and in some instances include train description indications in the actual reproduction of the track on the approach sections of the various signals.

Several methods of operation are used, one employing one thumb-switch for each route, while in others the route is set up by the operation of two push-buttons, or alternatively a thumb-switch and push-button located on the panel front plate at the entrance and exit of each route respectively. The present trend on British Railways is to use push-buttons throughout, of the three position type "push" for route setting and "pull" for route cancellation. D.C. relays are used for interlocking purposes, the most recent of which employ miniature type relays.

Point operating mechanisms and signals are conventional; shunt and subsidiary signals are of the position light type. Multiple lamp route indicators are used in station areas, and junction type indicators for the higher speed junctions. All-electric point machines are both A. C. and D. C., but in A. C. traction areas they are controlled by means of local A. C.-immune controllers or relays.

ELECTRO-PNEUMATIC POINTS OPERATION

The D. C. searchlight signals which remain, are to a large extent inherently immune to operation from 50 cycle currents, and as in the case of multi-unit signals are mainly controlled by local relays of the A. C. immune plug-in type. In recent installations the



The control panel of the completely automatic marshalling yard of the Western Region of British Railways at Margam, South Wales. The electrical control system was provided by Associated Electrical Industries Ltd., London.

miniature relays are also being used in outside locations. Electro-pneumatic operation of points is being used extensively, A. C. immunised electrically-operated point valves being controlled direct over contacts of relays in the signal boxes.

In those regions where D. C. traction is being retained, conventional A. C. signalling methods are perpetuated, using A. C. vane relays and circuits generally, except for those circuits confined to the signal boxes which are now operated on D. C.

For the protection of level crossings, British Railways are introducing both automatically controlled lifting half barriers and local or remote control full barriers, with warning bells and flashing red lights in place of the conventional gates which are almost universally used in Britain. Several installations will be in service as part of the modernisation plan, and at least one set of controlled electric barriers is already in service in a 50 cycle traction area.

The mechanisation of marshalling yards is being actively adopted by British Railways, and new yards are being built at strategic points, eliminating many of the smaller and older gravity yards. In recent years several yards have been fully mechanised and in all cases employ electro-pneumatic retarders.

FULLY AUTOMATIC YARD

The most recently completed yard is fully automatic, making use of the latest electronic technique including radar and analogue computors, and is the most up-to-date in Europe. It is designed to sort 4,500 wagons daily and a total of 220 trains in and out each day, having 12 reception lines and 50 sorting sidings. The yard points are automatically operated on a route system, but can be controlled individually from the control panel which is accommodated on the top floor of the control tower. Preparations for humping a train are made by feeding a punched tape into a tape reader, which, when operated, translates the siding destination and other information into electric signals. The pressure applied by the retarders is automatically determined by radar speed measurement and assessment of rollability. The amount of space left in a storage siding into which a wagon is to be received is automatically measured, so that a wagon speed can be reduced to a value compatible with the distance left to run, so preventing violent buffering with wagons already standing in the sidings.

Hump signal indications are continuously repeated in the humping locomotive, so that the driver may readily observe them in whatever position he is standing in the reception sidings. This is a form of cab signalling. Other fully automatic marshalling yards are in the process of installation.

In a period of a few years the industry will not have supplied a considerable amount of equipment for installation by British Railways, but will have supplied and installed some 2,000 track miles of colour light signalling with track circuts, some 75 interlockings and the mechanisation of eleven marshalling yards, as an interim contribution towards the British Railways Electrification and Modernisation programme.

The firms concerned in the developments mentioned in this article are :—

Associated Electrical Industries (GRS) Ltd., 33, Grosvenor Place, London, S. W. 1.

The Siemens and General Electric Railway Signal Company Ltd., East Lane, Wembley, Middlesex, England.

Westinghouse Brake and Signal Company Ltd., 82, York Way, King's Cross, London, N. 1.

STEPS TO CHECK INFERIOR COAL SUPPLIES TO RAILWAYS

The Deputy Minister for Railways, Shri Shah Nawaz Khan, was asked in the Lok Sabha during question hour by Pandit D. N. Tiwari whether any arrangement had been made to check the supplies of inferior quality of coal for railway consumption.

He said that railway inspection had been introduced from August 10, 1960 for coal received from public sector collieries in Bokaro and Karanpura areas of the Bengal and Bihar coal-fields. The question of extending such railway inspection to other coal-fields was also under consideration.

Proceeding, the Deputy Minister said that every effort was being made to eliminate the receipt of inferior quality coal progressively by instituting inspection by railways and by other measures such as procurement of coal under contracts entered into directly by the Ministry of Railways which would inter alia provide for suitable rejections when the quality was below the specification of the contract and also by allowing the Railways to select within the allocations made by the Coal Controller, the collieries from which they draw their supplies.

Asked to give figures of financial loss and loss of time due to consumption of bad quality of coal during 1959-60, the Deputy Minister said that it was difficult to make any reasonably correct financial estimate. As regards loss of time, 169 mail or express, 357 passenger and 899 through goods trains lost more than 30 minutes each on account of inferior coal during 1959-60.

WORKSHOP ACCIDENTS

By R. G. Hardikar

HE shouts loudest whose house is on fire. How true and how natural. If this be the case where private property is at stake, is it any wonder that a wife or a dependent widowed mother will weep her bitterest when the very life of her dearest bread-winner is at stake? The grief due to loss of life or permanent injury to the bread-winner is more agonizing and tragic if the mishap takes place during Holi, Dasserah or Diwali festival. Just imagine the agony of the fond parents when they were rushed unawares to behold their eldest son (20) lying unconscious in a Hospital. He was in a very precarious condition. Wavering between life and death, under oxygen. This happened during Dasserah a few years ago.

INDIFFERENCE AND NEGLECT

The young lad, a fresh recruit, with only a few month's service as a casual labour, falls in a factory through 15 ft. on a steel rail laid in hard concrete floor. The main switch of an electric overhead travelling crane was fixed high up in the roof structure as shown in Fig. 1. The only approach to this switch was up the ladder. The supervisor responsible for personally manipulating the main switch when men were 'on line' attending to the crane under breakdown, was on terra firma 15 feet below when the victim dropped to the ground behind this supervisor and sustained serious internal injuries. The injured was first removed on a stretcher to the First Aid Post and thence to a Hospital, 8 miles away, in the Ambulance.

What would the parents have felt and done were they to discover that the only available stretcher was in the deplorable condition shown in the photograph, Fig. 2, reproduced here; or, the Ambulance was out of order, when their precious son was in the jaws of death?

DISOBEDIENCE OF RULES

I took up my first job on 1st December 1935, on a small Company-managed railway. In the Christmas Week of that year the District Medical Officer was summarily removed from Service, as in the opinion of its Chief Medical Officer, the DMO did not attend promptly enough to a drunken employee who sustained injuries due to a fall through 8 feet some two miles away; late after mid-night. Against this I can also cite the case of a Linesman on one of our big State-managed railways. Some 10 years ago I was crossing a busy railway yard on the bank of a wide river, with an electric torch in my hand. I was hurrying to catch a train to return to HQ. On my right, I heard voices nearby. Through the winter smog I could see nothing at all. My electric torch revealed a bamboo ladder resting against a 30 feet high lamp post. The feet of the ladder were resting against the rail of the nearer track. One man was at the top of the ladder. Two others were on the ground below on either side of the ladder. The test lamp in hand and the voice-of-authority

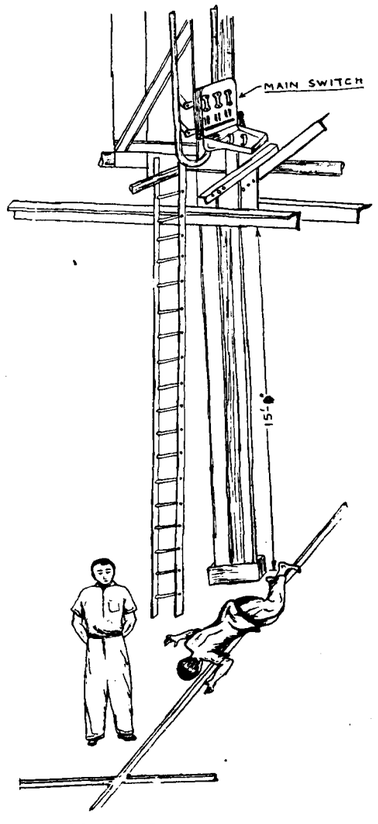


Fig. 1. Victim of Negligence

conveyed to me that one of the two men below was the Linesman. He was in charge of the operation—Replacement Fused Lamp. On being taken-up as to why the Linesman was working in a manner involving grave risk to life or limb, very lame defence was offered. On return to HQ, official records established that the particular Linesman had 5 previous written warnings issued to him for "serious gross disregard of Safety Rules and endangering human life". His appeal against my removal-from-service, drafted by his union officials, was upheld by competent authority. The offender's punishment, however, was lowered to "withholding issue of privilege pass and PTOs for a period of two months".

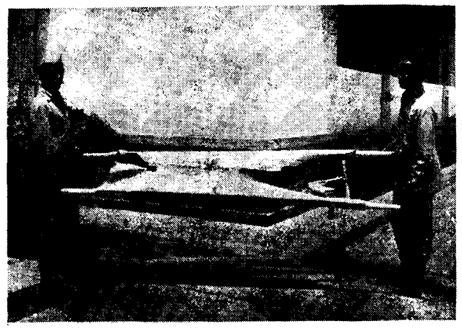


Fig. 2. Disgrace Discovered

In the recent past a junior colleague consulted me on how best to curb factory accidents. He had the signal misfortune of having had three electrocutioning deaths in nine months while officiating in a higher post. His quest for elder-brotherly advice recalled to my mind an American film on Factory Accidents I saw in a mofussil town many years ago. The film, accompanied by typically humorous and interesting commentary, showed how factory accidents occur to workers and how easily they can be averted by workers themselves. The need of sound coaching (training) is accepted now-a-days even in games. Cannot one then expect the Indian factory worker to respond to training directly imparted to him in a language he easily understands?

FAITH IN SUPERNATURAL

The stretcher shown here will speak volumes when exhibited before factory staff, supervisors and senior subordinates and the serious accident to the eldest son, referred to above, narrated along with other case histories. The annual Railway Week which has now come to stay should be utilised to make factory workers "Accident Conscious". Just as a cricketer faces every ball knowing fully well that any carelessness on his part in tackling it will certainly cost him his 'life'; so must a factory worker be "coached" to avert accidents by always expecting to encounter them like the snake-in-grass. A neighbour who flaunts a ricketty old office car, provided at his disposal once narrated to me that on being asked why the drivers say their prayers with closed eyes and folded hands before commencing their first trip in the morning, learnt that some drivers prayed that they be not involved in any road accident and molested by enraged pedestrians. Others prayed that the ricketty old office car does not conck out during the course of the day's work and make them toil. The Indian Factory Worker must be trained to rely more and more on his individual craftsmanship and technique. Unwarranted and excessive faith in divine intervention will never help a swimmer to cross the English Channel. He or she has essentially to rely purely on the strength of the arms.

There is a vast field for the Ministry of Information and Broadcasting to requisition the services of an able and imaginative Cine-Director like Satyajit Ray and produce a Documentary on factory accidents in collaboration with other ministries. While producing such a film the Ministry should also study accident histories during construction periods of our major Projects.

Such a Documentary is sure to pay rich dividends in the fulfilment of the 3rd Five Year Plan.

ELECTRIFICATION OF RAILWAYS IN SEALDAH DIVISION

The Deputy Minister of Railways, Shri Shah Nawaz Khan, told the Rajya Sabha during question hour that in the Sealdah Division, electrically operated suburban services were likely to be introduced in stages between 1962-63 and 1963-64, provided the replacement of the existing aerial telecommunication circuits underground cables by the Post and Telegraphs Department and power supply arrangements by the West Bengal State Electricity Board were in time.

Asked whether the doubling of the railway track between Dum Dum junction and Barasat in the Sealdah-Bongaon line of the Sealdah Division was under consideration. Shri Shah Nawaz Khan said: "Not at present".

British Railways 25-kV. a.c. Electric Locomotive

General Electric Co. Ltd. 3,300-h.p. Bo-Bo passenger locomotive for the London Midland Region

THE first of 10 25-kV, electric locomotives ordered from the General Electric Co. Ltd. is now in service on driver training in the London Midland Region of British Railways. The locomotives are designed for a wide range of passenger and goods duties, including the haulage of 100 m. p. h. express passenger trains, and carry British Railways type "A" designation, the serial numbers being E 3036—E 3045, inclusive. Provision has been made for operation on both 25-kV, and 6.25-kV. 50-cycle a. c. supply.

The mechanical parts for these locomotives have been designed and built by North British Locomotive Co. Ltd., as sub-contractors, and the specification requirement of a maximum axle load of 20 tons, using the Bo-Bo wheel arrangement, has been met with a comfortable margin, the overall weight of the first locomotive being below 77 tons. This has been achieved, using traditional materials, by very close attention to the structural and detail design for minimum weight of all major and minor components.

A valuable feature of the locomotives is that they have been designed to give the advantages of a duplex equipment. With the exception of the main transformer and its associated equipment the locomotive can be divided into two virtually identical halves. In emergency, in addition to the ability to isolate single traction motors, a complete bogie can be cut out with its auxiliary equipment, rectifiers, and so on.

The principal characteristics are as follow:—

Wheel arrangement	Bo-Bo
Maximum speed	100 m. p. h.
Continuous h. p. rating	3,300
Maximum tractive effort	50,000 lb.
T. E. at continuous rating	21,000 lb. at 54 m. p. h.
Weight in working order	76½ tons.
Length over buffers	53 ft. 6½ in.
Height over cab	12 ft. 4 7/16 in.
Maximum width	8 ft. 8¼ in.
Bogie wheelbase	10 ft.
Bogie pivot centres	29 ft. 6. in.
Wheel diameter	4 ft.
Radius of minimum curve	4 ch.

ARRANGEMENT OF EQUIPMENT

The high-tension equipment is contained in a steel enclosure, one side of which forms the inner wall of the corridor connection between the two cabs. The supply change over switch and the motor driven tap changer are mounted on top of the main transformer which is centrally located and effectively divides the h. t. compartment into two sections. Each of these

British Railways type "A" 3,300-h.p. 25-kV. 50-cycle a.c. electric locomotive hauling passenger stock during driver training on the Styal Line, London Midland Region.

sections contains one of the h. t. apparatus frames and one bank of rectifiers with secondary h. t. gear, symmetrically arranged about the transformer. Access is obtained through doors from the corridor.

A machinery compartment is located at each end of the locomotive between the cab vestibule and the h. t. compartment in which are mounted the vertical motor-generator blower sets and other auxiliary equipment. At one end are mounted the two exhauster sets, a rack for the brake equipment control valves and a chemical toilet; the main air compressor is mounted at the other end, together with an auxiliary compressor which is normally used when preparing a locomotive for service, and runs off the battery to provide sufficient air pressure to raise the pantograph and close the air-blast circuit breaker.

The access doors to the h. t. compartment are fully interlocked with the pantograph raising and roof earthing gear in such a way that they cannot be opened without first dropping the pantograph and earthing the air-blast circuit breaker. The pantograph cannot be raised to the operating position until the doors are closed and locked.

Batteries, weak field resistances and air reservoirs are carried under the main frame between the bogies.

Underframe and bodyframe, showing thin-plate double-skin construction.

The principl runs of cable are carried in a duct below the corridor floor.

Current is collected from the overhead line by one of the two Stone-Faiveley pantographs, feeding through a Brown-Boveri air-blast circuit breaker to the supply change over switch. This is an off-load switch operating under the control of automatic voltage detection and selection equipment to give the correct transformer tapping for running on a line voltage of 25 kV. or 6.25 kV.

The transformer output is taken from two secondary windings, each of which supplies eight Com-Pak mercury-arc rectifiers. These are arranged so that each pair of traction motors is fed in bridge by four rectifiers from each secondary. The connections are such that while under normal conditions the motors operate in series pairs, they would be effectively in parallel under wheel slip conditions. Return current to the track is taken through earth brushes running on the outer ends of the road wheel axles.

RECTIFIERS AND TRANSFORMERS

Liquid cooling is used for the excitron type rectifiers to meet the traction duty requirements of minimum size and stability in operation. Separate cooling circuits for the anodes and cathodes, under thermostatic control, ensure that the optimum anode and cathode temperatures are maintained within close limits. Extended tests in railway vehicles under varying service conditions have demonstrated its suitability in this direction.

The main transformer is of the oil-cooled type in which the oil is rapidly circulated through a radiator by a motor driven pump.

Each motor-generator blower set supplies air for two traction motors and one half of the electric equipment. The axial type blower is mounted vertically below the m. g. drawing air through the rectifier radiator mounted behind louvres in the body side. From the blower the air is passed downward into a duct from which feeds are taken to the traction motors and the air-cooled main motor chokes and the transformer oil radiator. Air flows upwards through the motor chokes and through one half of the horizontally mounted oil radiator, being discharged to atmosphere through a hooded cowl on the roof.

Pumps for the rectifier coolant and transformer oil circulation are driven by capacitor start-and-run induction motors supplied from an auxiliary winding on the main transformer.

CONTROL SCHEME

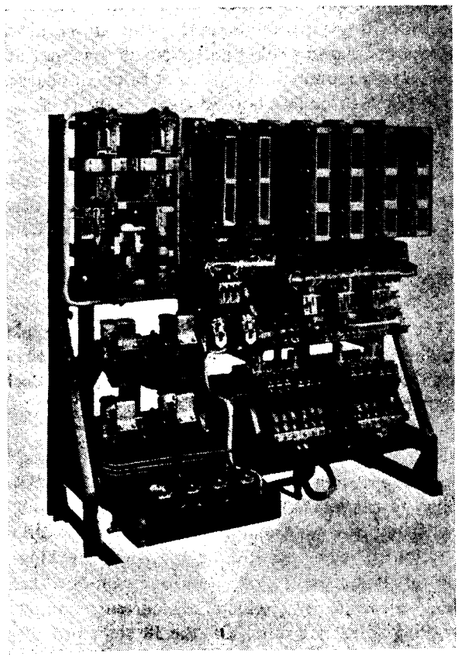
The transformer has a separate tapped regulating winding under the control of the h. t. tap changer, arranged to give a total of 38 steps of voltage regulation.

Specially developed for traction applications, the tap changer combines positive step location with the ability to run through rapidly either up or down, thus facilitating quick switching operations. It comprises a series of cam-operated non-current-breaking tap selectors immersed in oil, and four cam-operated air-break divertors on which all current making and breaking is carried out. Of the 38 steps provided, 19 are transformer taps and the other 19 are obtained by inserting resistance in circuit.

The master controller is arranged to give either individual notch control or automatic run-up or run-down. There is a total of 40 notches, comprising the 38 voltage steps mentioned, followed by two steps of motor field weakening on full voltage. An over-current relay is arranged to lift at a pre-determined current to arrest further notching so as to reduce the likelihood of tripping the overloads under run-up conditions.

Each traction motor is fed through an overload controlled e. p. contactor and a second contactor which together are used for motor isolation. Two steps of field weakening are provided by divert resistances and a permanent smoothing divert resistance is connected across each field. Reversal is effected by two electro-pneumatically operated two-motor reversers.

Each of the two vertically mounted motor generator blower sets incorporates a single phase a. c. driving motor, a d. c. generator and an axial flow blower. Power for the driving motors is taken from the main transformer auxiliary winding, and for starting purposes the sets are run up to speed by motoring the generator from the battery, automatic changeover to the a. c. supply being provided.



High-tension equipment frame

The d. c. output of one set is voltage regulated and this set is used to charge the battery, and to operate one exhauster set and the auxiliary compressors. The other m.g. set is not voltage regulated and operates the main compressor and the second exhauster set. Provision is made in emergency for isolating either m.g. set, all essential duties being then taken over by the other set.

TRACTION MOTORS AND DRIVES

The four traction motors are six-pole series-wound force-ventilated machines fitted with compensating windings. Class "H" insulation is used throughout and the ratings are as follow :—

Continuous rating	750 h.p.	725A.	850V.	1,165 r.p.m.
One-hr. rating	890 h.p.	875A.	850V.	1,100 r.p.m.

The motors, which are mounted through rubber pads on the bogie frame, have fabricated frames to which are bolted the hubs of the Brown-Boveri spring drives, which accommodate the relative movement between motor and axle. The motors are supported in the bogie frame on three point mountings, two being brackets on the motor frame and the other an arm extending from the hub of the Brown-Boveri drive.

The drive comprises a 5 deg. single helical reduction gear with a ratio of 25/74, the large wheel of which is mounted on a quill shaft carried in roller bearings in the drive hub. In the face of the gear is a ring of spring loaded pads, which engage with face dogs integral with a spider pressed on the road wheel hub. The drive is thus torsionally flexible and the axle is free to move vertically inside the quill shaft. An oil-bath lubrication system is installed.

LAYOUT OF CAB

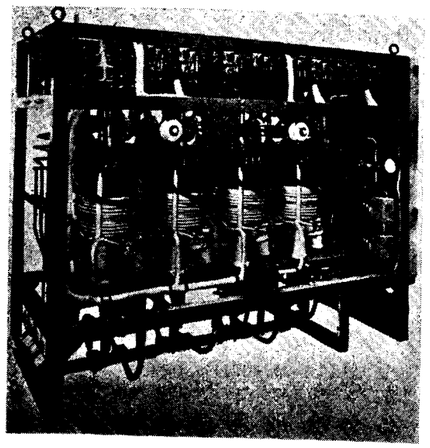
The driver's cab at each end of the locomotive follows closely the size and layout established by the B.T.C. and approved by the Railway Unions, with minor adjustments dictated by the constructional methods adopted. Fully adjustable seats are fitted for driver and assistant driver at the full width desk, and draught screens behind each seat extend the full height of the cab.

The roof is double-skinned, packed with insulation, and the steel framing of the cab front, and the robust construction of the desk are designed to give a measure of collision protection to the crew. Electric heaters are fitted alongside and behind each seat and in the vestibule, and the driver's and assistant driver's windows are glazed with Ther-glass screens for electric de-misting. These screens are of laminated glass with a fine wire matrix, invisible to the naked eye, incorporated in the laminations.

MAIN FRAME AND SUPERSTRUCTURE

The main frame base and body framing are formed entirely of thin steel plate as an integral structure. This design, which is the result of considerable stress analysis and investigation, eliminates all unnecessary material and weight, and provides a carefully proportioned and distributed stress throughout the complete structure.

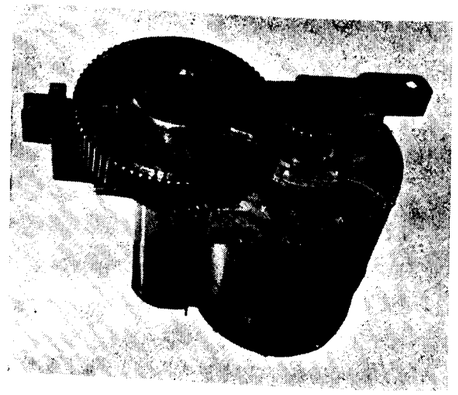
The base is a full width shallow box section and is curved round and upwards to form the bases for a series of vertical pillars. Corresponding sections of the



Frame of Com-Pak rectifiers, showing piping for liquid cooling.

cant rail are curved downwards to form the top junctions of the pillars. Large radii are used to avoid stress concentration, and in effect each of the body sides forms a Vierendeel truss. In the central portion of the width the top deck is raised and the bottom plate lowered to increase the depth of the box section.

At the pillar locations, box-form webs extend between the top and bottom decks of the main-frame base, and the two decks are also tied and reinforced by a number of longitudinal webs. The vertical members at the location of each cab rear bulkhead and at the front door pillars, are curved over to form the roof arches. These are tied together and deep side gussets transfer a proportion of the buffing loads evenly through the structure to the body side frames.



Fully-suspended traction motor with Brown-Bovery spring drive incorporated in the reduction gear.

The drag boxes are fitted with B. R. standard hooks and screw gear and are arranged for the later installation of central automatic couplings, and are fitted with oval headed hydraulic buffers. The complete frame was designed to withstand a standing and buffing load of 200 tons without overstressing any part. Strain gauge tests carried out on one of the frames have successfully demonstrated its ability to meet these requirements.

Between the cabs the roof is removable in five sections to allow for the lifting out of main equipment for overhaul purposes, the roof skin of aluminium alloy being attached to a light steel frame-work. Four half-drop windows are fitted on the corridor side of the body with two fixed windows on the other side for illumination of the h. t. compartment. The outer skin of cold rolled full finish steel sheet is welded to the bodyside frame members.

BOGIE CONSTRUCTION

The four-wheel bogies are of the swing bolster type, with welded box-frame construction, fabricated in $\frac{3}{8}$ in. steel plate. The weight of the superstructure is

transferred to the bogies through four pillars which extend from the locomotive main frame to the bogie bolsters. These pillars, two at each bogie, are located centrally between the wheels in the longitudinal plane, and outside the centre lines of the journals in the transverse plane. The pillars terminate in spherical pads sitting in spherical seatings, to which manganese plates are welded. The plates in turn slide on manganese pads bearing on the bolsters. The complete assembly is inserted in a sealed oil bath.

Traction, braking, and transverse forces are transmitted by steel king pins attached to cast-steel centres which in turn are welded to the main frame. Each pin sits in a rubber bonded steel bush fitted to the bogie bolster. The thrust point is arranged below the axle level to minimise weight transfer. Traction and breaking forces are transmitted from the bogie to the bolster by rubber bushed traction links.

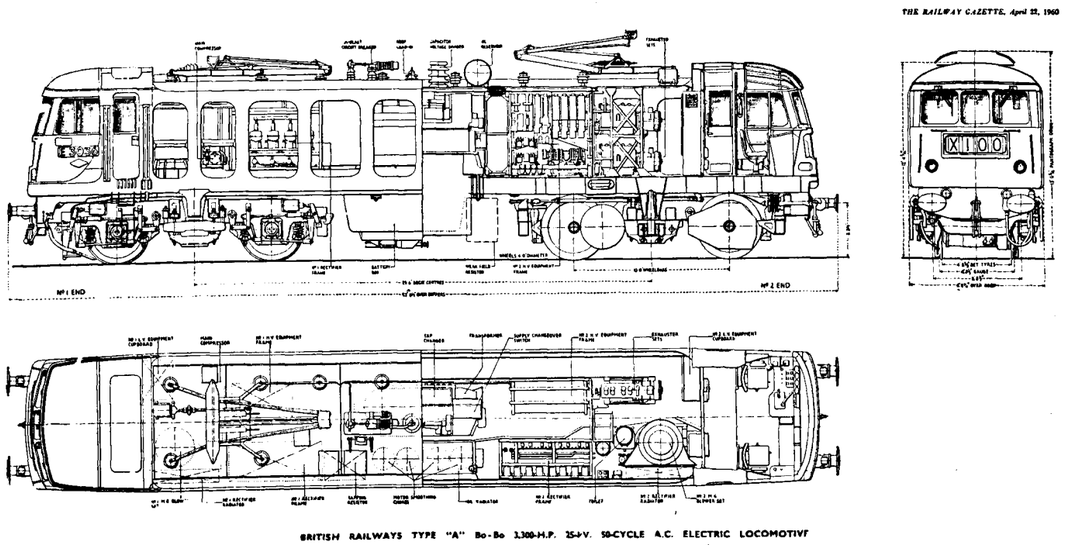
The vertical load on the bolster is transferred to the bogie through two double-coil springs at each end of the bolster, the springs seating on a bracket suspended from the bogie by spring links fitted with rubber bonded hemi-spherical pads. In addition to the cushioning of vibration these also assist in centralising the bogie after negotiating a curve.

Movement of the bolster springs is controlled by hydraulic dampers anchored to the spring link brackets and the top of the bolster. Lateral sway is checked by swing links and rubber dampers. The bogie frame is supported on double-row roller bearing axleboxes by two nests of coil springs at each end. The springs are rubber cushioned at each end and attached by links to a compensating beam resting on the axlebox. Manganese steel faced guide liners are bolted to the frame to facilitate replacement, and rolled steel wheels and tyres are fitted.

BRAKE EQUIPMENT

The brake equipment provides air braking on the locomotive and vacuum braking on the train. When hauling vacuum braked stock the locomotive air brakes are controlled by the driver's vacuum brake valve. The equipment is suitably arranged for the hauling of fully braked, partially braked, and unfitted stock. Eight-in. dia. brake cylinders, one for each wheel, are externally mounted above the axleboxes, operating through clasp brake rigging. Automatic slack adjusters are incorporated.

Air is supplied to three main reservoirs with a total capacity of 9 cu. ft. by a Metcalfe-Oerlikon type "2A. 115" compressor with a General Electric motor, while vacuum for the train braking is provided by two Westinghouse type "4V 110L" exhausters, also with G. E. C. flange mounted motors. These run at slow speed for maintaining vacuum and are speeded up for



brake release. Provision is made for the running of one exhauster off the battery for limited periods while traversing dead sections in the overhead line.

The hand brake in each cab operates through the power brake rigging on one pair of wheels on the adjacent bogie. The auxiliary compressor is a Reavell type "TBC5" machine with integral G.E.C. motor.

Anti-slip braking is fitted under the control of push buttons on the drivers' desks, to give a limited brake application so as to reduce the tendency to slip under poor adhesion conditions. Sanding is provided for the leading wheels of the front bogie in each direction of travel, the sand boxes being incorporated in the cab structure, with filling doors in the cab sides. It is hoped that the use of sand will be unnecessary because of the electrical characteristics of the scheme which limit the tendency to uncontrolled wheelspin, and the provision of anti-slip brakes.

The locomotive have been designed to the requirements of the British Transport Commission under the general direction of Mr. S. B. Warder and Mr. J. F. Harrison, Chief Electrical Engineer and Chief Mechanical Engineer respectively of British Railways Central Staff.

Principal sub-contractors include the following :—

Mechanical equipment	...	North British Locomotive Co., Ltd.
Radiators	...	Serck Limited
Blowers	...	Aerex Limited
Battery	..	Nife Batteries Limited
Main Compressors and brake equipment		Davies & Metcalfe Limited
Auxiliary compressors	..	Reavell & Co., Ltd.
Exhausters	..	Westinghouse Brake & Signal Co., Ltd.
Wheels and axles	..	Taylor Bros. & Co., Ltd.
Buffers and springs	..	G. Turton Platts & Co. Ltd.
Spring drives	...	Brown-Boveri & Co. Ltd.
Axleboxes	..	Skefko Ball Bearing Co., Ltd.
Windows	..	Beckett Laycock & Watkinson Limited.
Therglass screens	..	Verres Industriels S. A. Montier J. B.
Pantographs	..	J. Stone & Co., (Deptford) Ltd.
Air-blast circuit breakers		Brown-Boveri & Co., Ltd.
Cab instruments	..	Smiths Industrial Instruments Limited. J. Stone & Co., (Deptford) Ltd. Nalder Bros. & Thompson Ltd.
Cable	..	Pirelli-General Cable Works Limited.

(Courtesy—The Railway Gazette)

EXPANDED METAL STEEL SHEETS FOR GENERAL PURPOSES

The Indian Standards Institution has prepared draft Specification for Expanded Metal Steel Sheets for General Purposes [Doc: SMDC 5 (258)].

This specification covers expanded metal steel sheets used for general purposes and includes process of manufacture, sizes of mesh, properties, dimensions and physical tests, such as cold bend test, etc.

This standard is a revision of the same specification first issued in 1954. One of the new provisions included in the draft revision relates to the requirements with regard to supply of blank steel sheets and plates. Also in view of the decision of the Government of India to change over to the metric system of weights and measures, all values appearing in this standard have now been given in metric units. This draft standard (which is in English) will be circulated shortly to interested producers, consumers, and technologists for eliciting technical comments and will be open for comments for a period of 3 months from the date of circulation.

Television—A Medium of Visual Communication in Railways and Industry

By N. P. Gupta, M.Sc., D.I.I.Sc.
Philips India Ltd.

SINCE electro acoustic introduced the electronic "ear" in communications, thus allowing remote monitoring of sound signals, there has been a need for similar aid in the field of vision—a system, that would make it possible to survey all kinds of operations and events from distance.

The Television is the system that provided the electronic 'Eye' and so added the sense that was lacking.

INDUSTRIAL ASPECTS OF TV

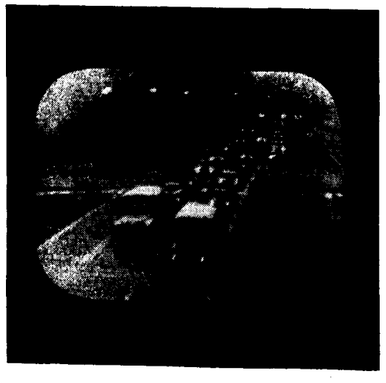
In several countries studio-television has now become a normal feature of daily life and there this medium of entertainment and education has become nearly as generally accepted as the common radio. It was therefore not at all surprising that the possibility was examined to utilize television for other purposes as well. The wide experience gained with studio-television proved very useful and in the last few years television is appearing everywhere as an aid to industry, science, commerce, education and traffic control.

Industrial television camera with remote control units for the adjustment of the lens and for the movement in the horizontal and vertical plane.

Here too, some teething troubles had to be overcome, but at present closed circuit television has developed in such a manner that in many instances the picture quality and the reliability of its equipment are equivalent to those of studio equipment.

What is closed circuit television ?

Closed circuit television is a simple means to transmit an image from one place to another in an electronical way. The necessary equipment consists of a small camera a control unit and a viewing screen. These units are connected by means of a cable. Advantages: Total cost of the equipment being comparatively low and the installation, maintenance and operation being simple.



Picture taken from the viewing screen of a TV monitor during observation of traffic on highway at twilight

The principle of closed circuit is the same as that of normal broadcast television, except the transmission of the latter being by air.

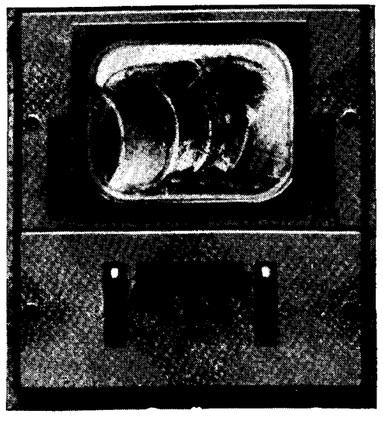
In order to adapt the equipment to all the exigencies put by the customer it has to be "tailor-made", i. e. fully adapted to the circumstances in which it is to work. For that purpose special accessories are necessary, as remote control of the optics, of the movement of the camera in horizontal and vertical plane, special housings for the camera to withstand heat, dust, vibration, radiation, etc.

Why closed circuit television ?

Because it will be an indispensable help for numerous applications in industry, commerce, education and traffic, etc. to boost production, to prevent accidents, to cut cost, to improve quality. In a lot of cases it will be the solution of otherwise insolvable problems. That's the reason why the purposes for which closed circuit television may be used are rather illimitable, so the number of applications is still increasing day by day. In a number of countries the increase in labour cost, together with the technical developments in TV equipment, are leading to wider opportunities for closed circuit television.

Prospects in closed circuit television

As regards the prospects for closed circuit television there is one fact that nowadays may hamper a still wider applications, namely the feeling that the equipment is delicate and that any eventual repair would be beyond the power of the firm's maintenance. However, the closed circuit equipment is constructed in such a way that it is to meet most of the industrial demands to which it may be subject. Further the serviceability is mostly such that an electrical engineer can easily make the repairs.



Observation of a jet engine during a bench test.

Industry is, however, gradually getting more and more interested in this new medium and more and more commercial and industrial organisations realize the possibilities offered by closed circuit television.

Aspects and applications of the system

As regards the different applications of closed circuit television it may be stated that they will be found in such a wide variety that it will hardly be possible to give a review. Or it must be said, as a manufacturer of closed circuit equipment states in his documentation: "Whenever it is too dangerous, too inaccessible, too far, too hot, too high, too dark, too tiring, too inconvenient, too scattered, too expensive, closed circuit television should be considered".

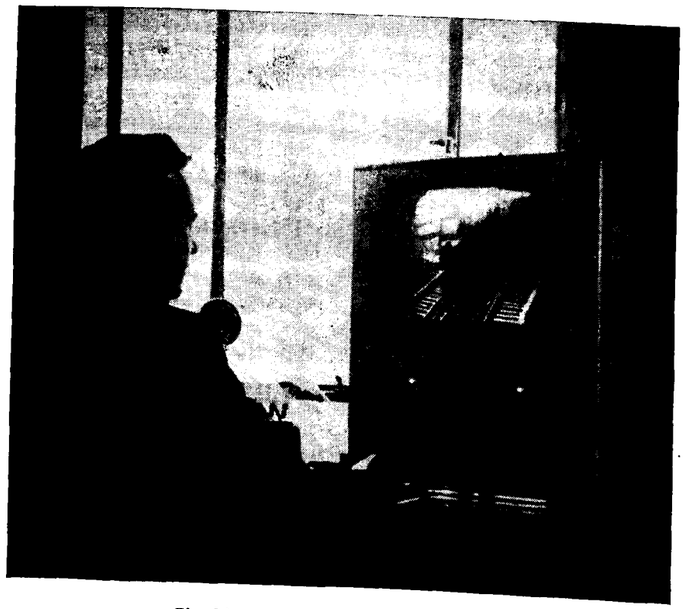
Among the various possible purposes of closed circuit television in different fields of application the following deserve special consideration—Closed Circuit T. V. in Railways.

CLOSED CIRCUIT TELEVISION IN RAILWAYS

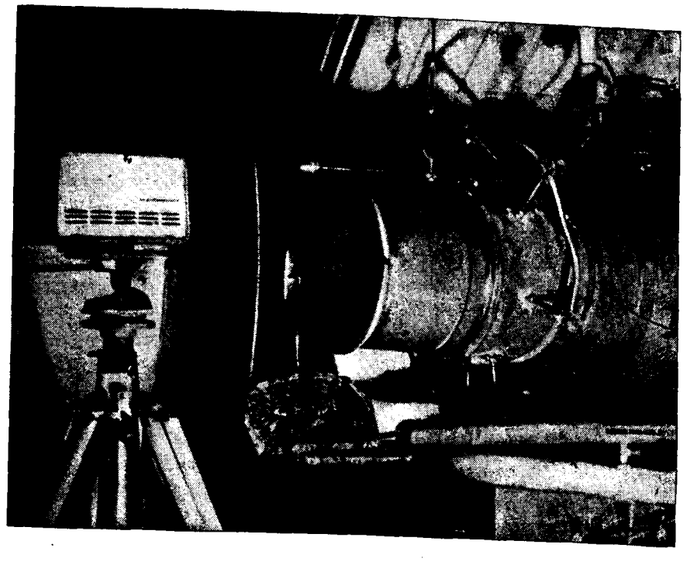
In India, the Closed Circuit TV is on the verge of being introduced in various spheres: in Industry, Medical Science, Technical and Academic Research Institutions and Railways. The application of TV in Industrial, medical and academic fields is not very unknown to us, but it is rather a new concept for Railways in India.

In advanced countries like U. S. A. and the Continent, TV has made itself known widely in Railway traffic control, checking the railway points, in marshalling yards for vigilance of the yard etc.

Railway Traffic control: In the platform, the board showing departure and arrival of trains, which at present works in a complicated electrical circuit, can be simplified by Closed Circuit TV. A number of TV receivers is to be installed at various points on the platform and the information printed on a small card can be simply placed under a properly adjusted TV Camera. The impression thus televised can be monitored in the TV receivers, linked with TV Camera



Checking points by a railroad employee.

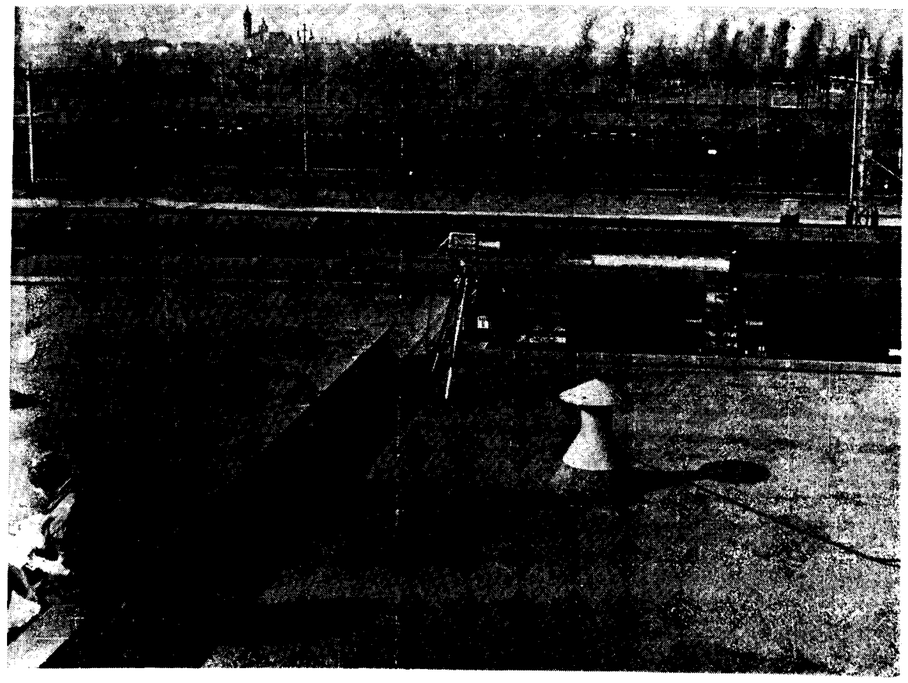


by cable, installed at various parts of the platform. The televised information can also be projected on a large screen 10′ × 13′ in dimension by a mammoth TV projector. This, however, needs a well shaded place so that stray light from the surrounding does not disturb the screen. This can solve the problem of using a number of separate TV receivers.

The remote control of points on the track for railway traffic can be efficiently conducted from the control room having the possibility of a direct viewing of the position of the train on track in TV receivers installed inside the cabin which is being connected with TV Cameras by cable suitably installed on various points on the tracks.

In a large platform where a number of trains comes in one after another on the same line, the end point of the train is an important factor to note. This can be easily viewed in TV Receivers inside the control room, linked with TV Cameras placed on the selected positions on the platform where the trains are to terminate, thus helping the man in charge of the control to allow the various trains to come into and leave out of the platform without any risk of occurrence of accident.

Marshalling yard problems: The main problem of a large marshalling yard is to direct the various wagons of the incoming train to different tracks destined for different places from the main line control point. The Present system is to do all the work by individual personnel. Points men direct group by group the incoming wagons to different tracks. One person on each track checks the wagon numbers, and the total number of wagons, and records the same which is rather a time-consuming job. This, however, can be checked by installing TV Cameras at the Central Control point on the incoming side and on each track separately which can pick up the incoming train and the various wagons on the different tracks. The operation can be remotely viewed in individual monitors installed in the control cabin. The control cabin monitors (TV Receivers) are to be individually linked with TV Cameras with corresponding control unit placed at various parts of track by suitable cables. The control man can direct the wagons to different tracks by observing TV signal from the central point



T.V. Camera installed to pick up the railway movement on the station yard.

on the main tract, remotely, and note down the total number of wagons and count the corresponding number of the wagons directly from the TV Receivers installed in the control room, linked with different cameras installed on different tracks.

VIGILANCE ON THE RAILWAY YARD

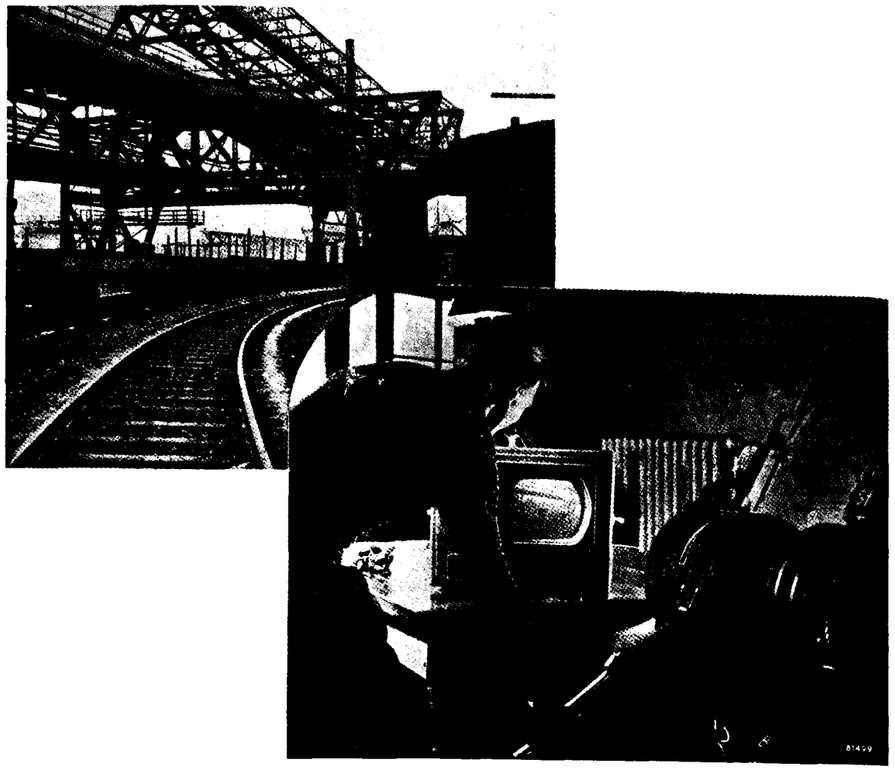
Each year Railways suffer a huge loss due to theft of materials from wagons lying on different parts of the yard. As a safety measure, Railways have to requisition a large number of watchmen all over the yard (a system which may not always work out cent percent efficiently).

This, however, can be easily solved by installing TV Cameras on properly erected masts at different parts of the yard to have a vigilance look all over the yard which can be continuously monitored remotely by TV Receivers connected with the cameras connected by cable from one central place.

The installation of such cameras are to be specially done, i. e. it should be remotely controlled for pan and tilt condition on its axis, it should be fully weather, dust, shock-proof, the lens should be a loom type whose focal length can be remotely controlled, and focussed; the aperture of the TV camera lens should be self adjustable type depending on the condition of light by suitable photocell and servo arrangement.

Industry

Control of combustion inside boiler furnaces, observation of water level gauges, checking slab positioning, observation of smoke stacks, control of rolling mill processes. Observation of firing of rocket



T.V. Camera installed on the bend of the track and traffic is controlled from the control room by viewing the track on a T.V. monitor.

engines, checking jet engines, observation of the interior of nuclear reactor furnaces.

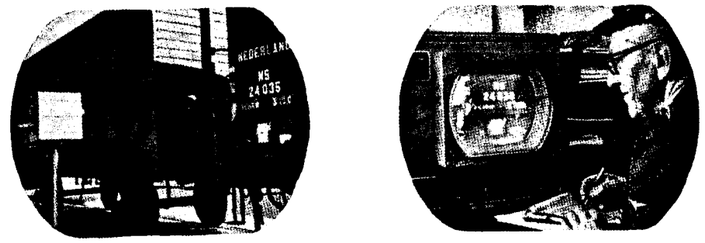
Commerce

Checking signatures in banks checking bank balances and files, sales promotion in department stores, training and education, showing operations and microscopic displays to large audiences, showing training films in different locations saving teaching positions and the improving quality of instruction.

Traffic

Checking of railroad loading, linking up traffic relations on difficult crossings, scanning runways for extending field of vision of control tower, checking the functioning of railway points.

In the following paragraphs a description is given of a number of applications of closed circuit television, from which an impression may be got of the widness of this field :



T.V. Camera installed close to the track to pick up Wagon Nos.

Traffic control

In order to obtain a better way to regulate traffic on dangerous crossings closed circuit television has become an expedient. The camera being attached to a building replaces the policeman in a traffic box. The image taken is transmitted to the police station where the traffic lights can be operated to obtain the best possible traffic regulation. By means of several cameras on different crossings the varying traffic densities can be controlled in such a way that a smooth flow of traffic will be ensured.

Observation of jet engines

During bench tests for jet engines normally only one side of the engine can be observed by the technicians who perform the tests, namely through a small window in the wall of the control room. During the tests, however, it would be desirable that also the other side could be watched in view of possible defects, e. g. oil leakage. By installing a TV camera the entire engine can now be continually watched. The camera has to meet very special exigencies owing to the prevailing very high sound level and thus has to be constructed to stand the severe vibration occurring. The image obtained is by no means inferior to one produced under normal conditions.

CHECKING BALANCES AND SIGNATURES IN BANKS

In banking houses closed circuit television has also found application for checking the depositor's signatures, bank balances and files. Without leaving the counter the clerk can, by means of an intercom system, call for the original signature or for the balance, which appear on the screen of the viewer situated in his near proximity. In this way a very efficient and time-saving procedure is attained.

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.

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.

An Important Announcement

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

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

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

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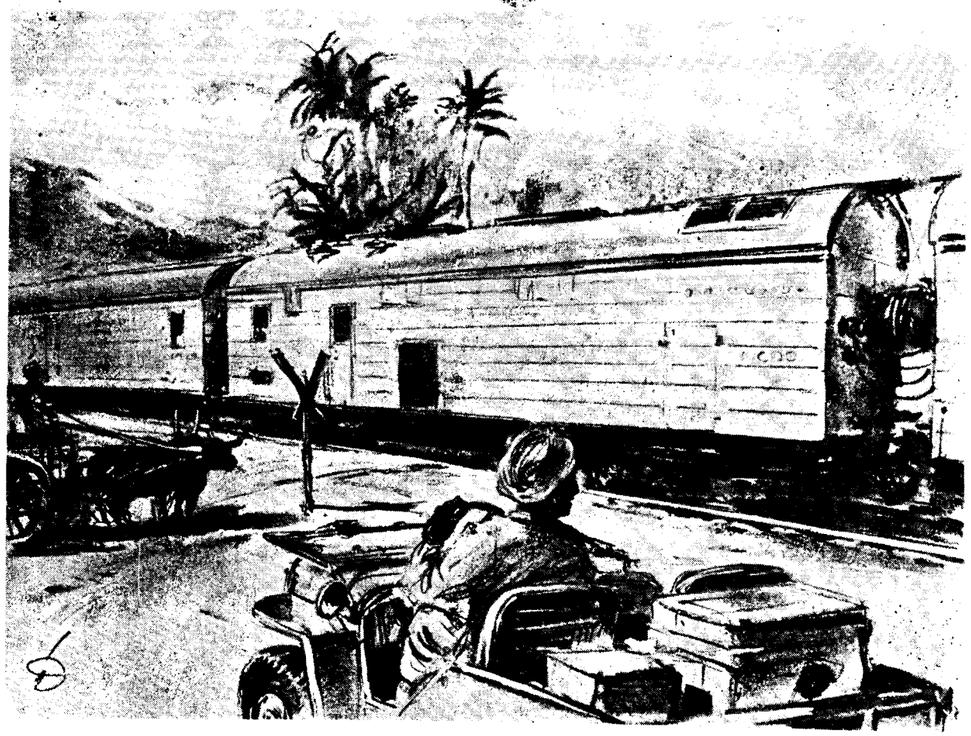

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Write for detailed information. We shall be glad to advise you how to be one step ahead in refrigerated railroad traffic.

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