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GENERAL ENGINEERING SUPPLEMENT

The Great Artery of the Ganges Valley

By M. M. Khan
General Manager, Eastern Railway

The second Plan period will go down in the history of the Eastern Rly. which is the great artery of the Ganges Valley as a period of significant changes.

It is during this period that a third class passenger secured his right to sleep during night journey without payment of an extra charge, people could receive parcels addressed to them at their doorsteps through S.C.D. and an Industrialist could send goods to their destination within a prescribed period through Q.T.S. and express goods services.

The period also saw the birth of electrification of certain sections in the Howrah division, besides completion of new rail links and yards of vital importance to the country.

IT has quite often been said that the Railways have shortened distances. But at no time in the history of the Railways was it more correct than on that trying summer afternoon in 1959 when, standing near Jim Corbett's Mokameh, our Prime Minister opened the Rajendra Pul over the river Ganga, which in her 300-mile course through the Bihar Valley had so far remained unbridged and had divided the State into North and South Bihar.

If the Rajendra Pul had helped the integration of the agricultural North with the minerally-rich South, the not-much-publicized ferry service between Farakka and Khejuriaghat has also brought the two halves of the truncated West Bengal closer. Then again, the rich Ranchi plateu, so far inadequately served by a narrow gauge track, has been conspicuously placed in the broad gauge railway map of India.

There are some of the important achievements of the Eastern Railway, the great artery of the Ganges Valley during the Second Plan. These can well be regarded as landmarks in the history of Indian Railways.

The second Plan period also saw the introduction of two distinct forms of railway traction—electric and diesel—after a century of monopoly enjoyed by the steam locomotives of George Stephenson.

IMPROVING COMMON MAN'S LOT

It was during this short span of five years that the common man, undertaking a long journey, has come to enjoy the amenity of spending his first night on a third class sleeping berth without paying any extra charge. It was also for the first time since the war that he could send a chit to the Railway's contractors and ask them to collect his parcel from his doorsteps in Calcutta or in Patna.

HANDLING INCREASED TRAFFIC

Transportation today is a highly complex industry and no accurate analysis of the performance of a transport undertaking is possible without inevitable reference to such technical terms as "wagon loading" "net ton miles", "passenger miles", "engine miles per day per engine in use" etc.

During the last year of the first Five-Year Plan i.e. 1955—56, the Eastern Railway had loaded on an average 4,272 wagons every day, consisting of 2,427 wagons of coal and 1,845 of other commodities.

The total loading of goods had amounted to 29.86 million tons. In 1959—60, the originating goods traffic rose to 37.44 million tons. The traffic for the last year has been estimated at approximately 39.82 million tons.

COAL MOVEMENT

Coal constitutes about 64 per cent of the entire goods traffic carried by the Eastern Railway. Coal loading during the first ten months of 1960—61 recorded an increase of 113,647 wagons as compared to the corresponding period of the previous year.

In December 1960, 115,898 wagons were loaded with coal and coke, as against 90,843 in December 1959. In January this year 6,170 wagons were loaded daily with coal and other goods as against 5,342 in January 1960. Despite the emphasis on coal loading, the Railway, however, has not only maintained but substantially improved its performance in goods loading.

Of the total target production of 95 million tons of coal at the end of the Third Plan, the Bengal and Bihar coal-fields will be called upon to produce 70 million tons. The bulk of the increase in the coal-fields will have to be carried by the Eastern Railway.

Eastern Railway's expansion programme under the Second Plan was integrated with the rapid industrial growth taking place in the region served by the Railway, particularly the steel, coal, cement, jute industries and with increased movement of food grains.

With the steel plants at Durgapur, Rourkela and Bokaro going into various stages production, the execution of the expansion scheme of the steel industries at Burnpur and Kulti, establishment or expansion of other industries like cement, paper, jute, chemical fertilizer etc., increase in agricultural output and rapid development of collieries, goods traffic of this Railway is expected to soar new heights during the Third Plan period.

PASSENGER TRAFFIC

In spite of the vital but strenuous role played by the Eastern Railway in the movement of goods to help the planned economic development of the country, the problems of the passenger have not been lost sight of. In 1959—60 out of every 100 miles covered by Eastern Railway trains, 54.1 miles were done by passenger trains and 45.9 by goods trains.

Against the target increase of 15 per cent in passenger trains miles set for the Second Plan, the Eastern Railway has already provided an increase of 15 percent on non-suburban and 26.9 per cent on suburban services, thereby achieving an overall increase of 13.8 per cent. The target for the Third Plan is only an increase of 15 per cent in seat miles and there should be no difficulty in achieving this target.

About 229 million passengers—more than half the population of India had borded Eastern Railway trains in 1959—60. During the year just ended 248 million used this Railway.

ELECTRIFICATION

Thanks to the electrification of Howrah—Burdwan and Shooraphuli—Tarakeswar sections, more people are now living in the outer suburbs of Calcutta than previously. Ten years ago (1951—52), the Howrah division of the Eastern Railway was carrying daily on an average 72,680 suburban passengers. It is now carrying 1.75 lakh suburban passengers every day.

The number of trains on the electrified sections has been nearly doubled. There are now 126 electric trains, against 66 steam trains before the introduction of electrification. The time taken for the journey has also been considerably reduced.

The carrying capacity of the EMU trains is also much higher than the older trains. During the peak hours, a three-unit EMU train provides seating and standing accommodation to 1680 passengers, as against 650 in a conventional steam train. This has gone a long way in reducing over crowding on these sections.

Despite the unprecedented increase in its passenger traffic the Howrah division is still far behind the performance of the Sealdah division, which had carried 107 million suburban passengers in 1959—60. The Sealdah Division still handles 64 per cent of the total suburban traffic on the Eastern Railway. The problems of this division are being tackled vigorously. The electrification work of this division on 25 kV single phase AC system is going on. In the meantime, the Rs. 89-lakh Sealdah station and yard remodelling plan has made satisfactory progress.

The existing system of signalling in Sealdah division is not adequate to deal with the increasing number of trains that would be run after the completion of electrification. The two cabins at Sealdah will be replaced by an electrically operated automatic cabin working on the route-relay system of interlocking.

NEW RAIL LINES

Out of the total anticipated cost of Rs. 79.97 crores on Second Plan works, the construction department's share was Rs. 28.55 crore plus Rs. 7.46 crores which this department was called upon to spend on provision of rail facilities required by the new steel industries.

Of the new lines, the 133-Km. Chandrapura-Muri-Ranchi section has already been opened to both passenger and goods traffic. Nearly 9 Km. of the line from Ranchi to the extreme end of Hatia yard has also been completed. The construction of Hatia-Bondamunda section has been included in the works programme of the Third Five-Year Plan. When complete, the new line will be used for the movement of coal from the Bokaro and Jharia coal-fields to the Bhilai and Rourkela steel plants.

The 53-Km. Baraset-Basirhat-Hasnabad broad gauge line in West Bengal is being laid through the area which was once served by the now-defunct Baraset-Hasnabad Light Railway. The estimated cost of the project is Rs. 25.6 crore. Passing through the outer suburban area of the city of Calcutta, the line will provide an outlet for the agricultural and forest resources of the Sunderbans. Formation and bridge-work of the line are nearly complete and linking of the track has been started. The line is expected to be opened towards the end of 1961.

In South Bihar the Eastern Railway is spending Rs. 25 million to lay a 53 Km. railway line, which will connect Bukhtiarpur with the ancient city of Rajgir, sanctified by Gautam Buddha. The line will thus link up Patna with the Rajgir and the ruin-studded international university of Nalanda. This line is also expected to be opened towards the end of 1961.

A stretch of 13 Kms. of railway line between Damodar and Kalipahari has already been opened to goods traffic. This is helping the heavy ore traffic for Durgapur to bypass the busy yard at Asansol. The remaining 2-km. stretch of the line, with a 150-fly-over across the main line, is expected to be opened to traffic shortly.

Of the seven lines in the Karanpura and allied coal-fields, each with a big yard at the colliery site, five have been completed and opened to traffic. The work at Sayal Siding has also advanced substantially and loading has started on this line. The Tildanga-Faraka line with a broad gauge wagon ferry between Farraka and Khejuriaghat has also been opened to goods traffic.

NEW RAILWAY YARDS

Of the new yards, the exchange yard at Hirapur, the coke oven plant yard for the steel plant at Durgapur have been completed and commissioned. The yard to serve Dugda washery is also ready except for some minor works which will be carried out when the washery goes into production. The construction of the yard at Patratu has also been progressing satisfactorily.

With the satisfactory progress of the Second Plan works some of the works earmarked for the Third Five-Year Plan have also been taken up in advance. The aggregate cost of these works is roughly Rs. 20 crore which includes the construction of the 161 km. Hatia-Bondamunda section, with a branch to Purnapani, doubling of the 93-km. Barkakana Loop between Patratu and Tori and between Kumandih and Barwadih, and the Patratu-Damodar Branch.

The second phase of the remodelling of the Andal yard and the exchange yard to serve the Indian Iron & Steel Company at Hirapur will also start in the current year. Necessary survey for the construction of a line to serve the Patratu thermal power station has recently been carried out and the work will be taken up shortly.

IMPROVED SIGNALLING

In the coal-field area improved standard of interlocking and token-working have been introduced with a view to increasing line capacity. As coal traffic during the Third Plan will be much greater in volume than that of the Second Plan, the sectional capacity of the Railway will be increased by providing standard III interlocking, tokenless working and also by doubling the single line Patratu-Tori and Kumandih-Barwadih sections.

On the main line, additional safety measures have been provided by introducing lock and block working between Mathrupoore Block Hut and Mughalsarai. All non-interlocked stations on the Sahibganj loop have been interlocked. Similar measures are being taken on the Bandel-Barharwa loop and the southern section of Sealdah Division.

Track circuits are being provided on the platform lines at Sealdah, Patna, Asansol, Naihati, Kiul and Sitarampur stations. This will reduce the chances of accidents within the station areas.

The important marshalling yards at Mughalsarai and Andal are being mechanised. The electrified Howrah-Burdwan section has been provided with colour light

signals. Similar work is in progress on the Asansol-Dhanbad section.

The public address system at Howrah and Sealdah stations has proved a success. During the Third Plan more stations will be provided with loud-speakers.

DIESEL TRACTION

The introduction of diesel locomotives on the Eastern Railway was another significant march in the Railway's bid for modernisation during the second Plan. These 1,950 HP locomotives have set a new pattern in the movement of goods traffic on certain busy routes of this Railway. In the beginning, the diesels were made to work 2,300-ton goods trains between Gaya and Gomoh/Dhanbad. This section has a stretch of 14 miles in a gradient of 1 : 80. Later, with the arrival of more diesels, working of goods trains hauled by diesel locomotives was extended to Mughalsarai and to Barkakana *via* Sone Nagar and Barwadih. Each of the diesel locomotives has been earning an average mileage of about 7,500 miles a month. The engine miles per day per engine in use have been of the order of 250.

Diesel traction will be expanded during the Third Plan period. A new shed is being set up at Patratu in the heart of the Karanpura coalfields which are being developed by the National Coal Development Corporation.

The diesel locomotives to be based at Patratu will not only meet the increasing transport requirements of the Karanpura coalfields, but will also move heavy coal trains of 3,600 tons over the new link between Garhwa Road and Chunar, now under construction. This will reduce the pressure of movement to up country direction over the Sone-Nagar–Mughal Sarai section.

RAILWAY WORKSHOPS

The major workshops of the Railway at Kanchrapara Jamalpur and Lillooah are playing an important part in the repair and maintenance of rolling stocks. A system of payment by results has recently been introduced on a limited scale in the Jamalpur workshops. This system will be gradually extended to all the railway workshops.

The Jamalpur workshops have started production of 40-ton steam cranes. The manufacture of the Box type wagons has been taken up in the Kancharapara workshops.

QUICK TRANSIT SERVICE

The Express Goods Service is available between Howrah on the one hand and Patna, Gaya, Dhanbad, Bhagalpur and Ramporchaut on the other. A similar service is available, every alternate day, between Patna and Howrah. Quick Transit Services with guaranteed time of delivery have been introduced between a large number of stations.

It was during this period that the Eastern Railway diversified its activity by participating in the Bihar State Road Transport Corporation.

In its desire to serve those areas which are away from the railhead the Eastern Railway opened five out-agencies during the Second Plan period. Proposals for opening out-agencies at several other points in West Bengal, Bihar and U. P. are being examined.

STAFF WELFARE

The performance of any organised industry is, in the ultimate analysis, a reflection of the sincerity and efficiency of the man who run it. With an army of 1.73 lakh men the Eastern Railway is ready to attack the problems of the Third Plan so that the Rail transport capacity may keep pace with the demand.

The health and welfare of the staff and their family is one of the major concerns of the Administration. The Railway is at present running 8 hospitals, 75 health units, 10 chest clinics, 10 dental clinics. Two hundred and forty beds in sanatoria have been kept reserved for T. B. patients. Another 76 patients are receiving treatment in other sanatoria at the expense of the Railway.

The Railway is running 119 schools of different types. A subsidized hostel has also been opened at Patna for the sons of employees. Three technical and vocational training centres impart training to staff, their children and dependents.

As a measure of economic assistence to the railway men's families, the Mahila Samities on this Railway are being encouraged to fabricate hospital and other staff uniforms and thus supplement their family income.

About 55,000 quarters have already been made available to the staff and more will be built during the Third Plan. Seven mobile libraries are now running on this Railway to supply books to the railwaymen at wayside stations. Cheap Holiday Homes at healthy places situated in congenial environs provide opportunity to the railway staff to get away periodically from the stress and strain of their daily lives.

MODERN METHODS OF EARTH COMPACTION

By G. W. C. Garrould, F.R.S.A., M.I. Mech. E., M.I.E. (Ind.)
Technical Adviser to the Board of Parry & Co. Ltd.

So much thought has been given in recent years to the methods of improving the surfaces of heavy duty roads and aerodrome runways, to enable them to withstand shock loading and to preserve them against severe tropical and arctic conditions, that there is a very real danger of overlooking the improvement which in the same period, has been made in earth compaction.

2. Obviously, without adequate supporting foundation, a tough weather-proof surface is in itself no answer to the problem, for even the best of surfaces must distort and crack unless the earth beneath has been properly compacted to prevent settlement.

3. Deliberate earth compaction probably started when our fore-fathers first observed how beautifully the hooves of cattle compact the surface of cattle tracks, for since earliest time herds of sheep and goats, have been used in various parts of the world to consolidate earth works. By driving a herd backwards and forwards across the top of made-up soil, and at each pass adding a fresh layer of loose soil, a fairly effective method of compacting quite large masses of earth can be developed, and in this manner many embankments and earthdams have in the past been made in this country.

4. The Disadvantages of this method are obvious. A large herd of animals must be maintained if the work is to be done expeditiously, and on a construction job, a herd is naturally both awkward to protect and difficult to maintain in fodder.

5. Considering a sheep or a goat purely as an "individual compactor", it will be observed that the animal is not of a particularly efficient design, as despite its comparatively tiny footprint, it is not, in itself, heavy enough to consolidate more than a very thin layer of earth on each journey.

6. SHEEPSFOOT ROLLER

A Roller was therefore, developed for this compaction work and in its earliest form it was simply a heavy drum fitted with projecting spikes, blunt at the end. When rolled across a loose earth surface, this roller had much the same effect as the passage of a herd of small-footed, but rather more heavily built animals. The projecting feet of 'Tampers' were made to stick out sufficiently far to lift the body of the Roller quite clear off the ground and as the roller could be made of solid iron, or alternatively made hollow but filled with sand, the unit weight on each projecting Tamper could be so arranged as to apply a relatively high individual compaction pressure to the ground.

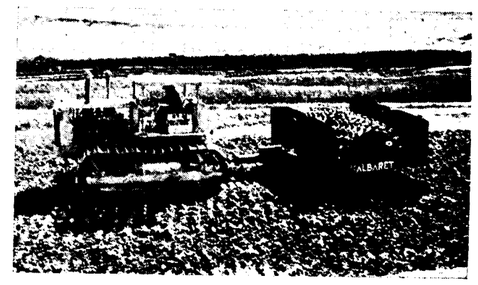


Fig. 1

7. The Sheepsfoot Roller, as it came to be known, soon showed that it had a fundamental weakness in design. With the Tampers spaced well apart to obtain maximum impression, the ground could not be compacted uniformly, yet when the Tampers were brought closer together to achieve uniform compaction, they were found to present to the ground so wide an area of point contacts as to convert the Sheepsfoot Roller virtually into a plain roller, and in the process the distinctive character of the Sheepsfoot Roller was of course completely lost.

8. This weakness has been overcome to some extent by two methods, the first by increasing considerably the diameter of the Roller, and second by retaining the Roller at the same diameter but arranging the rows of Tampers in spiral helices around the cylindrical surface of the Roller as is shown in Figure 1.

9. By varying the shape of the projecting ends of the Tampers to a round or a rectangular section, the Roller can be made more suitable for different classes of material and a number of different Sheepsfoot Roller designs have appeared on the market from time to time, with each manufacture claiming one

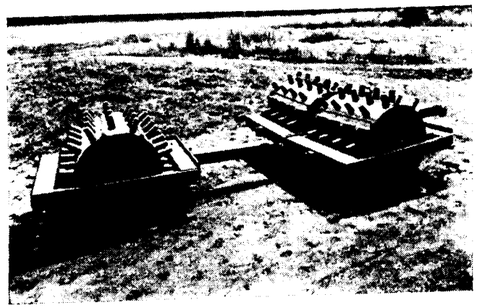


Fig. 2

advantage or another. In general, however, it may safely be assumed that good average compaction can be obtained with Tampers of circular section and conical in form, and the projection of the Tamper from the Roller should be from seven to nine inches. Regardless of whether the Tamper foot is square or round, good results can usually be achieved with an area of six to eight sq. inches exposed to the soil, but experience shows that in practice the individual bearing surface of the Tamper should be made to increase in direct ratio to the weight applied, and in inverse ratio to the increase in the bearing properties of the soil considered.

10. A good average performance however, is seldom ideal as the engineering solution to any problem, and in this particular Problem we must take cognizance of the very considerable variation in soils likely to be encountered in different parts of the world, or even in different parts of the same country.

11. Thus, a Sheepsfoot Roller designed for a certain class of soil may operate most indifferently on a soil which is either more loosely knit, or more dense and binding. Furthermore, soil on the same construction site may vary considerably with changes in the weather, and a Sheepsfoot Roller which operates quite properly during one week, may be in difficulties the next. Despite its shortcomings however, the Sheepsfoot Roller is fairly cheap and easy to produce, and because of this it is, in some parts of the world, still in steady demand. Sheepsfoot Rollers are usually manufactured in sizes from 3 to 13 tons per ballasted drum and in sizes varying according to the weight from 30 to 60 inches in diameter, and from 40 to 60 inches in length.

12. To obtain a clear run for instance of say 10 feet wide at one passing, two 60" Sheepsfoot Roller would be arranged as a pair side by side, with a third Roller of the same size and weight arranged to follow in tandem, a few feet in rear and placed centrally, so as to cover the untamped earth left in the gap between the two front Roller. Because of the large turning circle required if Sheepsfoot Rollers have to be turned round at the end of each run, and because of the surface disturbance caused to the soil in turning Sheepsfoot Roller round, the tandem arrangement of Rollers is only used on large open sites. In relatively confined spaces the Double Drum Roller is instead coupled on its own, to its Crawler Tractor so that alternate push and pull operation can be done, the Sheepsfoot Roller being worked crab-wise, backwards and forwards across the site without having to turn it round.

13. The arrangement shown in Figures 1 and 2 is very typical. It may be seen that fore and aft of each Sheespfoot Roller, there are steel and boxes arranged so that the Rollers can be ballasted at site to the optimum weight which the class of soil requires. A useful estimating rule for determining the size of the Tractor required for a large Sheepsfoot Roller on reasonably soft earth is to assume 7 HP per ton, taking into account of course, the nett weight of the complete Roller plus the additional weight of the ballast in the sand boxes. Crawler Tractors are usually better suited for this class of work, particularly when the made-up ground to be compacted is not level, and where stopping and starting may be required at fairly frequent intervals.

14. One unavoidable disadvantage in using the Sheepsfoot Roller. is that in the process of compaction, its Tampers must penetrate the surface of the ground in order to consolidate it, and this leaves the surface in a loose broken condition as the illustration quite clearly shows. Because of this surface penetration, the Sheepsfoot Roller has a distinct limitation as to the depth to which it can effect compaction. Thus, a comparatively thin layer of fresh soil only, can be handled at each pass, if uniform compaction is to be achieved, and a good rule to observe is that each successive layer of soil to be compacted, should never exceed in depth the equivalent of 60% of the length of the Tamper, otherwise the Sheepsfoot Roller will not be able to operate to anything like maximum efficiency.

15. The number of "passes" required to obtain uniform compaction is a matter of simple experiment at site, but experience has shown that according to the type of soil encountered the number of passes will vary from 6 to 16 with a fair average around 12.

16. In carrying out an experiment at site on a new soil, it will soon be observed that after a certain number of passes, the soil will reach a condition where no further consolidation is taking place. A critical point has in fact been reached and beyond this the Roller is only achieving an elastic deformation and rebound in the soil surface. With a little experience in the field therefore, an observer will be able to decide the number of passes required for the design and weight of the Roller he has in operation, and he will find that maximum intensity of compaction will usually be reached at a depth which corresponds to about 30% of the length of the Tamper.

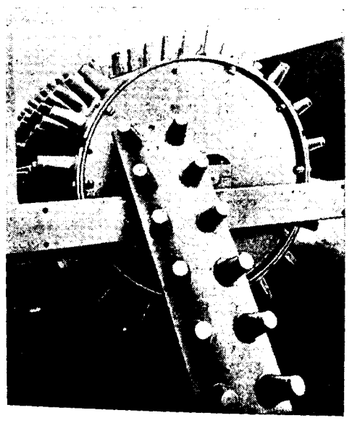


Fig. 3

17. The fact that the Sheepsfoot Roller consolidates by penetrating the surface of the ground is obviously most inconvenient when the Roller has to be moved from one place to another the high point loading on the Tampers will disturb ground which has been already levelled, and may do very serious damage to a finished surface even penetrating well laid macadam. For this reason it is usually necessary to go to the expenses of moving Sheepsfoot Rollers from site to site by Trailer and it was to avoid this expense among other reasons that an ingenious variation to the standard Sheepsfoot Roller, was introduced some years ago in France, by making the roller "convertible".

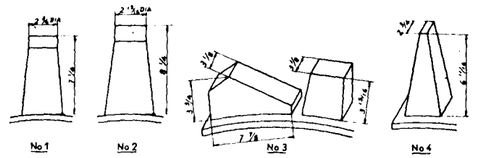


Fig. 4

18. This "Convertible Roller" is illustrated in Figure 3 and is in essence a plain drum, onto which a series of curved plates can be bolted when the Roller reaches the site. The curved plates have the projecting Tampers welded on them, as will be seen from the illustration, so that with the detachable plates removed, the Drum can be rolled conveniently to the site as a plain roller doing no damage to the surface over which it is being hauled. On arrival at site the plain drum can be converted quite quickly, to a Sheepsfoot Roller simply by bolting the curved plates into position. A further advantage of this method is that spare plates can be held at site to provide simple maintenance and a replacement can be made if an individual Tamper becomes damaged, without delaying compaction operations longer than it takes to unbolt one plate and to bolt its replacement into position.

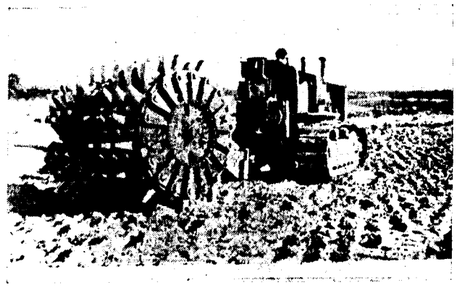


Fig. 5

19. Although this novel method overcomes the transport difficulty, the Convertible Sheepsfoot Roller is at best, only a general purpose machine and suitable for the contractor who has only the simple problems of earth compaction to handle. The inherent shortcomings of the Sheepsfoot Roller are still there and the Tampers on such Rollers are no more capable of independent variation to suit different soil densities, than the fixed Tamper design of Roller. To achieve some measure of flexibility the Contractor can of course, purchase along with the plain Roller several sets of curved plates, each set mounted with a different design of Tamper, and in practice this is sometimes done.

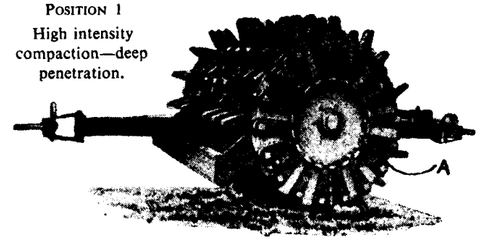
20. The shapes sketched in Figure 4 show the popular types to Tampers in common use today. The design No. 4 in the sketch for instance, provides a steel Tamper sufficiently spiked to enable it to be used for breaking into layers of shale and soft rock or exceptionally hard baked soil as is often encountered in desert country. Surfaces broken up in this manner can then be levelled and finally compacted by the more conventionally shaped Tampers. The Cleaning Rakes which lie in between the rows of Tampers, and which can be seen in several of the Sheepsfoot Roller illustrations, can be shaped specially when the spiked Tampers are in use, so that they shear off the clinging lumps of earth or soft rock, and in this shearing action, hasten considerably the systematic break-up of the surface soil.

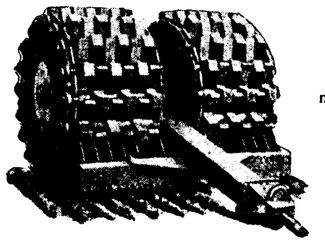
21. THE TURNFOOT ROLLER

The problem of varying the shape of the individual Tamper, and thereby varying the unit pressure which the Tamper will exert upon the soil, in order to achieve increased or decreased penetration, is one to which considerable thought has been given by most of the leading manufacturers of Compaction equipment. Perhaps the cleverest and most novel patent Roller yet produced to achieve variable soil penetration, is the "Turnfoot Roller". This roller, developed in France and illustrated in Figure 5, comes remarkably close to the ideal answer, as it is a very simple matter to adjust pressures in the field, and even more important on some sites, the Turnfoot Roller can be used, like the Convertible Roller with the spiked Tampers in Figure 4 above, to prepare a soil surface before starting compaction operation, or to break up an old patch of macadam when re-surfacing a road.

22. Perhaps it would be prudent to explain here, than it is a common experience when compacting a loose back-fill of relatively weak soil, to find that the surface is itself not capable of supporting the weight of a Sheepsfoot Roller. In consequence the Tampers sink in so deeply even when the Roller is unballasted, that the surface is broken up or "fluffed" excessively, and efficient compaction rendered impossible. For a weak soil of this sort, it is therefore, necessary to make one or more passes with a smooth Roller over the surface before deep compaction can be started. With the versatile Turnfoot Roller this pre-rolling can be done as one of its several operations, without calling in the assistance of a separate Roller. An explanation of the way in which this Roller can be converted in the field for its various operations is set out below in view of its somewhat novel design.

POSITION 1
High intensity compaction—deep penetration.





POSITION 2
Intermediate compaction—medium penetration

POSITION 3
Superficial compaction—surface rolling.

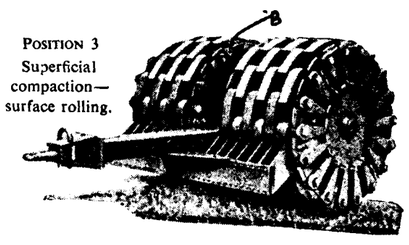


Fig. 6

23. Figure 6 shows this Turnfoot Roller with its Tampers arranged in three positions, and the sketch in Figure 7 illustrates in elevation the penetration, and in plan the effective areas which would be imprinted upou the ground when the Roller is drawn forward with the Tampers in these different positions. The sets of Tampers it will be seen, are supported on cross shafts marked 'B' in the illustration. These shafts are arranged around the circumference of the two fixed end plates of the Roller to form the Roller Drum, and are secured in position at each end by radial keys marked 'A'. It is a simple matter in the field to release the keys, to rotate the shafts to which the Tampers are securely fixed, and to lock the shafts again in the selected position by these radial keys.

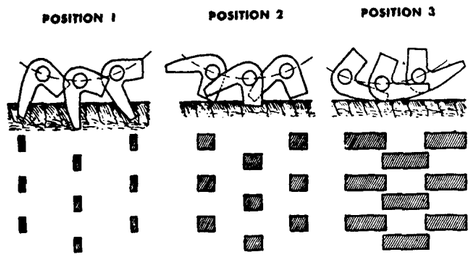


Fig. 7

24. In "Position 1" the projecting Tampers are all turned so that they present to the ground the smallest bearing surface. When the Roller is drawn forward in this condition, these Tampers tend to penetrate deep into the soil, and because of their relatively small independent bearing surfaces, they compact the soil with the highest intensity. If the next lower intensity of compaction is required, the shafts must be rotated to "Position 2". Here the Tampers offer individually to the surface of the soil an area nearly three times as great as in "Position 1", and in passing leave behind an imprint correspondingly less intense. Finally, to obtain the lowest intensity of compaction, the shafts must be rotated until the Tampers are in "Position 3", when the imprint which they leave upon the soil as illustrated by the shaded areas in Figure 7, is again seen to be nearly three times the area of the previous imprint.

25. In practice, with the standard "Turnfoot" Roller, the Tampers are designed to provide an individual pressure area of 7 sq. ins. in "Position 1", 19 sq. ins. in "Position 2" and 48 sq. ins. in "Position 3", but variations in design can be made from the standard to suit peculiar soils.

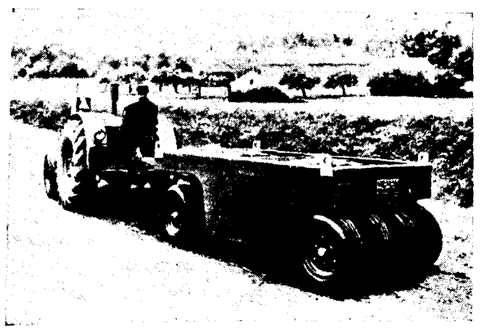


Fig. 8

26. One might suppose that with the final design of the Turnfoot Roller, the earth compaction Engineer had reached his ultimate objective, and yet in deciding to abandon those herds of goats and sheep in favour of his Sheepsfoot Roller, he has become seriously in danger of forgetting that on loose soil where the individual animal can stumble heavily into the hollow of some unseen rabbit-hole, his sheepsfoot Roller will pass safely over the top blissfully ignorant of the fact that the rabbit-hole even existed.

27. This is a serious failing, as it is for these very areas of weak bearing pressure that the compaction Engineer is constantly searching, and when he drives his motorcar along the area which his Sheepsfoot Roller has just consolidated, he too may find that the Rubber Tyred wheel of his car suddenly has sunk into this self-same rabbit-hole. In fact it is a common experience to come upon a macadam road surface marred by sudden hollows and depressions, and wherever this occurs it is a sure sign of faulty consolidation of the foundations under the road surface.

28. Most of us have had the miserable experience of driving or being driven over such roads, and have watched with apprehension if we happen to own a vehicle ourselves, the unfair way in which local authorities often allow these hollows to develop and then fill them in with road metal to a level above the general road surface, so that the Rubber Tyred vehicles whose owners incidentally, pay a tax to use the road, can be employed to finish the consolidation work which the road Engineer should have done employing proper compaction machines, at the time of re-surfacing that part of the road.

29. The "Tarred" road as we call it is after all, nothing more than a strip of consolidated foundation with a water-proof skin in the form of bitumenized stone, or asphalt, spread over the top. If in preparing the foundation, the rabbit-hole depressions have been neglected, one cannot expect the thin water-proof skin on its own to carry the heavily laden rubber tyred vehicles which will soon be using the road, and it is these rubber tyred wheels seeking their support from the foundations of the road, which will soon find out the points of low bearing pressure and start little subsidences, which for want of a better expression we describe as "pot-holes".

30. PNEUMATIC TYRED ROLLERS

Although "pot-holes" in the road must have been a great worry to our fore-fathers, it has been left to

this generation to devise an entirely new method of earth compaction, and just as they noticed the fine road surface produced by cattle tracks and applied the principle to earth compaction, so the fine hard groove left behind by the motor tyre has been adapted for modern earth compaction machinery.

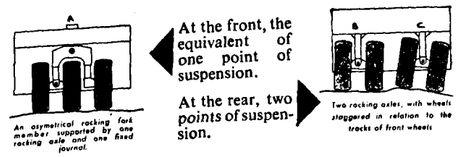


Fig. 9

31. Considerable experimental work had been done before the World War, on the continent, in the U.K. and in America, in applying multi-tyred vehicles to earth compaction, and during the war multi-tyred "Tank Transporter", whilst designed primarly to spread the heavyload of the Tank over the road surface so as to cause as little damage as possible, did, when driven off the road, achieve a measure of success as a soil compactor, and was in fact used in some areas during the war to produce emergency landing strips.

32. Compactors with wheels mounted on a rigid chassis are however, very inefficient and can obviously be used only on level ground. Furthermore, the tyres must be so arranged that the tracks of the forward wheels lie in between the tracks of the rear wheels otherwise a heavily ridged area will result, such as that left behind by a train of lorries unexpectedly diverted across a field.

33. The general purpose rubber tyred compactor must have as part of its fundamental design the ability to sink its rubber tyred wheels individually into the unseen rabbit-holes, and this has been achieved by two distinct methods, each commonly used by compaction manufacturing Companies. The first is based upon the simple rule of statics that uniform load distribution develops automatically, when a load is placed at the centre of gravity of three supporting points, and the second upon the simple principle which we all use when riding a bicycle, that if one can maintain a centrally placed load on two wheels without falling over sideways, the wheels will endeavour to carry their equal share of the load.

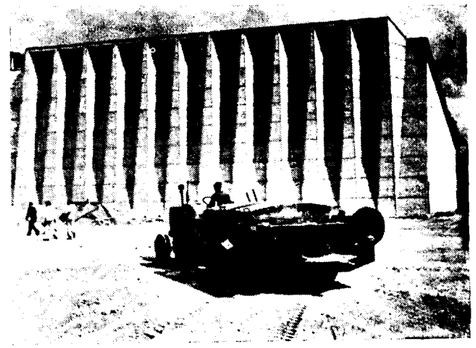
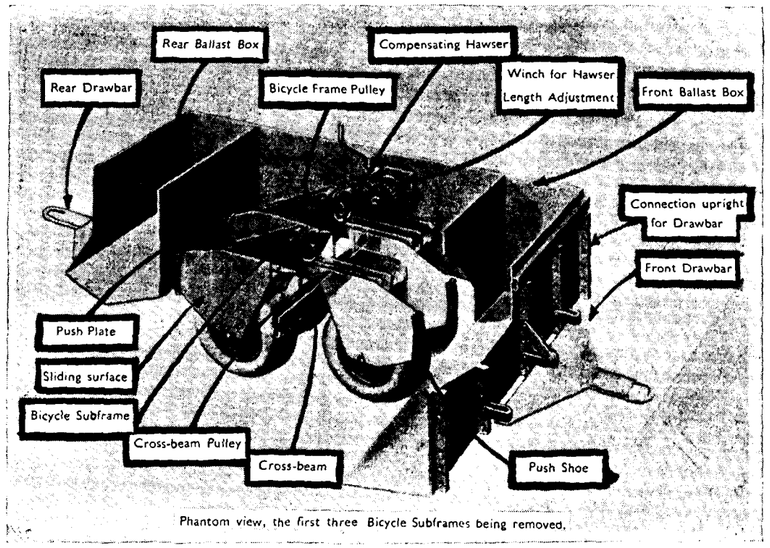


Fig. 10

34. Obviously, the designer of the first isostatic compactor was faced with the problem of how to arrange the rear wheels so that their tracks covered those left behind by the front wheels. A little thought will show that whilst this can be arranged quite easily with a three-wheeled tricycle, trouble starts when the front wheel is replaced by a pair of wheels, as this then necessitates the use of an odd number of wheels at the rear.

35. By the clever expedient of pin-jointing and then splitting the front axle off centre, the designer has been able to introduce a peculiar suspension incorporating three front wheels each partially independent of one another and yet all inter-dependent in operation, and at the rear the even number of four wheels. A typical example is to be seen at work in Figure 8 where a 6 feet wide Isostatic Compactor weighing about 10 tons ballasted, is being towed behind an ordinary agricultural tracter. It is consolidating the earth foundation of a road, and every foot width of soil behind that compactor has been subjected to an equal intensity of pressure by the load from the rubber tyres, by using this special type of suspension. On a machine of this size the load on each tyre can be increased to $1\frac{1}{2}$ tons dead weight, by filling the open hoppers with sand, and from the illustration it will be observed that a fine compacted surface is being achieved.

36. The sketch in Figure 9 shows the simple yet most effective way by which this equal distribution of the load has been achieved. In plan, the three supporting points. A, B & C which the separate axles provide for the vehicle, represent the apices of a triangle, with the centre of gravity of the vehicle divid-



Phantom view, the first three Bicycle Subframes being removed.

Fig. 11

ing the median of this triangle in the ratio of 3 : 4. The asymetrically designed rocking front fork thus carries 3/7th of the total weight of the vehicle, and as each tyre has the load transmitted to it through a pin-joint it transmits to the soil beneath its tread 1/7th of the total weight, irrespective of the load supported. In a similar manner the rear wheels mounted in pairs one on each side of the supporting points, each carry through their pin-joints their 1/7th share of the total weight of the vehicle.

37. As the wheels rock easily on their pin-jointed axles, the tyres ride freely up and down, pressing with the same intensity into the hollows as onto the rises. and as the treads on the back tyres overlap those of the front, they cover together the whole area and leave behind a smooth densely compacted surface, where every square foot of soil has been forced to support the same intense bearing pressure. Once a foundation has withstood such wheels, it can be relied upon easily to withstand the wheel loads of normal, vehicular traffic, the lurking bogey of "pot-holes" becomes a night-mare of the past, and the smooth unblemished surface to be found mile after mile on the modern road, is the direct result of this compaction method.

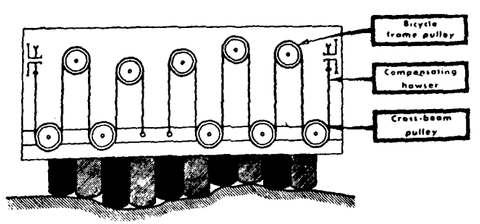


Fig. 12

38. The "Rocking Axle" compactor is essentially a road-maker and in studying the illustrations, it be-

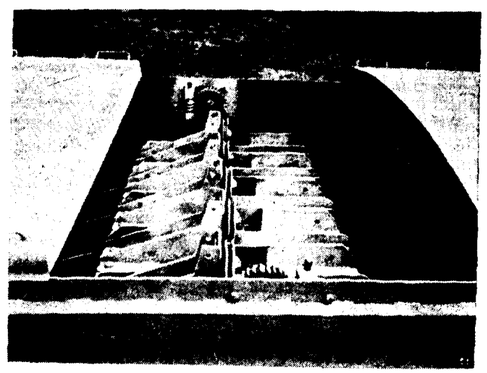


Fig. 13

comes self-evident that this principle is limited in its ability to compensate for uneven ground surface by the amount of movement which is available on the hinged axles. There must be a radical departure in design if a compactor is to be made capable of exerting a constant tyre load with one or more of its wheels for instance, operating at the bottom of a shallow trench. Furthermore, when considering heavier compactors up to say 100 tons dead weight, it is quite conceivable that the unexpected failure of the supporting earth, due to a soft patch coming under one tyre might well displace one wheel to an extent that would throw a vehicle built on any "rocking axle" suspension principle, completely out of equilibrium.

39. The compactor using the "bicycle" principle appears in several forms with single or pairs of rubber tyred wheels compensating one another through levers or ropes or even springs. The design using springs whilst it may be cheaper to manufacture, suffers like the "rocking axle" compactor, from the serious disability that it cannot have any one of its wheels deeply displaced by rough ground, without altering substantially the load which the affected wheel and its neighbours will exert upon the ground, and it is therefore not a "deep-compactor" in the true sense of the word.


Fig. 14

40. A machine using the rope compensating system between pairs of wheels, is illustrated in Figure 10 where a 15 ton Compactor is being hauled over a thick layer of loose back-fill. The method employed in transmitting equal load to the wheels irrespective of their relative positions is shown in the 'phantom view' in Figure 11. The rubber tyred wheels it will be seen, are each arranged in pairs on what might be described as a rather heavily built 'bicycle frame', but with the very important exception that unlike an ordinary bicycle the front and rear wheels are not in line, but are offset from one another, the width of a tyre tread apart.

41. The effect of this overlapping arrangement is clearly illustrated in the diagramatic sketch Figure 12 where the front tyre shaded black, and the rear tyres shaded grey to show their relative positions. The steel plates which form the sides of the 'bicycle frames'

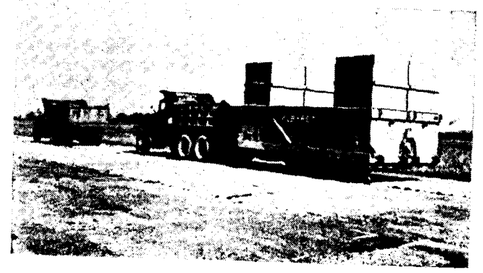


Fig. 15

are free to slide vertically up and down in between the rigid supporting members of the chassis, but they are prevented by these supporting members from any lateral displacement and the wheels cannot therefore roll over sideways.

42. To achieve an evenly distributed bearing pressure on the ground, the load of the Compactor must now be shared equally between this row of bicycle frames, and to do this where the normal bicycle would expect to have a saddle to carry its load, these rather special bicycles have instead, each a grooved pulley. When standing on even ground these raised pulleys are all level and in a row, as can be clearly seen in the photograph Figure 13.

43. Looking again at the 'phantom view' Figure 11, it will be seen that there is a cross beam which holds the supporting members rigid in the chassis, and also that this beam carries low down, a series of grooved pulleys. The pulleys are so proportioned that with the "bicycle frames" standing in position, the grooves of the upper and the lower pulleys correspond exactly vetically up and down.

44. A light steel hawser is now reeved into position from the holes or 'dead-eyes' as they are called, shown near the middle of the beam in Figure 12, outwards to the winches mounted on the inside walls of the chassis. By operating the winches, the slack in the hawser is first taken up and then as the hawser

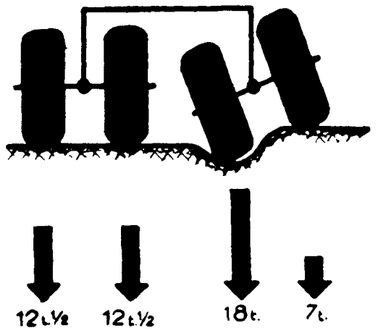


Fig. 16

tightens between the upper and lower pulleys, the whole chassis is hoisted gently onto the backs of the 'bicycle frames'. This winching is continued until the necessary ground clearance has been obtained under the Compactor. It will be observed that as the hawser lies vertically between the upper and lower pulleys, this simple winching procedure has slung the whole load of the Compactor centrally between the pairs of wheels. Each "bicycle frame" whilst it finds itself completely interdependent upon its neighbours, is not by this clever device fixed rigidly in position, but carrying a load slung across its back by a hawser. Thus the front and rear wheel of each bicycle frame are quite free to move up and down about the centre line of the hawser, without disturbing

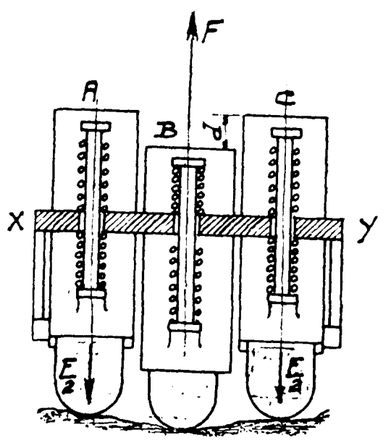


Fig. 17

their share of the vertical weight, which the pulley at the centre of the bicycle frame has to support.

45. A little reflection will reveal the simple fact that no matter in what position the pulleys are standing relative to one another, the steel hawser, is subjected continuously to a tensile load equal to 1/10th the weight of the Compactor. Thus, each "bicycle frame" must carry its 1/5th share and each Rubber Tyred wheel in consequence of its complete freedom to move in the vertical plane, its 1/10th share of the total weight of the Compactor. Again, it will be noticed that there are large ballast boxes fore and aft of the wheels, so that with ten tyres supporting a maximum

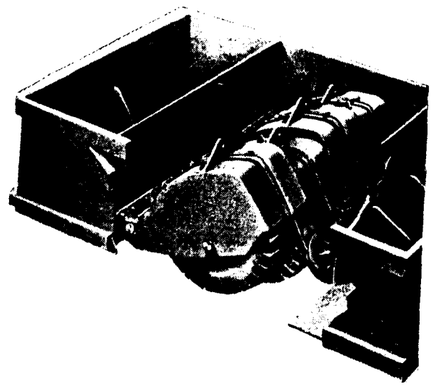


Fig. 18

service weight of 33,000 lbs. an individual tyres load of about 1½ tons can be exerted upon the ground uniformly across a 7 feet width of track.

46. From the point of view of economy, it is instructive to compare the illustration of this 15 ton Rubber Tyred Compactor shown at work in Figure 10, hauled by a 60 HP Tractor, with a smaller 10 ton Sheepsfoot Rollers shown at work in Figure 1, which as stated previously, needs 7 HP per ton for effective haulage.

47. A comparison of Horse Power required to haul different types of Compactors is not however, particularly instructive. The maximum draw-bar is the real, accurate comparison, and here we find that whilst a draw-bar pull in the neighbourhood of 450 lbs. per hauled ton, is quite adequate for a Rubber Tyred Compactor, a draw-bar pull of as much as 700 lbs. per hauled ton is not uncommon with Sheepsfoot Rollers.

48. To account for this considerable disparity in efficiency, one must first visualize the high percentage of energy which a Sheepsfoot Roller has to absorb in just disturbing pre-compacted particles, and in visualizing this we find ourselves brought back again to the fundamental difference between these two divergent techniques—the Old uneconomical method of compaction by penetrating the soil with rows of individual Tampers each having a relatively high point loading,

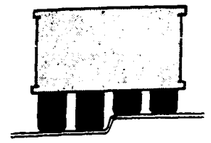


Fig. 19

yet together compacting only scattered points here and there along the way—and the New and more economical method, with modern smooth rolling rubber tyred machines which pass over the top of the soil, and in passing subject the particle of soil beneath the treads of their tyres to an intense, accurately distributed compacting load, right across from one side of the machine to the other, and right along the full length of the way.

Fig. 20

49. Even greater economy can be achieved using heavier machines capable of deep compaction, such as the 50 ton and 100 ton monsters illustrated in Figure 14. These machines support themselves on a single row of heavy duty tyres so placed as to exert a load of anything up to 25 tons dead weight per tyre. Apart from compaction work, such rollers can be used most admirably, for checking the permissable bearing pressures on made up earth where subsidence is suspected, and for testing the bearing capacity of virgin soil.

50. A comparatively new but very important application is the testing of existing Runways to ascertain whether or not they have the safe bearing capacity to receive the heavy planes now in use on International Services. Figure 15 shows a 100 ton Compactor being towed by two lorries up an old war-time landing strip at the Beauvais Airport. By working steadily backwards and forwards across old concrete the Compactor can test every square yard of suspect concrete, and will literally punch great holes through the surface where the concrete and its reinforcement below has rotted or its supporting material has washed away. To see this huge machine slowly roll forward over a hollow patch and then with one or more tyres literally crunch through the surface, like crushing an egg-shell, is to the uninitiate, startling and most impressive.

51. To achieve these intensive bearing pressures, the individual wheels are usually carried in frames held rigid fore and aft, with a hinge at one end and a cable, link, or spring arrangement at the other. It is obviously most important with such heavy machines, that the load, which each wheel exerts upon the ground must be kept within close limits, and a variation of plus or minus 10% is considered the maximum permissable for good practice. By limiting this out of balance a major subsidence can be prevented from occuring under one wheel, and the wheel itself so protected by the design that its tyre does not suddenly find itself subjected to terrific overload, with the whole side of the vehicle trying to rest upon it and push it further into the ground as would otherwise occur. This is a very real danger, and most of us have seen at some time or another a fixed axle vehicle such as a heavy lorry with one wheel sunk into the soft earth, and the whole weight of the lorry and its load, apparently determined to press the offending wheel further and further into the ground.

52. On relatively flat ground a "link" mechanism instead of a fixed axle, can achieve a reasonable balancing effort between the wheels, but as will be seen in studying Figure 16, this becomes quite impractical on uneven ground. In fact as the sketch shows a depression of 10" will produce a very severe overload on the sunken tyre, and in addition a dangerous rolling effect on the side-walls of the tyre, the combined effect of which can soon cause irreparable damage. The "spring" arrangement though quite frequently adopted, is not without serious drawbacks when rough surfaces are encountered, for as will be seen in the

sketch Figure 17, the downward displacement of one wheel creates uneven compression in the supporting springs, which naturally translates back as unequal loads beneath the wheels. This reasoning however, may not be quite as obvious and easy to vizualize as with the "link" mechanism, and a typical case may therefore help to illustrate this point.

53. Suppose on uneven ground the centre wheel of a Spring Mounted Compactor sinks to a depth *d* below its neighbours, then as the yoke XY must remain in equilibrium, a force F will be exerted *upwards* by the yoke XY upon the ballast box B, and a force F/2 must necessarily be exerted *downwards* by the yoke upon the neighbouring ballast boxes A and C. It thus becomes self-evident from the sketch, that the Rubber Tyred wheel under B has now had part of its load relieved, and that this load has been transferred as an extra load to be shared by the wheels at A and C.

54. It follows therefore, with this Spring Mounted design that the equal weight distribution between all wheels which the machine can develop on level ground disappears as the machine roils onto uneven ground. In fact, one must conclude that the efficiency of this design varies in inverse proportion to the unevenness of the ground over which it is being hauled literally touching bottom when one wheel sinks into the ground to a point where the compression spring is sufficiently closed for the wheel to be lifted off the ground by its neighbours.

55. Not only therefore, does this type of Spring Mounting defeat its main object, which is to dispense to the soil over which the machine travels as nearly equal wheel loads as possible, but also it relieves the bearing load on the sunken wheel just where the soil needs its consolidation most i.e. at the suddenly dlscovered patch of weak bearing pressure ; the point in fact where the pot-hole menace will start to develop if the area of weak bearing pressure is passed over. Although an improvement on the Sheepsfoot Roller it is thus apparent that the Spring Mounted Compactor still suffers from one of the serious shortcomings of its predecessor, for it can partially bridge over soft areas of low bearing pressure, and in this one defect the spring design fails to achieve its objective.

56. To counter to some extent the excessive over-loads encountered by those Manufacturers who cling to the link and the spring designs, special tyres such as the Michelin "Metalic" can be obtained, but on construction work often remote from general supplies, any special requirements of this sort are best avoided and instead an effort should be made to keep to the more standard 20 and 24 ply tyres wherever possible.

57. It is partly for this reason, partly because of its simplicity of operation and maintenance, and partly because of its easy adjustment for ground clearance, that the cable tyre suspension is considered pre-eminent. The arrangement in the phantom view Figure 18 shows the single Rubber Tyred wheels in their shrouded steel-covers, and the reeving of the light steel hawser over the back of each corresponding pair of wheels and through the idler pulley in the middle.

58. To repair a tyre in the field or to replace it, the whole rocker member comes out easily through the top of the machine, whilst for adjustment of road clearance, or even adjustment so that one pair of wheels can be used to compact an earth surface above or below the level of the other as shown in the sketch Figure 19 this is done simply by hitching the steel hawser to separate pegs provided along the back of each rocker member.

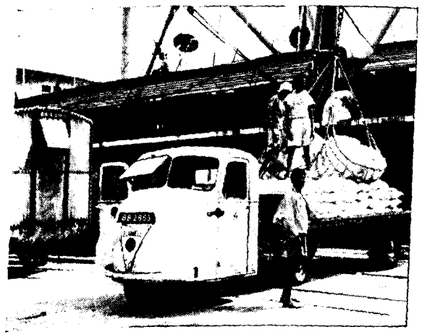
59. A machine such as the 50 ton Compactor, shown in Figure 20 at work on a site in Turkey, will require an 130 HP crawler tractor to haul it, and in terms of cubic feet compacted per hour, such heavy pneumatic tyred rollers stand without equal wherever consolidation of earth is required, for aerodromes, embankments, or on earth dam construction. By comparison with the 5" to 8" thin layer of soil, requiring 6 to 16 passes in the case of surface compactors, we find that these heavy compactors will handle layers of loose back-fill over 2 feet thick, and usually 4 to 8 single passes are sufficient to consolidate.

60. Beyond the range of compaction machinery which is towed behind tractors, there is of course like the common steam and diesel roller which one still sees at work upon the highway repairing road-surfaces, a range of self-propelled Rubber Tyred Compactors using similar methods of suspension to those described above, and more recently hydraulic suspension, and it is hoped to deal with some of these designs and their applications in a subsequent article.

RAILWAYS—ANCILLARY ROAD TRANSPORT

By An Engineering Correspondent

THE Scammell Mechanical Horse is widely used by Railway Authorities both in Great Britain and Overseas for general haulage from railway depots to warehouses and docks and for the distribution of goods to customers in towns. Two types of Scarab are available, the 3 ton and 6 ton unit with petrol or diesel engine for payloads up to about 8 tons. These Mechanical Horse units can be operated with a wide variety of semi-trailers—flat platform, van bodied, machinery carrier etc. The motive units are fitted with Scammell automatic coupling and are extremely manoeuvrable in confined areas as they can turn in less than their own length. One Scarab tractor can run 24 hours a day hauling many different types of load. While one trailer is being hauled another trailer can be loaded or unloaded ready for collection by the Scarab on its return trip. The automatic coupling gear is foolproof in operation and the Scarab can be uncoupled from one trailer and coupled to another in a matter of minutes.



A Scammell Scarab Mechanical Horse and semi-trailer of the Malayan Railways Administration being loaded on a dockside in the Malayan peninsular.

Typical of their use by Overseas Railway Authorities is the fleet operated by the Malayan Railways Administration who are at present using 25 Scammell Scarab Mechanical Horses with 72 6-ton Scammell semi-trailers.

The Scammell SCARAB Mechanical Horse for inner zone Transport

SINCE its inception in 1933 the Scammell Mechanical Horse has become one of the most familiar sights in Urban Districts throughout the world and has long since established an excellent reputation for all-round efficiency and economy. The Scarab motive unit and trailer can turn in less than its own length and can manoeuvre into positions inaccessable to any other type of vehicle. The Scammell automatic coupling gear enables one tractor to operate with multiple trailers, so that the tractor can be constantly working, hauling one trailer while additional trailers are being loaded or unloaded.

With its extreme manoeuvrability, versatility, and interchangeability of trailers, the Scarab provides a swift distributive service unequalled by any other form of road transport.

The outstanding advantages of the Scammell system of instantly and automatically coupled tractor/trailer combinations have been so appreciated both at home and overseas that leading vehicle manufacturers produce specially designed four-wheeled tractor chassis fitted with Scammell coupling gear to enable them to operate with Scammell trailers for hauling loads over greater distance than the economical working radius of the three-wheeled Scarab.

Operators in all fields of transport attest to the outstanding economy and success of the Scammell system. Users can be found in every type of trade, Government Departments, Municipalities and Railways both at home and Overseas. British Railways alone use thousands of Scarab tractors and Scammell instantly coupled trailers.

The Scammell Coupling Gear

Fitted to the front end of the trailer is the Scammell Patented retractable undercarriage. On the tractor frame are two ramps or runways fitted with shock absorbing buffers designed to take the flanged wheels of the trailer portion of the coupling gear. The automatic locking device consists of two steel double claws engaging rollers on the oscillating beam on the trailer turntable. Uncoupling is by a hand lever in the driver's cab. Coupling or uncoupling is of extreme simplicity and can be effected in a few seconds. Action of coupling automatically provides the connection for the trailer rear light and trailer brakes. Note snug and unobtrusive position of trailer jockey wheels when coupled to tractor.

'HUNSLET' BALLAST CLEANING MACHINE

By An Engineering Correspondent

THE Hunslet Engine Co. Ltd., well-known locomotive manufacturers of Leeds, have recently supplied to British Railways, North Eastern Region, a six-foot and shoulder ballast cleaning machine.

The 'Hunslet' ballast cleaning machine ensures efficient drainage through the ballast with the minimum of line occupation. When working it cleans the ballast in the shoulder and the six-foot at operating speeds up to 600 yards per hour, during which time it can deal with 300 tons of stone ballast. It is a self-propelled vehicle capable of travelling from stabling point to working site under its own power.

If the shoulder only is being cleaned, free passage is afforded for trains on the adjacent road of a double track line. Route availability is high as the machine is designed to a 20 ton axle load and in accordance with British Railways' Ll loading gauge.

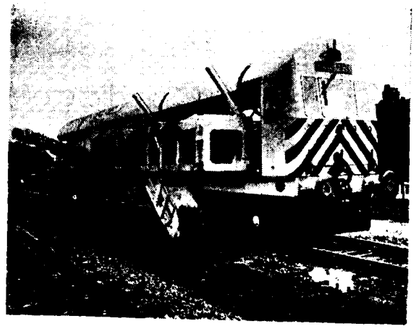
It is not intended to clean underneath the track as the provision of thoroughly clean ballast at both ends of the sleepers permits drainage of rain water throughout the road-bed to cleanse the centre section.

The vehicle is powered by a Rolls Royce type C6TFL diesel engine developing 208 b. h. p. at 1800 r. p. m. at the continuous rating. It drives four Deri-Sine duplex hydraulic pumps through a toothed belt and 'Hunslet' gearbox.

Two digging heads are provided, one on each side of the machine. Each is individually controlled for speed of digging, depth of cut etc., and is completely retractable by means of hydraulic rams within the body of the machine for travelling. The digging belts are each driven by an hydraulic motor and are fitted with easily removable, hardened steel picks or tines. The ballast is carried on the digging belts and deposited on conveyors which transfer it to the screens.

Double-deck, vibrating screens of dry type are provided having a mesh suitable for 2"—¾" ballast. They are divided by a centre plate to provide independent screening for the left and right hand digging heads. From the screens the cleaned ballast gravitates to chutes on either side of the vehicle and is returned to the track. The dirt is carried away by disposal conveyors.

All the conveyors are of 24" wide troughed belting driven by hydraulic motors. Two dirt disposal



'Hunslet' Six-Foot and shoulder Ballast Cleaning Machine.

(Photograph by kind permission of North Eastern Region, British Railways.)

conveyors are provided. The second of these can be rotated to deposit soil to the rear or to either side of the machine. This conveyor is retractable to within the body of the vehicle for travelling.

The bogies are designed in accordance with British Railways' practice and employ standard components. The leading bogie is driven by means of an 80 h. p. hydraulic motor and two speed, epicyclic gearbox. Hydraulic braking is provided on all wheels while a screw type handbrake operates on the four wheels of the leading bogie.

LEADING PARTICULARS

Length over buffers	65′ 2″

Distance between bogie centres*	47′ 3″
Fixed wheelbase	8′ 0″
Overall width, when travelling	8′ 1½″
Overall width, with both digging heads working.	15′ 2″
Overall height above rail level	12′ 11¼″
Weight in working order (approximately)	65 tons.
Maximum axle load	20 tons.
Maximum travelling speed	20 m. p. h.
Maximum working speed	600 yds/hr.
Cleaning capacity per hour (stone ballast)	300 tons.
Width of trench	24″
Depth of trench (maximum)	15″

* The dimensions of the body bring the vehicle within the Ll loading gauge on curves down to six chains radius.

The Hunslet Engine Company are pleased to acknowledge the assistance and co-operation of British Railways, North Eastern Region, in the development of this machine.

Thermoelectric Refrigerators made on Commercial Basis

The first thermoelectric refrigerator freezing units to be produced on a commercial basis have been built by the Norge Division of the Borge-Warner Corporation in the United States. Five hundred of them were built for installation in the 500 rooms of a new hotel in Chicago.

By using the thermoelectric principle, heat or cold can be generated directly from electricity without the use of any refrigerant gas or moving parts. The new thermoelectric refrigerator-freezers have no compressors or other moving parts. This means that they should require almost no repair or maintenance, the Norge Company says.

The company said that the new refrigerators will not be made for homes for another three to five years. They will, however, be made in increasing quantities for hotels, hospitals, doctors' offices, and similar establishments, it added.

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

THE SURI-TRANSMISSION

MR. M. M. SURI

It has been repeatedly stressed that strict secrecy and speed of development are the essence of commercial success, till an invention is proved. For this reason, in spite of the fact that great efforts have been afoot for over three years, hardly a word has been spoken to reveal the art or science of the Suri-Transmission. Somewhat of a mystery has surrounded the transmission ever since the Chairman Railway Board, Mr. Karnail Singh, announced its merits publicly. A great volume of enquiries have piled up. Time has come to answer some of these.

Effort has been made to briefly put across in the write-up that appears on next page, the general principles of construction and operation of the Suri-Transmission. The matter revealed is just sufficient for any engineer to grasp the fundamentals and know the advantages of the Suri-Transmission. Experts would want to know much more, the manner of superimposition of the diesel engine characteristics, actual test results with figures, measured cushioning at changeover, and a horde of other relevant data. To them, at this stage, I can only offer my apologies. Our associates, Messrs. Maschinenbau Kiel (MaK) desire some more time to lapse, some more range of horse powers to be covered (2000 h.p.), before data collected from bench tests and service trials is made public.

But I sincerely trust that the following pages answer a great many questions and satisfy a large measure of technical curiosity.

M. M. Suri

THE SURI-TRANSMISSION

By M. M. Suri
Jt. Director (Diesels)

A BRIEF DESCRIPTION

THE Suri-Transmission, in its latest form, provides simple but highly efficient means for transmitting power in diesel rail traction units. It employs only two circuits, a Brockhouse type of convertor–coupling, and a fluid-mechanical-coupling. The two are arranged in parallel. The convertor-coupling can be arranged, according to particular needs of actual service, to cover the vehicle speed range from zero to 60—70% road speed. The fluid-mechanical-coupling comes into function from that speed onwards upto 100% vehicle speed.

A judicious superimposition of diesel engine characteristics obtained by 'reverse governing' upon the Brokehouse convertor–coupling and the fluid-mechanical-coupling, makes the Suri-Transmission a very satisfactory means for universal application to rail traction. In the larger horsepowered vehicles, e. g. 400 to 2000 h. p. and above, advantages of the Suri-Transmission summarised below are of even greater interest—

SURI; TRANSMISSION
(AS BUILT BY Mak.)

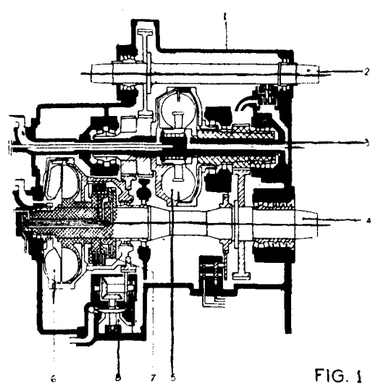


FIG. 1

1 HOUSING
2 INPUT SHAFT
3 CONVERTOR REACTION SHAFT
4 OUTPUT SHAFT
5. BROCKHOUSE TORQUE CONVERTOR
6. FLUID SYNCHRONISER
7. PLATE CLUTCH
8 OIL PUMP

(i) Because of two circuits only, the construction is simple, compact and robust, low in weight and in price.

(ii) Using a convertor-coupling, the need for automatic changeover is obviated, simplifying control systems, primary and secondary. Manual control over circuit changeover is provided enabling good drivers to effect maximum amount of saving in fuel. The transmission is inherently fool-proof against mismanipulation, and indifferent or poor driving cannot result in overall operational efficiencies any worse than those obtained with the best automatic transmission circuit changeover governors, even when the governors are fitted with load-speed correction mechanisms.

(iii) The circuit changeover from the convertor-coupling to the fluid-mechanical-coupling occurs under full load and power of the diesel engine, without shock, and without interruption at any stage of tractive effort of the vehicle.

(iv) The losses inside the transmission are a minimum, and both the hydraulic as well as the mechanical circuits yield optimum efficiencies in their respective ranges (Fig. 2).

(v) The part-load efficiencies in the convertor-coupling are exceptionally high for which reason this transmission is ideally suited for shunting purposes.

(vi) Because of highest attainable efficiencies available from the mechanical line of transmission, which can be engaged from 50—70% road-speed onwards, this transmission is ideally suited for mainline service.

(vii) An added gain of the order of 1 to 2% in the overall efficiency of the locomotive accrues from operation in the purely mechanical line of transmission. All Electric and Hydraulic transmissions require power for dissipating the heat generated inside the transmission system. The mechanical line when engaged requires no cooling. In fact, advantage can be taken of this to relieve even the engine cooling circuit to some extent, by providing a heat exchanger between the transmission oil and the radiator water. This makes effective use of the radiation capacity of the transmission housing when running in the mechanical gear. This feature is of real interest to Railways of tropical countries.

The exploitation of 'reverse-governing' technique using the 'Suri-Governor' on diesel engines developed in collaboration with Messrs. Maybach Motorenbau has played an important role in the success of this transmission and in its universal applicability. The use of the Brockhouse convertor-coupling, specially developed for use in the Suri-Transmission, also marks an important advancement in the technique of obtaining higher traction efficiencies for locomotion.

In rail traction the cost of fuel on any large Railway System of the world, generally represent the single largest item of expenditure. On the Indian Railways, for example, fuel costs amount roughly to 14% of the total operating expenses of the Railway.

A close study, especially on Indian Railways, reveals that 80—90% of the total fuel consumption takes place between the speed range of 70—90% designed speed of the Motive Power Vehicle—the locomotive or multiple unit high horsepowered railcars etc. It is, therefore, of the greatest important that the efficiency of transmission in this operating range of the rail-vehicle should be the highest attainable.

It is known that the highest possible efficiency between the input and the output shafts of a transmission can be achieved only through pure mechanical means. Whenever means such as, electrical, hydro-dynamic, and hydrostatic are used, losses of energy occur in conversion of mechanical energy of the input shaft to electric, hydro-dynamic or hydrostatic energy and losses occur once again in reconversion of this back to mechanical energy at the output shaft. These losses at both conversions are inherent and inescapable unless the input and the output shafts are mechanically and directly brought together with rigid coupling means. Energy is then transmitted from the input to the output shaft without any losses.

SURI-TRANSMISSION
CHARACTERISTIC CURVES

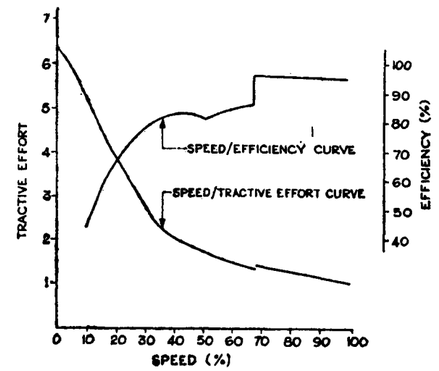


Fig. 2

While with existing electric transmission, efficiency of transmission at rail of the order of 85% is achieved; and with hydrostatic or hydro-dynamic (convertor types) approximately 80—82% is achieved; and with hydro-dynamic (coupling types) approximately 90% is achieved; with a pure mechanical transmission a total efficiency of transmission unit at rail of approximately 95% can be demonstrated on a locomotive. It is, therefore, possible to save fuel costs to the extent of 5—10% by adoption of pure mechanical transmissions in preference to other rail traction transmissions.

Although the advantages of higher efficiencies of mechanical transmissions have been well-known, their applications on rail traction units have been limited to units of a maximum of 400—500 h.p. Application to larger units presents some basic difficulties more particularly in the case of rail traction.

A popular mode of coupling mechanically is by way of a plate clutch. The limitations of a clutch are readily understood. For example, when a train is picking up speed, at the point of changeover from one line of transmission with higher gear ratio to another line of transmission, the input shaft and the output shaft to be coupled by the clutch are moving at different speeds. Thus when the two shafts are suddenly coupled, considerable momentum will have

to be destroyed of all the primary members, shafts, gears, diesel engine etc., which are connected to the input shaft, in order to bring down the speed of the input shaft and synchronise it with the speed of the output shaft through the clutch. The shock load generated through change of momentum is inversely proportional to the time taken to effect the change. Therefore, if the clutch closes suddenly effecting coupling in an instant, the resultant high shock load, especially in cases of higher horsepower vehicles, tends to damage the transmission parts as well as the diesel engine. On the other hand, if the transition time is allowed to be larger and shock loading limited, as by permitting a progressively decreasing slip between the plates of a clutch till synchronisation is achieved, the plates of the clutch are subjected to considerable wear necessitating frequent replacement. This is not acceptable in present-day rail traction because of the fact that Electric and Hydraulic transmissions now in use have already reached a stage in their development where in spite of intensive use, frequent attention is unnecessary and parts do not wear, or require renewal, for periods of a few years at a stretch.

One means employed in the case of mechanical transmission to obviate these difficulties is through interruption of power from the engine when changing from one to another line of transmission. This is the case with automobiles or light railcars. In heavy duty rail traction, where the trailing weight is high compared to installed horsepower, this interruption of power is infavourably viewed. When a train is accelerating, especially on a gradient, and the speed has been achieved where a change of gear is required, any interruption of power instantly slows down the train. A continuity of tractive effort is most desirable for rail traction right through from zero to 100% road-speed. During the operation of changing from one to another line of transmission, especially in case of the mechanical line of transmission of known designs, care has to be exercised to put back the throttle of the diesel engine. Otherwise, during the momentary total sudden offloading of the engine when one line is disengaged, and before the mechanical line can be engaged, the diesel engine and all primary components of the transmission would shoot up in speed further aggravating the difficulties faced in engaging of the complimentary parts of the mechanical coupling. For this reason also, an interruption of transmission of torque has been found unavoidable in existing mechanical transmissions.

The types of mechanical couplings used in Rail Traction today are either friction plate clutches, claw

FLUID-MECHANICAL COUPLING CHARACTERISTICS.

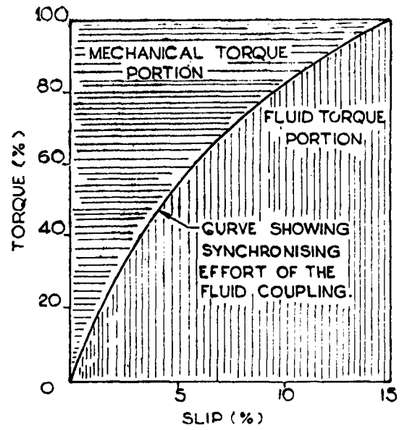


Fig. 3

clutches, or band-brake-type with epicyclic gearing. All these known methods achieve high efficiency of transmission, but result in disadvantages mentioned above which limit their use to low horsepower vehicles only.

The Suri-Transmission makes use of a fluid-mechanical-coupling wherein the mechanical-coupling housing provides within it, a small and inefficient fluid coupling (with high slip). This fluid-mechanical-coupling is arranged parallelly to a Brockhouse convertor. The operation of the whole transmission unit, its controls as well as the detailed features of designs of the different individual components in combination result in a transmission unit which successfully overcome the problems enumerated above.

The transmission as applied to a 650 h.p. Shunter is outlined in Fig. 1. The gear ratios selected are such that the torque convertor when filled accelerates the vehicle to approximately 70% maximum speed with the diesel engine running at full power and at full speed. The direct mechanical line is arranged to cover 70% to 100% speed. Fig 2 shows Tractive Effort/Speed Curve.

At start the torque convertor is filled with fluid while the direct mechanical line is kept fully disengaged till the time the vehicle speed reaches 70%. At this

time the two complimentary parts of the mechanical coupling are running at different speeds, the primary part attached to the engine is running at 100% speed while the secondary part attached to the output shaft is running only at 70% speed. To change from torque convertor circuit to the mechanical line, the flow of fluid to the torque convertor is diverted to the mechanical coupling which houses a high slip small size fluid-coupling, e.g. with a slip of 15% or so. As is well-known a fluid coupling with this high slip is, in size and in weight, much smaller than the conventional traction coupling for rail traction which has a slip of the order of 4—6%. It would be readily appreciated that a 15% slip coupling is very soft in its action and, therefore, when fluid is filled into this coupling its engagement is gradual, cushioning the shock to primary and secondary parts.

The use of this small coupling, characterised by unusually high slip, solves the following problems immediately for rail traction :—

(i) The size of the coupling and its weight, and hence the weight of the transmission unit is reduced. The simplicity and compactness of design are important for rail traction transmissions.

(ii) The changeover from the torque convertor to the fluid coupling even when carried out within a minimum of time, does not shock load the components of the transmission. With this arrangement, there is no need to effect interruption of torque. The change is carried out with the engine running at full power and speed.

(iii) Because the fluid coupling acts softy due to its high slip, it is not important that the torque convertor be emptied instantly and the coupling filled slowly in order to avoid the two circuits with different gear ratios working in opposition to each other. In the Suri-Transmission, no elaborate mechanisms are required, nor any exacting time controls, for filling and emptying of the two circuits because the risk of damage due to the two circuits remaining filled simultaneously and working in opposition to each other is very much reduced by the use of this unusually soft coupling.

(iv) This feature of overlap of circuits resolves the problem of sudden offloading of diesel engine and the tendency to suddenly shoot up in speed at a gear change—a difficulty experienced in most cases on known transmissions. The engine is never offloaded because before the first circuit, i. e. the torque convertor has fully disengaged, the fluid coupling has already come into function and taken the load of the engine.

It can be seen that without taking recourse to any elaborate control mechanism of filling and emptying of the various circuits, or providing the diesel engine with super-sensitive and exacting governor controls, the change from one line to the other takes place with smoothness, with continuity of torque, and with the engine under complete control, simply by deploying the high slip of a small and inefficient fluid coupling in the transition stage. At this stage the torque convertor has been emptied and the high slip coupling filled. The engine speed has dropped to 85% with the vehicle still at 70% speed. This in effect means that partial synchronisation has already taken place between the two complimentary parts of the mechanical coupling. It is no longer necessary to engage the plate clutch too instantaneously or very slowly in order to avoid wear to clutch plates or prevent shock loading because,

(i) Partial synchronisation has reduced the difference between the input and output shafts to 15% and therefore, relative slip is now much less ;

(ii) At higher relative speed difference between input and output shafts, the co-efficient of friction is lower necessitating higher coupling force, which leads to much higher heat generation and excessive wear of plates. Partial synchronisation in itself results in prolonging the life of clutch plates to the desired minimum in rail-traction ;

(iii) When the clutch plates are being engaged, full torque is already being transmitted through the fluid part of the fluid-mechanical-coupling and the clutch plates are only acting in addition. The fluid part is helping actively throughout while the clutch plates are progressively taking over. The results of this technique of parallel working of fluid and mechanical coupling are extraordinarily interesting. When the torque splits through two channels i.e. hydraulic and the clutch plates, the torque through the fluid part of the coupling is

progressively reduced. Immediately that happens, as shown in Fig. 3, the slip of the fluid coupling reduces in accordance with well-known fluid dynamic principles. As more and more torque is transmitted through the plate clutch and less and less through the fluid, the fluid acts more and more severely to synchronise the input and the output shaft speeds. Thus a high slip coupling initially acts as a partial synchroniser and then in combination with a plate clutch it aids total synchronisation upto the moment of complete engagement.

(iv) Results have shown that the engagement of the plate clutch in this manner does not cause any shock to the transmission and the engagement is hardly felt on a locomotive.

It is, therefore, a feature of extraordinary interest in the Suri-Transmission that an inefficient high slip coupling, which by itself would be an unacceptable component in a rail traction transmission, and a simple plate clutch which also is an unacceptable mode of coupling in a rail transmission of high horsepower, nevertheless, when combined to act in the manner explained, results in a very satisfactory transmission unit characterised by its exceptionally high efficiency, by delivery of uninterrupted torque from zero to full speed, and by smooth changeover from fluid to the mechanical circuit and vice-versa. To a railwayman, this means savings in fuel costs and case of operation, both for shunting as well as for mainline operation.

BRITISH LEAD IN RAILWAY ELECTRIFICATION

British engineers and manufacturers who have been working on new railway electrification projects have gained experience which has given them a lead in this form of engineering, said the chairman of the British Transport Commission, Sir Brian Robertson, addressing the Institution of Locomotive Engineers in London. Manufacturers, he said, had learnt and discovered things which had been unknown before.

Sir Brian, who was lecturing on "The Locomotive of the Future", reiterated both his faith in the future of British Railways and in the skill, efficiency, and integrity of British industry. He said traffic conditions on British Railways were probably more exacting than on any other railway in the world, "and equipment which will stand up to them has passed the sternest test".

When British Railways embarked upon their modernization plan, "the members of the British Transport Commission shared the considerable apprehension about the reliability of high-powered main-line Diesel locomotives", said Sir Brian. "Our only experience to date had been rather uncomfortable, and we were aware that railways in other countries had encountered a considerable amount of trouble when they first embarked on the plan of Dieselization.

CONFIDENCE JUSTIFIED

"I am glad to be able to say now that our decision to have confidence in British engineers and manufacturers to turn out locomotives that would not involve us in a sea of troubles has been justified. The standard of performance of our main-line Diesel locomotives, taken as a whole, does them much credit".

Sir Brian thought it could be justly claimed that the design panel set up by the British Transport Commission had fully justified its existence, "and that the appearance of our new locomotives and rolling-stock gives witness to the effectiveness of its efforts".

Speaking of electrification, Sir Brian said that British Railways had adopted the 50-cycle, 25 kV, alternating current (AC) system after careful thought. It was possible to argue that a direct current system of lower voltage would have been quicker and easier. "In spite of this, I am satisfied that the decision taken was a right one, and certainly the AC system is practically the only one which is saleable today in the export market."

*** *** ***

"DEODORANT" FOR DIESEL FUMES

A Diesel "deodorant" which neutralizes Diesel fumes and produces, instead, "an aroma of ice-cream soda" has been developed by a British firm specializing in oil additives and engine testing equipment. The firm believes that the new development can put an end to the present obnoxious smell of Diesel fumes from exhausts of road, rail, and water traffic using the oils.

The Ventilation and Heating of Diesel Railcars

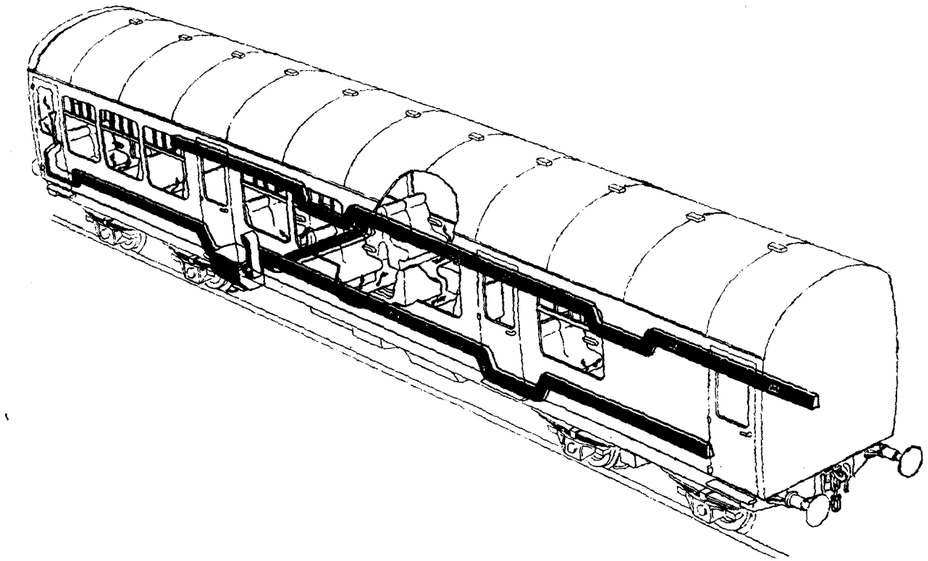
THE most modern method of ventilating and heating of diesel railcars is by a system of ducting, incorporated in the railcar and connected to a Dragonair DVLA80 Heating and Ventilating Unit. These units, designed and manufactured by a Portsmouth Company in the United Kingdom, are in use by British Railways and have proved very efficient in providing comfortable travelling conditions both in winter and in summer.

Heating is fully automatic when the heat switch is selected, the maintenance of correct temperature conditions being controlled by thermostats situated in the coaches. The supply of warm air is immediate, thereby being no delay as with such methods as steam and hot water heating systems.

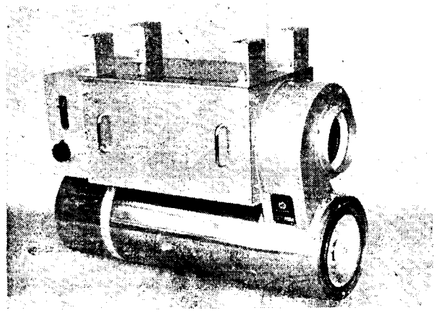
When ventilation is required without heat, the switch is moved to the 'vent' position and the fan operates, blowing unheated fresh air through the ducting in the coach.

The Dragonair automatic air heating and ventilating unit consists basically of a heat exchanger and oil burner and fan, operating on the direct-to-air heat exchange principle. Air drawn in by the fan is forced over the exterior of the heat exchanger which is heated from the inside by the burner, thus keeping the heated air separate from combustion gases and ensuring that only clean fumeless air enters the coaches.

The unit is strongly constructed of the highest quality materials and is designed for the minimum of easy servicing and incorporates automatic safety devices against flame failure and overheating. Both heat exchanger and burner are made of heavy gauge, heat resisting, stainless steel and their high efficiency is the result of long development and experience in air heating applications. The centrifugal fan incorporated in the DVLA80 is electrically driven and has a forward curved multi-vane impeller to combine quietness with optimum performance. Fuel ignition is by high voltage spark from a booster coil and the fuel system is complete with pump, fuel filter and solenoid valve. An orifice is also fitted, integral with the pump, which varies the fuel flow to the burner at different pump speeds. As both pump and fan impeller are directly driven from the motor, the air/fuel ratio for combus-



Typical Heater Installation for Diesel Rail Car.



The Dragonair DVLA.80
Ventilating and Heating Unit

tion is maintained (within the required range) for varying motor speeds between 20 and 31 volts D. C.

A control box is fitted to each heater unit and a Local Control Panel is supplied for mounting in each coach. A Guards' Control Panel is also available for 'through-train control' for each train set.

Through-train control enables any number of heaters to be operated simultaneously from one control point (i.e. Guards' Control Panel). The heater units can be operated for either heating or ventilating only by this method.

If required, individual heaters may be operated from their Local Control Panels.

In the unlikely event of flame failure or overheating conditions occurring the appropriate warning lights will come on and the heater(s) will switch off to relight automatically when normal temperature conditions are restored.

SPECIFICATION

Heater Output	Maximum 100,000 B.T.U/Hr. Rated 80,000 B.T.U./Hr. Minimum 35,000 B.T.U./Hr.
Fuel Consumption	0.65 galls/hr. @ rated output
Heated Air Temperature Rise	120°F @ rated output
Air Flow	600 cubic ft. per minute
Fuel	Gas Oil/Diesel Oil 35/45 secs. Redwood No. 1
Electric Motor	Ventilated, compound wound, ½ h p. 28 volts D.C. 2,800 r.p.m.
Flame Failure Protection	Integral Switch
Overheat Protection	Duct Thermostat
Overall Dimensions	Width 13.25 ins. Length 33.75 ins. Height 26.375 ins. (over mounting brackets) Weight 200 lbs.

Thermocouple Pyrometers with Indicators

The Indian Standards Institution has prepared draft specification for Thermocouple Pyrometers with Indicators covering requirements and tests for thermocouple pyrometers where the indication of temperature is done by a millivolt meter. This draft also gives reference tables for junction temperature and voltage for platinum-platinum, chromel-alumel, iron-constantan and copper-constantan.

Thermocouple pyrometers are being widely used in connection with the temperature measurements for obtaining energy balances in all thermal processes, particularly those involving combustion and heat transfer, and also in carrying out tests.

* * *

LEAD SHEET

The Indian Standard Specification for Lead Sheet which was first published in 1952 covering the requirements of lead sheets other than those used for chemical purposes, has now been revised so as to incorporate the requirements for lead sheets for general and chemical purposes.

In view of the decision of the Government of India to changeover to the metric system of weights and measures, the metric sizes for lead sheets have been included in this standard, along with non-metric sizes to which the industry is accustomed.

* * *

Henschel DH-1420 Locomotives for the South African Railways

THE first diesel locomotives of the South African Railways (S. A. R.) were commissioned in 1958. To enable the S. A. R. to form their own opinion on the respective merits of diesel-electric and diesel-hydraulic operation under the specific working conditions encountered, they ordered diesel-electric locomotives from America and diesel-hydraulic locomotives of equal power from us. The diesel power totals 1,420 b. h. p. The Henschel diesel-hydraulic locomotives were each equipped with two General Motors six-cylinder 6-567. C engines and Voith type L. 306 r drives. The wheel arrangement is B-B, and each bogie is separately driven by its own engine through the hydraulic transmission.

The locomtives are working in the Johannesburg area, the largest and richest district in southern Africa, where live most of the millionaires of the vast gold, uranium and coal mines in the Union of South Africa. In this highly industrialized area, our locomotives have the task of handling freight traffic on lines used to full capacity at a speed and flexibility superior to that of the steam locomotives hitherto used.

All diesel locomotives have been provided with multiple-unit controls so that up to three locomotives can be coupled to form a single motive-power unit able to meet, without difficulty, even the most exacting requirements of the S. A. R. in regard to tractive effort. With this type of working, the diesel locomotives are superior to steam locomotives also in regard to saving in labour. Whilst, with multi-headed steam-hauled trains, each of the steam locomotives must be manned, the manning of diesel locomotives can be confined to the leading locomotive, where the driver is able, by means of the multiple-unit control system, to control and supervise the following locomotives as well. The fireman of the steam locomotive, who is required to carry out heavy physical labour, is superseded by the driver's mate of the diesel locomotive who is merely required, for safety reasons, to watch the signals.

Experience has shown that the best results can be obtained by running double-headed trains. Locomotives coupled in pairs are now operated from Germiston (Transvaal) shed, which also serves as locomotive maintenance and repair shop, on the main lines from Johannesburg to the capital, Pretoria, and also from Johannesburg to the port of Durban, Natal. From marshalling yards in the vicinity, these locomotives usually haul long trains of empty wagons to the mining district around Kroonstadt and Witbank in the south, from which they return with heavy laden ore and coal trains to the Johannesburg area. Such trips occupy a maximum period of 24 hours. The locomotives must not stay away from the shed for much longer, as this is their only refuelling point, and their operating range would otherwise be exceeded.

Some of these locomotives are also used for heavy shunting duties, for which they have also been found excellently suited.

Both during shunting and during the hauling of heavy trains on lines with sharp curves and steep gradients, the high adhesion coefficient of diesel-hydraulic locomotives is of particular benefit. At starting and at low speeds, the tractive effort of these locomotives can exceed the adhesion power so that wheel slip is possible. With the diesel-hydraulic locomotives, however, where the two axles of each bogie are coupled by cardan shafts and where a smooth start is ensured by the Voith starting converters, the risk of wheel slip is much lower than with diesel-electric locomotives where each axle is driven separately so that it is much more liable to slip.

When a diesel locomotive hauling maximum load is working at low speed, where trasmission efficiency is still low, a large quantity of heat is engendered. With the diesel-hydraulic locomotives, this heat is contained in the oil of the hydraulic drive and can be removed easily by heat-exchangers built into the cooling system of the engine. With diesel-electric locomotives, however, this heat appears at the traction motors, and its removal by means of blowers is more difficult, with the result that the minimum permissible continuous speed is higher. Whilst our locomotives can be worked, without misgivings, at a minimum continuous speed of 6 m. p. h., the

corresponding minimum speed of comparable diesel-electric locomotives is 10 to 11 m. p. h.

Trial runs have also confirmed the very favourable acceleration characteristics predicted by Henschel, emphasizing the advantages of the diesel-hydraulic over the diesel-electric locomotives especially in the types of workings here encountered.

If diesel-hydraulic locomotives of this power class had to be re-designed to-day, they would be equipped with a Voith drive able to transmit the full locomotive power which, for lack of such powerful drives, was not possible at the time when the locomotives were ordered. With such a design, the central output shaft of the fluid drive would be connected by cardan shafts with both bogies, where the axle drives would likewise be coupled by cardan shafts. This would result in all four axles being coupled, so that the adhesion coefficient would be even more favourable. This design would also bring about a considerable reduction in maintenance work as only half the number of oil and water level check points and lubricating points would be needed.

Occasionally, our diesel locomotives have been used on electrified lines as they are, in the event of a power failure, available as quickly as the fire brigade. In this way, the electrified Johannesburg suburban services, which carry the heavy commuter traffic from the dormitory areas in the ourtskirts to the industrial centres of the town and are thus of special importance to South African economy at large, have repeatedly been maintained without difficulties or delays in the event of engineering works on the line or electric power trouble.

LARGE EUROPEAN DIESEL HYDRAULICS

The steadily increasing use of large diesel-hydraulic locomotives has been a striking feature in railway traction in 1959/60. This fact is clearly demonstrated by the following figures :

At the beginning of 1961 there were in service, or under construction for service, in Europe a total of 390 diesel-hydraulic line-service locomotives over the power range from 1,600 to 4,000 b.h.p., plus six further 4,000 b.h.p. locomotives for operation on the Southern Pacific and Denver, Rio Grande Western Railroads in the U.S.A. Of the total of 396 locomotives eight were of 4,000 b.h.p., 79 were of 2,700 to 3,000 b.h.p., 169 were of 2,200/2,300 b.h.p., and 21 were of 1,900 to 2,100 b.h.p. The remainder, 119, were of 1,600 to 1,750 b.h.p. Of these 396 locomotives, all except 27 had diesel engines running at 1,500 to 1,550 r.p.m., and 8 of the 27 had engines running at 1,400 r.p.m. Of the 396 locomotives a total of 300 had Maybach engines, and the remaining 96 were spread over six other makes. Mekydro transmission was fitted to 186 of the locomotives; a similar proportion was found among the largest powers, for of the 396 locomotives 191 were fitted with engines of 1,350 b.h.p. or more individual output, and of these 97 were equipped with Mekydro transmission. From 1,100 to 1,550 b.h.p. there were another 472 single-unit line-service diesel-hydraulic locomotives at work or under construction, and of these about 450 had 1,500-r.p.m. engines, 170 of them with Maybach engines and the remainder divided over eight different makes.

*** *** ***

A. C. ELECTRICITY METERS

With a wiew to bringing the existing Indian Standard for A.C. Electricity Meters (IS : 722–1955) in line with the latest developments in the meter manufacture as well as effecting changeover to metric system, the Indian Standards Institution has prepared a draft revision in two parts. Part I of the draft covers the general requirements of all types of A.C. electricity meters of induction type, and part II relates to specific requirements applicable to single-phase 2-wire meters. The second part also contains instructions for handling the meters for preventing damage to the working surfaces of pivots and jewels as well as for mounting the meter in an appropriate manner.

The draft standard will shortly be put into wide circulation to all interests concerned for eliciting their comments which will be taken into consideration before finalizing the draft as an Indian Standard.

ELECTRIFIED RAILWAYS OF THE USSR

By E. Khrakovsky
Engineer

THE Soviet Union is a land of boundless expanses. Its rapidly developing economy calls for a continuous growth of freight turnover. The main task now confronting Soviet railwaymen is to transport greater quantities of freight and passengers, delivering them as rapidly as possible to the points of destination. This task is being solved on the basis of a radical reconstruction of railways and their equipment. In this process the *main stress* is being laid on replacing obsolete steam locomotives with modern diesel locomotives and electric locomotives, as well as on implementing on a broad scale automation, remote control, and electronic computing machines.

As to the rates of electrification of railways and the length of railway lines provided with electric traction, the Soviet Union is far ahead of all other countries of the world. By the beginning of 1961, the Soviet Union had already electrified almost 14,000 km. of its railway trunk lines. Any that is much more than the total length of electrified railways of the United States, Britain and France combined. In the year 1960 alone, electric locomotives pulled trains along new electrified sections with a total length of more than 2,100 km.

WORLD'S LONGEST ELECTRIFIED RAILWAY

In the Soviet Union electric traction is introduced, instead of in small separate sectors, on whole lines stretching for thousands of kilometres. Only recently a new electrified railway connecting Moscow with the Donets coal basin has been put in operation. Work is nearing completion on the reconstruction of the Western part of the great Trans-Siberian railway, and by autumn of this year electric locomotives will speed along it, pulling trains on the Moscow-Baikal line which is more than 5,000 km long. This will be the longest heavy traffic electrified railway on our planet.

More than 200,000 reinforced concrete and metal support masts have been installed on this line. The builders have also constructed here hundreds of traction substations, reconstructed dozens of old steam locomotive roundhouses and erected a great many of other important structures.

Soviet enterprises have produced powerful electric locomotives for this line.

EFFICIENCY OF ELECTRIFICATION

The electrification of railways is connected with a great expenditure means and tremendous labour effort. Yet, the effect produced by it is really remarkable! When electric locomotives take the place of steam locomotives they can transport on the same railway line twice more freight at considerably greater speed. For instance, on the Trans-Siberiam line, which is serviced now by electric locomotives, freight trains from Moscow reach Irkutsk three days earlier. Not so long ago, on a sector with steep upgrades near the city of Krasnoyarsk two steam locomotives had a hard time pulling a 2,500-ton train. And right now a single locomotive on the same sector pulls a 3,000-ton train twice faster and with less effort.

Moreover, it should not be forgotten that electric locomotives are much more economical than steam locomotives, and their efficiency is four-five times greater. This means that, with the introduction of electric traction, it becomes possible to save vast

Alternating current electric locomotive on the Ozherelye-Pavelets line.

quantities of fuel which was formerly consumed by steam locomotives. As an example it may be said that in a period of three years, thanks to the electrification of railways, the Soviet Union was able to economise more than 30 million tons of coal. Specialists have estimated that in the seven-year period between 1959 and 1965 this figure will increase to 220 million tons.

The utilisation of electric traction will also help to reduce considerably operational costs.

CONVENIENCES

The conveniences for passengers provided by the electrification of railways are certainly very great. At present, electric locomotives already carry 60 per cent of all of the Soviet Union's suburban passenger traffic. By the end of 1965, the total length of electrified railways in the areas adjoining large cities will reach 10,000 km. Thus, the citizens of the country's 40 biggest industrial centres will be able to use this most convenient type of transport.

Passengers travelling for long distances will also benefit considerably, for electric trains go at much greater speeds, not to mention the fact that while travelling in them the passengers are relieved of the unpleasant steam-locomotive soot which turn dirty both clothes and liner.

ADDITIONAL ADVANTAGES OF A. C. CURRENT

The latest achievements of science and engineering are utilized in the electrification of Soviet railways. Extensive use is now being made in the country of the progressive system of electric traction using one-phase A. C. at the industrial frequency.

The application of A. C. helped to provide the overhead wires with a voltage eight times greater than the usual. (25,000 volts instead of 3,300 of D. C.). Thus, there appeared a possibility of installing much thinner overhead wires and thereby economizing several thousand tons of expensive copper. The number of traction substations on the railway lines was reduced by almost 50 per cent, and the equipment itself became much simpler. As a result the labour effort in the construction of power supply installations was reduced by 30-40 per cent.

And these are not the only boons provided by A. C. The new system of electrification of railways will help to supply simply and quickly electric power to the areas adjoining the railways. It is all done very easily: you install a transformer, fix wiring to it and take as much electric power as you like. With D. C. there was no such opportunity available.

And here is another remarkable novelty. All the installations built now on railways under electrification will have automation and remote control introduced on them. This means that a single man will be able to operate from his control desk all the intricate equipment of a railway section stretching for several hundred kilometres. He will only have to press several buttons on his desk and clever automatic devices will do all the necessary switching. Right after that a tiny lamp will flash up on the desk showing that the order has been carried out.

FURTHER PROSPECTS

Fourteen thousand kilometres of electrified railways is quite a substantial figure, yet it marks only the first stage of the stupendous plan of reconstruction of Soviet railways. By the end of the 7-year period (1965), electric locomotives will pull trains on railways with a total length of almost 30,000 kilometres, and will deliver about 45 per cent of the country's railway freight. And in another 5 years diesel locomotives and electric locomotives will completely oust steam locomotives.

Electrified railways will span the country from West to East and North to South. Powerful electric-locomotives will pull trains on all the major railways of Siberia and the Urals, the Ukraine and Transcaucasia, Kazakhstan and Volga regions, the Arctic area and the Baltic republics.

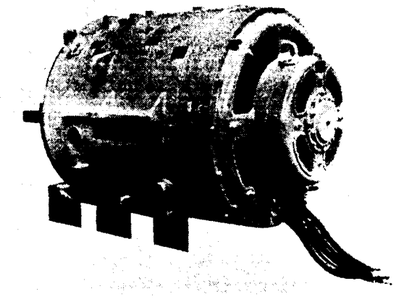
Electrical Equipment of New Type '3' Diesel Electric Locomotive for British Railways

By An Engineering Correspondent

ABOUT half of the 98 British Railways Type '3' 1550 h.p. diesel electric locomotives ordered from the Birmingham Railway Carriage and Wagon Co. Ltd. for service on the Southern Region of British Railways have now entered traffic. These locomotives will be used in the Southern Region's scheme to eliminate steam power over a large part of its area by electrification so far as possible and the employment of diesel traction for the remainder.

The design of the Type '3' locomotive broadly follows that of the same builder's Type '2' with, however, some important differences. Mainly, these result from the use of electricity for train heating instead of steam. The locomotives will work primarily in freight service but with sufficient passenger work to make the provision of train heating necessary. For these services sufficient coaches were available with electric heating. and it was therefore decided to eliminate the boiler with its water tanks and so permit the installation of a larger and more powerful diesel engine.

An important advantage of the system is that when the additional power of the larger engine is not required for heating—as when a freight train is hauled, or a passenger train in warm weather—it becomes automatically available for traction.



CG. 391 Main generator with auxiliary generator and heating generator (on left) for Type '3' locomotives.

British Railways Type '3' locomotive.

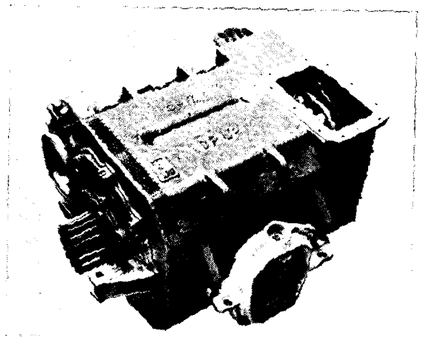
The Type '2' locomotive was fitted with a 6-cylinder Sulzer engine and Crompton Parkinson electrical equipment. The Type '3' is equipped with the 8-cylinder version of the same engine and a larger Crompton Parkinson generator, while the traction motors and certain other electrical equipment have only detail differences from those in the Type '2'.

The main, train-heating and auxiliary generator armatures are mounted on a common cast-steel rotor, with the auxiliary generator recessed into the end of the main structure, so that the machine is virtually three generators in one. This arrangement makes the maximum use of available space.

The machine is of the single-bearing type, with the armature shaft solidly bolted to the engine crankshaft flange and carried at the rear end in a roller bearing. The main generator is a 10-pole machine with separately-excited, self-excited, de-compounding and starting windings. It is rated at 1012 kw. 1760A 750 r.p.m. The separately excited train-heating generator is situated at the engine end of the machine. Its continuous rating is 235 kw. and it is provided with coarse regulation to give approximately 800V at 300A at any speed from 550 to 750 r.p.m.

Traction-type brush gear is used for both of these generators, with the brush holders carried in a revolving rocker fitted with a rack and pinion which allows every part of the gear to be readily serviced.

The auxiliary generator, fitted within the main housing at the rear end, is an 8-pole machine with a continuous rating of 57 kw. A voltage regulator of the rolling sector type maintains an out-put of 110V throughout the engine speed range.



C 171 Traction Motor.

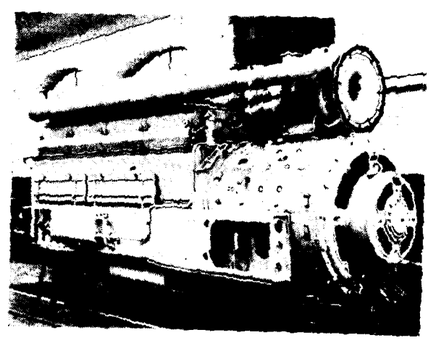
Four traction motors are fitted to each locomotive, driving through resilient gears with a ratio of 62-17. They are series-wound force-ventilated machines with a continuous rating of 305 h.p. 440A 580V. The brush gear can be serviced from a pit as it is of a rotatable type similar to that fitted to the main generator.

The motors are connected in parallel across the generator and the control system is arranged to provide maximum tractive effort without demanding maximum engine speed. Five stages of automatic field-weakening are controlled by a motor-operated cam group governed by the load regulator and a current relay. Isolation of a traction motor under fault conditions is provided by links on both positive and negative sides of the circuit.

A control cubicle houses HT and LT apparatus in combination, with a separate cubicle for the train-heating control gear. Control and engine-starting are provided by a Crompton 48-cell lead-acid battery of 168 A. h. capacity. This is carried in two draw-out boxes, one on each side of the locomotive.

A D.C. system was chosen for the train-heating on the grounds of efficiency and ease of regulation. As the heating generator is driven by the main engine, benefit is obtained from a natural phenomenon which governs the engine's actual power output. The nominal h.p. of 1550 is calculated at an inlet air temperature of 85°F and for any temperature below this figure the engine output will rise by about 15 h.p. for every 10°F of fall. In cold weather, therefore, when train heating is required, a considerable reserve of power,—probably as much as 60 or 70 h.p.—can be available for this purpose before traction output is diverted.

Heating current for the train is carried via either a single-pole feed and running rail return or a 2-pole feed in which the locomotive jumper is the positive feed and the adjacent carriage jumper the negative. The latter system is to ecome standard practice on British Railways, with an interlocking device to interrupt the feed to the heating contactor on the locomotive, should a jumper on any part of the train be disconnected while the heating current is on.



Sulzer eight cylinder 1550 h.h.p. engine coupled to Crompton Parkinson triple generator on combined bedplate.

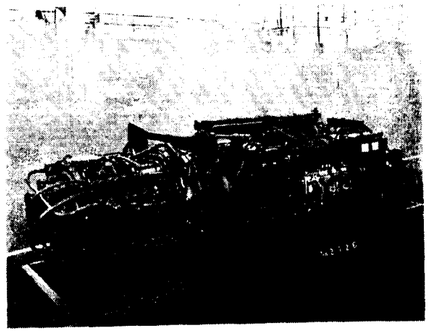
The general design of the engine and electrical equipment is aimed to provide economy in fuel consumption and longer periods between overhauls. Actual weight of the first Type '3' when tested and approved by British Railways Southern Region was 73 tons 8 cwts.—more than 1½ tons below the service limit of 75 tons with full fuel supplies.

A BUSY YEAR AT ROLLS-ROYCE

By An Engineering Correspondent

DEVELOPMENT OF ENGINE WITH FOUR-VALVE CYLINDER HEAD

IN November 1960, Rolls-Royce exhibited a 'Mark IV' version of the well-known 'C' range of diesel engines. The new engine is now commercially available in the turbocharged form for operators and builders to whom an especially high power-to-weight ratio is important. The extra power has been obtained by the introduction of four valves per cylinder, an arrangement permitting a free gas flow. Individual cylinder heads and gaskets are fitted in the Mark IV engine.

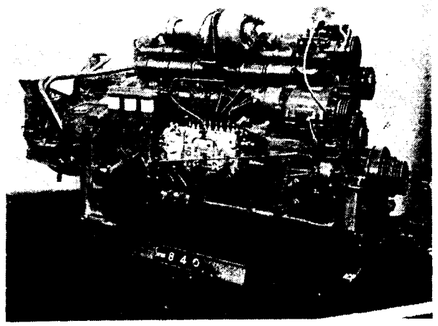


Supercharged eight-cylinder horizontal engine with torque converter and reverser for railcars.

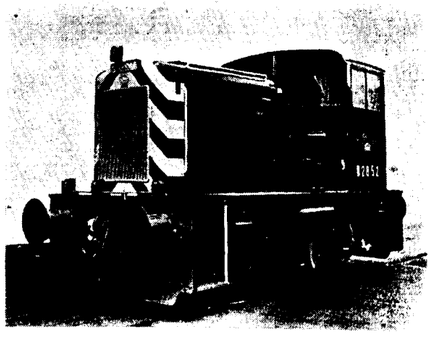
Fifty Mark IV eight cylinder turbocharged engines are now in course of delivery to the Swedish builders, Kalmar Verkstads A.B. for new shunting locomotives for the State Railways. A further twenty six-cylinder horizontal turbocharged units are being delivered to power Jamaican Railway Corporation railcars built in England by the Metropolitan-Cammell Carriage and Wagon Company Limited.

Although the Mark IV engines are now more in the limelight, Rolls–Royce are still supplying substantial numbers of the well-tried two-valve-head engines, in both horizontal and vertical types. Early in 1961, British Railways placed a repeat order through Drewry Car Company for forty 180 h.p. horizontal engines for railcars. Engines of this type were first delivered to British Railways in 1957, and on the busy suburban services of the North East Region, they are running for a period of 200,000 miles between overhauls.

The first diesel-hydraulic shunting locomotives commissioned by British Railways are also at present entering service. They are compact Rolls–Royce



Turbo-charged Mark IV eight-cylinder vertical engine with three-stage torque converter.



British Railways' 176 hp diesel-hydraulic shunting locomotive powered by Rolls-Royce and built by Yorkshire Engine Company.

powered Yorkshire Engine Company locomotives of 176 h.p. with the power equipment installed at an inclined angle.

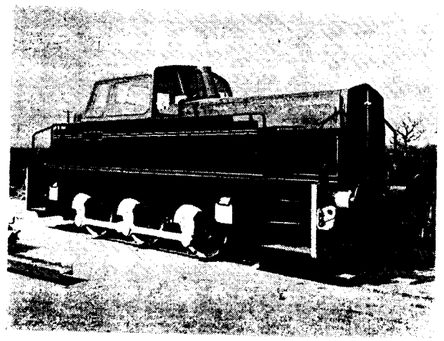
OVERSEAS ACTIVITY

A temporary pause in the modernization programme of British Railways has enabled British manufacturers to concentrate on the growing markets overseas where industrialization calls for an efficient transport system. The tradition linking British locomotives with early railway developments in many continents is being maintained—maintained with great effort in face of fierce international competition.

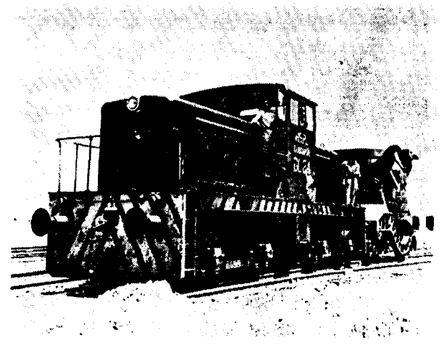
Rolls-Royce recognize that some countries who formerly bought all their machinery abroad are now in a position to manufacture for themselves and prefer to do so when large quantities are involved. In such cases they often find a readiness to consider local manufacture under licence. This has happened in the case of the company's Dart turbo-prop aero engine which is entering production with Hindustan Aircraft Limited.

NEW LOCOMOTIVES

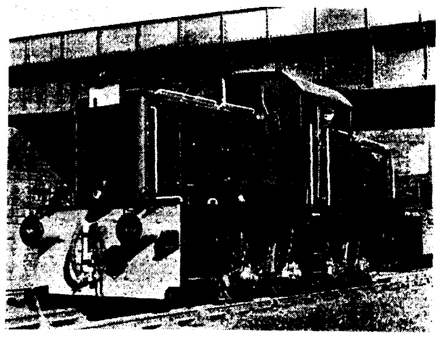
Two new Rolls-Royce powered locomotives, both diesel-hydraulic types, which have appeared since this time last year are worthy of mention. Last October the new Sentinel 0-6-0 48 ton industrial shunting locomotive entered service. Externally the locomotive is very similar to the popular 0-4-0 type with its low bonnet line and all-round visibility over the buffers. The standard 0-6-0 unit has a maximum tractive effort of 29,300 lb. and a maximum continuous speed of 18 m.p.h.



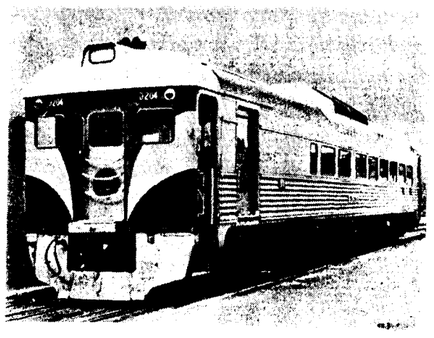
48-ton Sentinel 0-6-0 diesel-hydraulic locomotive.



Rolls-Royce powered A.E.I. diesel-electric 400 H.P. locomotive at Hindustan Steel.



600 H.P. 60-ton Taurus locomotive by Yorkshire Engine Company (Maximum tractive effort, 45000 lb. Maximum Speed 36 m.p.h.).



622 H.P. Budd railcar, operated by Canadian National Railways and powered by two Rolls-Royce C8SH diesels with torque converters and reversers.

In April of this year, Yorkshire Engine Company's long-awaited 600 h.p. *Taurus locomotive* was shown for the first time and handed over to British Railways for trial working. Its transmission principle, now known as 'Type S', was illustrated in last July's issue of this magazine. An unusual feature of the locomotive is its ability to give an initial tractive effort of 45,000 lb. from only one of its two 300 h.p. engines. Apart from heavy shunting duties, however, the Taurus was also designed for trip working on main lines, and has a top speed of 36 m.p.h. with both engines driving. Further technical details of these locomotives may be obtained from the manufacturers concerned or from the Railway Traction Department of Rolls-Royce Limited in Shrewsbury, England.

LIAISON

The Railway Traction Department of the company is willing to investigate and engineer complete power installations for customer's individual needs. It deals in virtually all railway power requirements for railcars, surface and underground locomotives, cranes, and generating equipment. A Newsletter describing the department's activities is published from time to time and is circulated free-of-charge to interested railway parties throughout the world. Copies may be obtained direct from the Railway Traction Department in England or through the company's distributors Messrs. William Jacks and Company Limited, who have offices in Calcutta, Madras, and Bombay.

Railway engineers travelling in Britain are welcome to visit the Rolls-Royce diesel engine plant in Shrewsbury, and may make arrangements to do so either before or after leaving India.

TABLE OF ROLLS-ROYCE DIESEL ENGINES FOR RAILWAY TRACTION

Type	No. of Cyl.	Induction	Traction Rating at 1800 r.p.m.	Length (in)	Width (in)	Height (in)	Weight (lb)	
VERTICAL ENGINES								
C4N	4	Normally aspirated	119 hp.	45	33	43	1990	
C4S	4	Supercharged	155 hp.	45	33	43	2200	
C6N	6	Normally aspirated	179 hp.	61	33	43	2500	(2730 with dry sump)
C6S	6	Supercharged	233 hp.	61	34	47	2790	(2860 with dry sump)
C6T	6	Turbocharged	262 hp.	61	33	47	2690	(2750 with dry sump)
C6T (Mk IV)	6	Turbocharged	295 hp.	61	33	47	2690	(2750 with dry sump)
C8N	8	Normally aspirated	239 hp.	73	33	43	3100	
C8S	8	Supercharged	311 hp.	73	34	47	3400	
C8T	8	Turbocharged	350 hp.	73	33	48	3370	
C8T (Mk IV)	8	Turbocharged	394 hp.	73	33	48	3370	
HORIZONTAL ENGINES								
C6NH	6	Normally aspirated	179 hp.	62	45	31	2460	
C6SH	6	Supercharged	233 hp.	62	45	31	2580	
C6TH	6	Turbocharged	262 hp.	62	45	31	2500	
C6TH (Mk IV)	6	Turbocharged	295 hp.	62	45	31	2500	
C8NH	8	Normally aspirated	239 hp.	75	46	33	3220	
C8SH	8	Supercharged	311 hp.	75	46	33	3340	
C8TH	8	Turbocharged	350 hp.	75	46	33	3250	
C8TH (Mk IV)	8	Turbocharged	394 hp.	75	46	33	3250	

Excellent Dependability Coupled with High Performance of MGO and AGO Diesel Engines

By An Engineering Correspondent

THE Diesel engines of compact overall dimensions, high running speeds and with superior power/weight ratios have become increasingly more popular for railways applications. This is particularly due to the fact that although the demand for power is increasing, the available engine-room space stays the same as before.

An engine of the type suitable for such installations, is the M. G. O. engine, manufactured by the SOCIETE ALSACIENNE DE CONSTRUCTIONS MECANIQUES of MULHOUSE, France, to the designs of the Societe Civile d'Etudes MAREP-GROSSHANS-OLLIER.

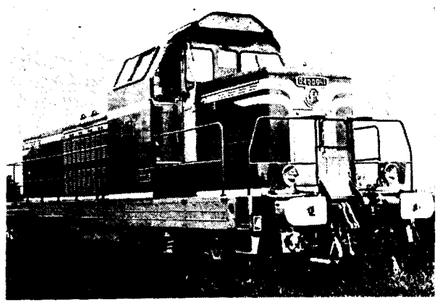
These engines produced at the MULHOUSE Works are of the L and the Vee—configuration operating on the four-stroke cycle and all share a common cylinder bore and piston stroke, these being 175 mm and 180 mm/192 mm respectively. It will be obvious that these almost "square" dimensions allow a fairly large piston area to be obtained relative to the swept volume which the short stroke enables the piston rubbing speed to be kept at a moderate level even when the engine is operating at the designed continuous speed of 1500 r.p.m.

M. G. O. by standardizing on the bore and the stroke dimensions are able to produce engines of from 300 to 1600 HP in units of from 6, 8, 12 to 16 cylinders with a large degree of component changeability between the various engines in the range. Among these interchangeable items are such important parts as cylinder heads, liners, pistons, main bearings, rocker assemblies.

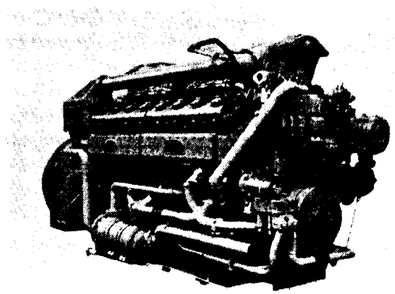
The possibility of equipping a whole group of railway engines with engines supplied by one manufacturer thus becomes a very attractive proposition, when a standard range of spare parts can be used for any type of railway engine in the group.

The SOCIETE ALSACIENNE DE CONSTRUCTIONS MECANIQUES (S. A. C. M.) also manufactures the A. G. O. engines which are quite similar in conception to the M.G.O., but of which the range of power is extending up to 3000 HP. As M. G. O., they also come in L and Vee configuration of 6, 8, 12 and 16 cylinders, but the cylinder bore is increased to 230 mm. and the piston stroke to 220/230 mm. They operate at a continuous speed of 1350 r. p. m.

Each engine type is available in normally aspirated or turbocharged forms. The turbocharged engines are available with or without intercooling of the inlet air.

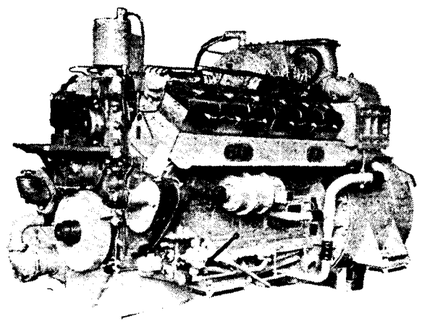


Locomotive built by the french Company ALSTHOM and equipped with a 1400 HP V 16 MGO engine of the SACM works.

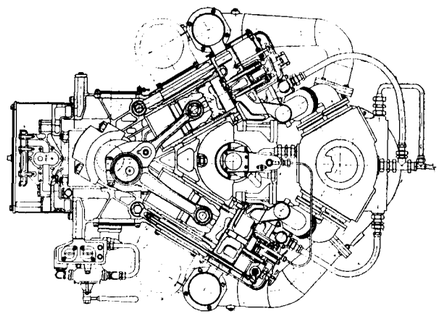


Railway traction unit with the V 16 MGO engine

Output : 1400 HP at 1500 r.p.m.



925 HP at 1500 r.p.m. Diesel railway traction unit with the MGO V 12 engine.



Cross section of supercharged MGO engine

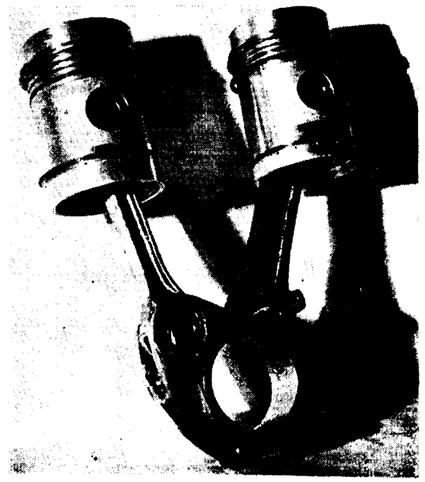
The turbochargers operate on the pulse-pressure system, they have name BROWN-BOVERI, NAPIER and HISPANO-SUIZA. The larger versions of engine use one blower on each bank of cylinders.

These engines are all of the direct injection type. A central multihole fuel injector in the cylinder head is supplied from a multi-cylinder scroll-type fuel pump located in the middle of the engine cylinder banks; the pumps are supplied by La Precision Mecanique and LAVALETTE.

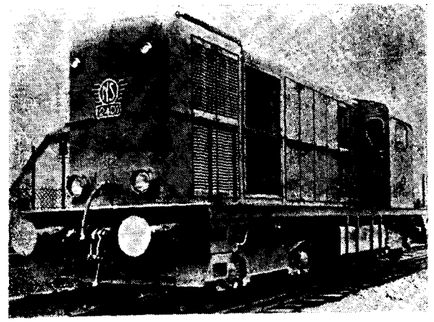
The pistons of light alloy have a swirl-type combustion chamber formed in the head. There are four compression rings and two oil-control rings, the top compression rings being chromium plated to limit wear. In the case of engines employing high pressure turbocharging the pistons are internally cooled by an oil jet. Lubricating oil, fed from the main circuit, flows into a groove located between the rings and the combustion chamber and is given force and direction by the dynamic stress of the piston.

A large degree of overlap is provided by the valve timing on the pressure-charged engines, the exhaust and inlet valves opening simultaneously at t. d. c. between the exhaust and induction strokes. By this means an ample supply of cool scavenge and charge air is admitted to the cylinders and thermal stresses in the cylinder heads, valves and piston crowns are decreased. The connecting rod assembly is of the master and articulated type, made of steel alloy drop forged. This design gives easy access through the inspection ports and makes it possible to mount or to take apart the whole assembly through the liner bore.

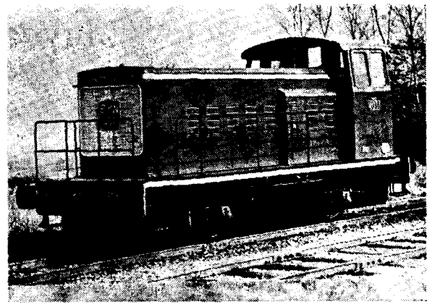
The cylinder block is of a one-piece frame of special high tensile cast iron with steel additions, in certain cases where weight is of great importance the cast iron structure is replaced by a welded steel frame. The crankshaft, flowforged chromium-molybdenium hardened steel, is carried by the lower part of the frame on bearings equipped with micro type shells made of steel backed copper-lead alloy. The crankshaft is fitted with a torsional vibration damper either of the dry friction or of the viscous type.



Especial type of piston assembly.



One of the 150 locomotives built by the French ALSTHOM works for the Dutch Railway Company and equipped with 850 HP MGO engines.



400 HP Diesel-hydraulic shunting locomotive built by SACM's Graffenstaden works and equipped with the MGO V 8 engine.

A gear pump lubricates automatically the whole engine. The exhaust turbo-blower on supercharged engines have their own separate lubricating system. Another gear pump, built in the same unit as the first one, forces oil through the oil cooler. The cooling system includes a relief valve in order to keep the pressure under 2 Kgs/cm (30 psi) whatever the ambient temperature may be.

Water is circulated around the liners by a centrifugal pump mounted externally on the cylinder block and through the external manifold cast in the cylinder block.

For special applications, an auxiliary water pump with the same capacity is provided on the other end of the same driving shaft, for cases where the oil cooling water must circulate in a special circuit, or to feed the air coolers on supercharged engines.

A ball governor of the activated sensivity type is located in the timing gear train under the same cover. It actuates, through intermediate rods, the injection pump racks. This governor can be controlled either as an all-speed governor or as a limit governor. A pneumatic, hydraulic or electric remote control device can be provided, depending on the intended application.

Another ball type governor, located in the injection pump driving shaft under the timing gear cover controls the variation of the beginning of the injection according to the speed variations of the engine.

Special safety devices are installed on all engines: an overspeed governor automatically shuts off the fuel in the case of engine racing, a safety valve also cuts off the fuel feed in the event of oil pressure dropping below a preselected figure. The engine, when equipped with electrical circuits, has also safety devices protecting it against overheating of cooling water and lubricating oil.

More than 950 engines for locomotives, 90 for shunting locomotives and 195 for fast railcars are already equipping railway engines in all parts of the world.

M. G. O. and A. G. O. engines are not exclusively used in the railway field of application. They are also very successfully employed as drilling units, on pipe lines, as generating sets, in marine applications, as motive power for marine generating sets on board a variety of vessels, as well as main propulsion units.

All these features together with low fuel consumption, compactness, sturdiness and variety of uses make the M. G. O. and A. G. O. Diesel engines of high performance and excellent dependability.

Bristol Siddeley Maybach Diesel Engines for Locomotive Propulsion

By An Engineering Correspondent

ONE of the largest manufacturers of motive power in the world, Bristol Siddeley Engines, produce, at their Ansty, near Coventry, England, works, Maybach MD diesel engines.

The fastest train in Britain — the Bristolian — is powered by two Bristol Siddeley Maybach MD 650 engines. These are twelve cylinder engines, each developing 1,135 h. p.

Orders for British Railways alone, either direct or through locomotive manufacturers, now amount to nearly 300 engines.

The MD range of diesel engines is manufactured in England by Bristol Siddeley under licence from Maybach Motorenbau GmbH of Friedrichshafen, Germany. These high speed engines power locomotives, trawlers and electric generators, and cover a power range of from 300 to 3,600 h. p.

They are all of the high speed type, running up to 1,600 r. p. m. with maximum efficiency. They are able, consequently, to deliver high power for a small bulk and weight.

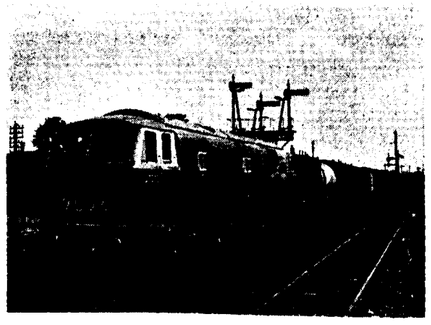
This permits the use of a much smaller engine room space than would be required for conventional large, slow-running units. A life of about 16,000 hours between major overhauls can be regarded as normal.

All the units in the MD range are four-stroke engines using throughout a common bore and stroke—the former being 185 mm. and the latter being 200 mm. The cylinder arrangement is in line for the four and six cylinder models and in Vee formation for the eight, twelve and sixteen cylinder versions.

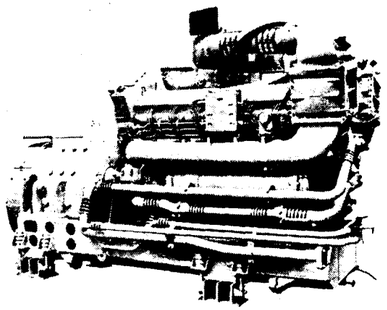
Bristol Siddeley Maybach engines combine the best performance and design qualities of high, medium and low-speed diesels; light weight and compactness; excellent thermal efficiency and long life. There are a number of unusual features contributing to the engines' long overhaul life, which are the result of very careful design and thorough development.

There are sixteen basic engines in this high-efficiency Bristol Siddeley range. Each of these can be pressure-charged, or pressure charged with intercooling. Mechanical, electric or hydraulic transmissions can be used.

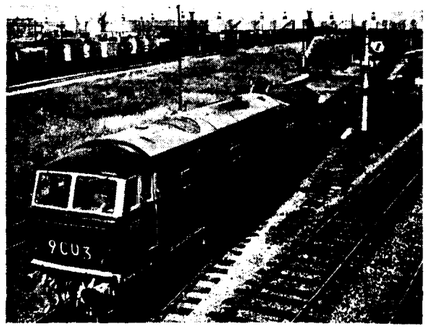
Swindon built "Warship" class Diesel Hydraulic locomotive D 804, fitted with two MD 650 engines. Hauling the express London/Bristol non-stop "Bristolian".



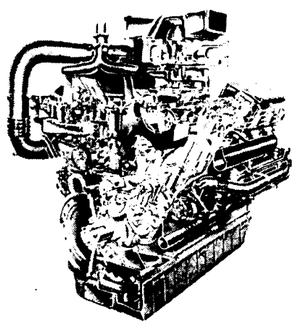
Beyer Peacock Hymek British Railways Type 3 Diesel Hydraulic Locomotive D 7000. Fitted with one 16 cylinder MD 870 engine and Mekydro transmission.



Bristol Siddeley/Brush 1500 h.p. Diesel Electric Generator set as installed in the Brush "Falcon" locomotive. Complete unit weighs only 11½ tons.



Beyer Peacock Hymek British Railways Type 3 Diesel Hydraulic locomotive D 7000. Fitted with one 16 cylinder MD 870 engine and Mekydro transmission.



The Bristol Siddeley Maybach MD 650 is a twelve cylinder engine in V form. It develops 1150 BHP at 1500 RPM for a weight of 10670 lb. It is 87 ins long, 55 ins wide and 87 ins high.
Large numbers of Bristol Siddeley Maybach engines are in use in British Railways Locomotives.

Bristol Siddeley Maybach production MD 870 engine. Being delivered to Beyer-Peacock at Manchester.

A major feature of the range is the disc webbed crankshaft. Each crankshaft web is a disc, the rim of which forms the inner race of a main roller bearing 14 inches in diameter. This arrangement allows the crankshaft to be exceptionally short and stiff while accommodating big end bearings of ample size between the webs.

The one-piece, tunnel-type crankcase, which follows the use of this type of crankshaft, is exceptionally rigid and is extended upwards to house the "wet" cylinder liners.

Reliable service performance, even under high load conditions, is obtained by the use of pressure-oil cooled pistons. In addition, piston cooling makes possible exceptionally small clearances, resulting in very low line wear.

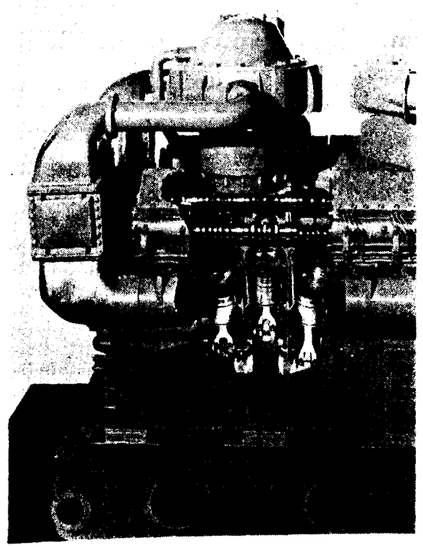
The pistons have detachable steel crowns which carry the three compression rings. A crown, with its rings, can thus be removed for inspection without drawing the piston or disturbing the big end.

Individual and interchangeable cylinder heads with a central pre-combustion chamber and small well cooled valves with automatic clearance adjustment. The use of small, and therefore lightly stressed valves, provides the advantage that heating of the valve decreases in relation to the reduction in the square of the head diameter, which determines the quantity of heat which must be dissipated through the valve seat and stem.

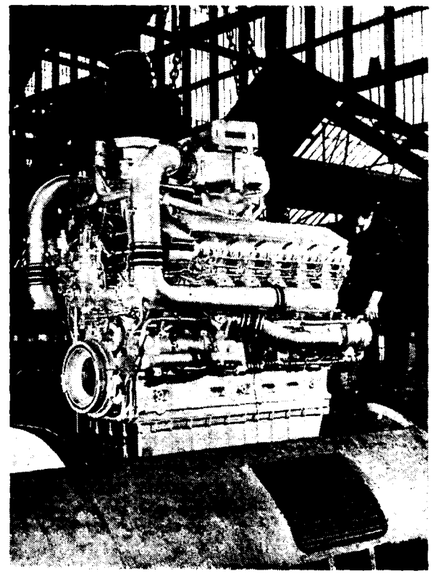
Piston crown temperatures are controlled by oil cooling and this, combined with the use of steel as the material, permits small clearance with fully cylindrical pistons, so that the whole piston surface is in even contact with the cylinder wall under all conditions of load.

There are three inlet and three exhaust valves per cylinder. These are operated by sliding guide covers which eliminate side thrust from the valve guides and ensure acceptable valve temperatures. Automatic hydraulic tappet control reduces both wear and maintenance.

Each cylinder has its own fuel pump and injector unit and each cylinder head is, of course, separate.



Sectioned model of Maybach twin overhead camshaft and crankshaft on roller bearings.



A Bristol Siddeley Maybach MD 650 12 cylinder V form high speed diesel engine being lowered into a D 800 class diesel hydraulic locomotive at the Swindon locomotive works. Locomotives powered by Maybach MD 650 engines haul such famous express trains as the Bristolian and the Cornish Riviera Express.

This permits all but major overhauls to be carried out with the engine still in position.

The use of a common bore and stroke throughout the range means that many components, such as pistons, valves, cylinder heads and connecting rods, are interchangeable throughout the whole range.

All engines in the Bristol Siddeley MD range are fitted with exhaust-driven turbochargers and, in addition, may be equipped with intercoolers for increased power where necessary.

For service life and maintenance, these diesels compare more than favourably with large, slower speed engines. They require much less engine room space and are easier to maintain because of the lighter weight of the parts that may have to be handled.

In addition, the possibility of changing an entire power unit in a few hours has obvious advantages,

especially where high service reliability is a specific operational requirement.

The combination of Bristol Siddeley and Maybach is a formidable one where top quality precision engineering is concerned. Bristol Siddeley have a world-wide reputation for their researches into and production of aero engines, jets and rocket motors. This experience is linked with that of Maybach, who have spent over 35 years in design development and production of the MD range.

In addition to locomotive propulsion, these units are equally suitable for auxiliary purposes.

In the United Kingdom, they are already in service in large numbers with British Railways, where they power the Western Region's diesel main line locomotives now introduced as part of the modernisation plan. The Beyer Peacock (Hymek) British Railways Type Three Diesel-Hydraulic locomotives, also recently introduced into service with British Railways, are powered by a single MD 870 diesel, with a rating of 1,920 h. p. at 1,500 r. p. m.

LEADING PARTICULARS OF BRISTOL SIDDELEY MD RANGE NOW ORDERED IN SUBSTANTIAL QUANTITIES FOR USE IN BRITISH RAILWAYS LOCOMOTIVES

	Weight	*Length*	*Width*	*Height*	*No. of Cylinders*	*Horsepower*
MD 870 —	14,220 lbs	112"	64"	89"	Vee 16	1920 b.h.p. at 1500 r.p.m.
MD 650 —	10,200 lbs	85"	57"	87"	Vee 12	1152 b.h.p. at 1500 r.p.m.
MD 655 —	10,700 lbs	90"	64"	87"	Vee 12	1440 b.h.p. at 1500 r.p.m.

DELTIC DIESELS MAY GIVE BRITAIN WORLD'S FASTEST RAIL SERVICE

Deltic Diesel-electric locomotives—the most powerful single-unit Diesels in the world—are now coming into the service of British Railways to speed up rail traffic on the Scotland-to-London east-coast service. Each costs £ 140,000, but is expected to cover over 200,000 miles a year compared with the 75,000 miles usually clocked by an express steam locomotive.

Next year, British Railways plan to introduce a regular six-hour schedule for the 393-mile Edinburgh-London run—lopping about 30 minutes off the present fastest service. Later it is hoped to cut the time even further.

At the flick of a driver's wrist the 3,300 hp Deltic can streak from 20 to 80 mph in a matter of seconds, at the head of a 400-ton train. According to English Electric, the manufacturers, maximum speed is 105 mph. Estimated fuel consumption rate is 1.75 gallons a mile.

As the British Railways modernization programme progresses, many of the speed restrictions imposed by civil engineers will be relaxed, and it is believed the Deltic will ultimately make the inter-capital route the fastest in the world.

* * * * * * * * *

NEW PROCESS MAKES STRONG DIE-CAST ALUMINIUM PARTS

By using sonics, or very high-frequency sound waves, in die-casting, it is now possible to make aluminium machinery parts by the die-cast method, which have much greater tensile strength than was previously possible. Aluminium parts made by the new process have at least 30 per cent more tensile strength than conventional castings, and in addition there are fewer defects, it has been reported.

By using the new process, machinery parts, including aircraft wheels, previously made of steel or brass in order to withstand high pressures can now be die-cast of aluminium. The sonics process was developed by engineers of the Adams-Mills Corporation of High Point, North Carolina, and is called Vibrocast. The company reports that it may also be used in the casting of copper, brass, and other non-ferrous metals.

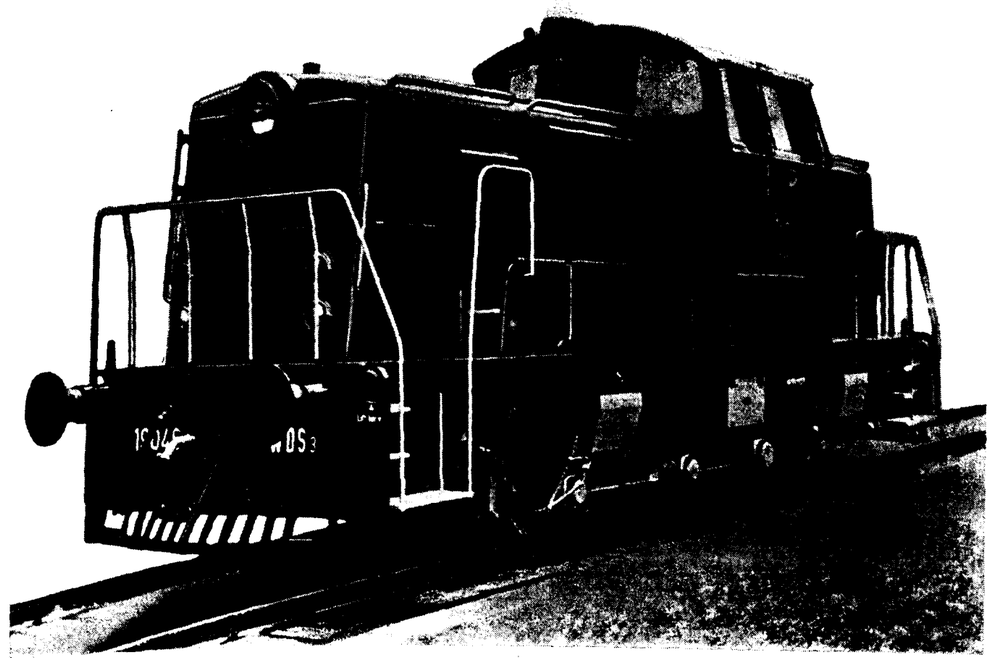
MaK Diesel Hydraulic Locomotive 650 HP type 650 C for tropical Service

By An Engineering Correspondent

GENERAL

BY order of the Indian State Railways MaK at Kiel have developed a Diesel hydraulic locomotive which fully takes into account special requirements existing for use in countries with predominantly tropical climate. With regard to quality and economy in use design and construction comply with highest requirements. They especially correspond to all requirements a Diesel locomotive of latest design should comply with in troublefree operation, easy maintenance, and a highly automatic operating equipment. In this connection we first of all have to mention the good accessibility to clearly arranged constructional assemblies, the indifference with regard to dust and dirt, the excellent ventilation of the driving cabine as well as of the engine-room by filtered fresh air, the automatic supervision and control devices (multiple unit control for operating 3 locomotives), and the consideration paid to the requirements of modern maintenance methods. The latter is realised by the possibility of changing complete constructional assemblies as for example the amply dimensioned cooling installation and the transmission units.

The locomotive is of the rigid frame type and axle arrangement C (0—6—0) and has excellent running properties also on lines of inferior quality. The length of the locomotive over the buffers is 10 700 mm, the maximum height 4157 mm, and the maximum width 30 30 mm. This 600 HP locomo-



tive of 57 tons operational weight is suitable as shunting locomotive and for line service as well. For this purpose the locomotive is equipped with a second stage (line service gear) by which a maximum speed of 65 km/h can be obtained. The maximum speed in shunting service is 27 km/h.

ENGINE

Prime mover is a totally enclosed Maybach Diesel engine type MD 435 with supercharging and electric starting, being elastically suspended on the locomotive frame. This 8 cylinder 4 stroke Diesel engine is of the "tunnel" V-type with centrally arranged combustion chamber. The maximum engine speed is 1600 r. p. m. The pistons are two-parted and pressure oil cooled.

This type of engine has proved its economy and reliability especially in Diesel locomotives under arduous service conditions in many years of service.

TRANSMISSION UNITS

The engine torque is transmitted to the turbo transmission through an elastic coupling and a universal joint shaft.

This locomotive is equipped with a hydro-mechanical transmission (SURI transmission) developed by MaK, which is distinguished by high efficiency, especially in the upper speed range of the locomotive.

The SURI transmission together with the 2-stage MaK reduction and reversing gearbox form a unit. The gears of latter may be changed if the locomotive is not moving. The SURI transmission incorporates a special type of hydro-dynamic torque converter having a reaction wheel being rotatable on an overrunning hub and a mechanical drive (direct drive). The SURI transmission combines the excellent properties of a hydro-dynamic converter having an infinitely variable torque conversion, with the favourable efficiency of a mechanical gearbox.

The converter, driven through a step-up gear, effects smooth starting of the locomotive thus avoiding jerks on the drive gear parts, and remains engaged in the lower and medium speed range of the locomotive. Hereby the converter reaction wheel is supported by the overrunning hub in one reaction direction only. As long as the torque is increasing a reaction torque is existing and the reaction wheel is stationary. If the torques of the turbine and pump become equal the stationary reaction wheel takes up rotation on the overrunning hub, and the converter acts as a hydraulic coupling. Hereby the hydro-dynamic part of the transmission has a favourable efficiency extending over a widened speed range.

With higher travelling speeds the highly efficient direct gear is engaged through a mechanical plate clutch. Simultaneously the converter is emptied. For the purpose of avoiding jerks on the engine and mechanical clutch a hydraulic coupling is parallel connected to the mechanical clutch. The hydraulic coupling synchronizes the speeds of the mechanical parts of the clutch to be engaged.

The Diesel engine is matched to this power transmitting system. The power and torque characteristics are deviating from normal designs, the output is almost constant down to 70% of the maximum speed. Furthermore the fuel consumption curves are adapted to the special requirements of railway traction.

Though the change-over of the transmission from the converter to the direct gear is automatically effected in dependance on the travelling speed and engine output, the transmission control is so designed that normally the gears are changed by moving down the driver's control lever to the discretion of the driver. This method was adopted on request of the Indian State Railways and has the advantage that the driver may select travelling with the converter or direct gear at certain output and speed ranges depending on the operational conditions. The speed range allowing gear change selection by the driver is limited. In the range below 40 to 50% of the maximum speed the manual gear change is locked, above about 70% maximum speed the direct gear is automatically engaged.

Furthermore the transmission control includes a safety device against overspeed and exceeding the permissible maximum speed on gradients. In case the maximum speed will be exceeded the safety device causes the brakes of the locomotive to be applied which will last as long as the permissible maximum speed is obtained again.

LOCOMOTIVE FRAME

The frame of the locomotive is welded throughout from rigid steel plates and rolled profiles. The frame platform plate is extended over the full width of the vehicle and has cutouts for the engine and transmis-

sion unit supported on the frame. The frame forms a system of high rigidity against distortion.

SUPERSTRUCTURE

This consists of the front engine housing, the cab arranged at appr. the middle, and the rear housing which accommodates the cooling installation. Part of the rear housing serves as fuel tank. Hood shaped housings contribute to the neat appearance of the vehicle. The housings are screwed on the locomotive frame and connected with the cab by elastical seals. Doors and flaps on the housings allow for access to the main components. At the ends of the locomotive there are flush mounted head lamps of 250 W each.

DRIVER'S CAB

This is closed all round and is arranged higher than the housings. Large front and side windows are provided and 4 deeper located buffer windows which all permit the driver to have an unrestricted view to all sides. On account of the tropical climate the driver's cab is provided with especially effective heat insulation and a cab ventilation with filtered fresh air.

The driver's desk is located at the centre of the locomotive and has operational controls at both sides. This arrangement allows the locomotive to be driven alternatively from both sides of the driver's desk.

For improving the driving comfort of a modern locomotive the driving cab equipment is completed by the following: additional ventilation by adjustable Monsoon louvres, upholstered driver seats, pneumatic wind screen wipers, dimming screens, shutters for the moveable side windows and a proper noise insulation.

RUNNING GEAR

The 3 wheel sets of the running gear are made to the specification of the Indian State Railways. The spoke wheels are pressed hydraulically onto the axles. The tread diameter of the wheels is 1092 mm. The wheels are fitted with renewable tires shrunk on.

The wheels sets are driven by coupling rods and jackshaft cranks arranged between the second and third axle.

The locomotive frame is supported by laminated springs on the axle boxes. The leading and intermediate springs are connected by compensating beams for improving the running properties. The axle boxes are equipped with anti-friction bearings. The guide faces of the axle boxes are lined with manganese steel plates welded on.

BRAKE EQUIPMENT AND SANDING

The compressed air and vacuum brake equipment consists of a direct acting locomotive brake and an indirect acting brake for the locomotive and train. Hereby the train is braked by vacuum and the locomotive by compressed air with the aid of a vacuum controlled compressed air valve. The brake forces act on a compensated 12-block brake with adjustable rodding. The brake forces are 73% of the locomotive weight with all supplies. Furthermore a manually operated hand screw brake is fitted acting on the trailing wheels. The wheels of the first and third wheelset are sanded by electro-pneumatically operated sanding valves in each direction of travel.

COOLING SYSTEM

On account of the special climatic conditions at the district of operation the locomotive is equipped with an amply dimensioned cooling system. The Diesel engine jacket water and the vacuum pumps are cooled directly. The engine lubricating oil, the turbo transmission oil, and the piston cooling oil are cooled by heat exchangers interconnected with the main cooling system.

The cooling panels consist of a number of standardized, replaceable radiator elements arranged at both sides of the rear housing.

The speed of the hydrostatically driven fan (system Behr) is infinitely controlled in dependance on the cooling water temperature. The system is dimensioned for full load at the maximum ambient air temperature to be expected but the average fan speed during a year will be below the maximum speed from which considerable savings in power and consequently fuel will result.

Radiator and fan are combined in a closed unit and can be removed together with the rear housing.

SAFETY DEVICES FOR ENGINE AND TRANSMISSION

The engine jacket water is heated by an oil fired warm water equipment before the Diesel engine is started or the jacket water is kept warm for maintaining the readiness for service. Thermostatically controlled equipment switches automatically on and off the warm water heater within the prescribed temperature limits. This equipment also avoids the Diesel engine from being started before the minimum temperature i. e. 45°C for the engine jacket water is obtained. When warming-up the engine or after the engine has been shut down an

electrically driven cooling water circulating pump will be operating.

The Diesel engine is automatically stopped if the cooling water temperature is too high, the lubricating oil pressure is too low, the lubricating oil temperature and the transmission oil temperature are excessive, in case the cooling water level is too low and the engine speed too high.

CONTROLS, SUPERVISION AND SAFETY EQUIPMENT

The Diesel engine and turbo transmission are controlled by a pneumatic device by which the required load on the engine can be continuously controlled with a control lever from both driving positions of the locomotive.

The pneumatic and electrical control and supervision impulses are transmitted through coupling hoses and cables arranged at the ends of the locomotive so that 2 or 3 locomotives can be coupled together in any position and can be remote-controlled and supervised from one driving desk. By these controls are mainly effected running and stopping of the engine, change of the transmission to the direct gear, the actuation and supervision of the reversing gear, and sanding. The reversing control cylinder is locked by a pneumatic locking device while the locomotive is travelling.

In case the Diesel engine on the controlling locomotive or on one of the remote-controlled locomotives is stopped automatically due to failure, driving in multiple unit operation can be maintained without interruption.

Excessive engine lubricating oil temperatures and stopping of an engine on the remote-controlled locomotives are indicated by warning lamps on the controlling locomotive.

All essential operational functions for the safety of the power unit installation and driving are surveyed by supervision instruments. Here are included a recording speedometer with running hour counter. The speedometer is equipped with a warning lamp which lights up if a determined adjustable speed is exceeded.

All controls and instruments are clearly arranged on the driving desk and are easy to survey from both driving positions.

ELECTRICAL EQUIPMENT

The tropic proof electrical equipment is operated with a tension of 24 V.

SUPPLIES

3000 ltrs. of fuel, 450 ltrs. of cooling water, and 280 kg of sand can be carried on the locomotive.

SUMMARY

The locomotive is equipped with approved structural assemblies specially selected for operation in tropical districts. Kind and extent of the implements are characteristical for a versatile and universal utilisation of the locomotive in tropical countries and guarantee an economical and troublefree operation.

The design of this locomotive results from thorough consideration of the technical board of the Indian State Railways who cooperated with the MaK having a long standing experience in designing Diesel hydraulic locomotives.

MaK Diesel hydraulic locomotive 650 HP for tropical service, axle arrangement C (0—6—0)

PRINCIPAL DATA

Axle arrangement	C (0—6—0)
Dimensions	
Gauge	1676 mm
Length over buffers	10700 mm
Total wheel base	4400 mm
Maximum height	4157 mm
Maximum width	3030 mm
Diameter of driving wheels	1092 mm
Overall moving dimensions	MAXIMUM MOVING DIMENSIONS Indian State Railways (LSC Drg. No. 19 Profile B)
Weights	
Operational weight (adhesive weight)	55,5 long tons
Axle load	18,5 „ „
Speeds	
with half worn tyres	
Shunting speed	27 km/h
Line service speed	65 km/h
Output of Engine	
at 1600 r. p. m. at district of operation i. e.	
at an elevation of 600 m above sea level, 55° C	
ambient air temperature and 60% relative air humidity 600 HP	

CZECHOSLOVAK DIESEL LOCOMOTIVES

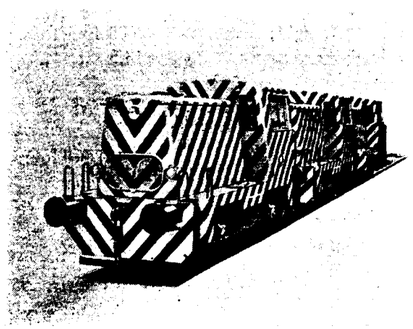
By Ing. L. Krejsa
ČKD Praha Research Centre

THE intense evolution of industrial production in the whole world naturally imposes continuously increasing demands on systematic modernization of tractive rolling stock.

The CKD Praha Works, which is entrusted with the development of diesel locomotives, has upheld the good reputation it has acquired during many years of traditional building of steam locomotives and prepared in a relatively short time a whole series of types of up-to-date diesel locomotives.

The whole range of required outputs is covered by two types of CKD diesel engines which, complemented with TATRA engines and built with different numbers of cylinders and different degrees of supercharging, have enabled the design of a suitably graduated line of diesel locomotives.

The smallest of them is the 1435 BN 150 two-axle locomotive which is intended for light shunting in industrial works and in small railway stations. It is fitted with a twelve cylinder, four-cycle, air-cooled TATRA 111 A diesel engine of 165 b. h. p. at 1600 r. p. m. and a mechanical, four-speed fully synchronized gearbox. This design has proved a well chosen one in view of the range of use of these locomotives.



Locomotive 1435 B 150 for Egypt

As TATRA 111 A diesel engines operate reliably in Czechoslovak lorries abroad, the securing of spare parts and their servicing present no difficulties. In addition, the co-operation of the TATRA diesel engine and the mechanical gearbox has been fully verified in railcars so that the most advantageous tractive qualities could be chosen for the locomotive. The fact that the wheelsets are driven through cardan shafts merits attention, since it is not a common solution in locomotives of this class and influences the running and tractive qualities of the locomotive very favourably.

Another significant advantage of this locomotive is the use of an automatic air brake which enables the locomotive to haul even such loads which it could not brake alone in view of its adhesive weight of 22 tons.

Its good tractive qualities, reliability and simplicity of design, the possibility of its use after minor adaptations for gauges of 900 to 1676 mm have proved of great attraction to a wide circle of customers even in countries with great climatic fluctuations as, for example, Egypt, China, India, the USSR, etc., enabling its manufacture in large series which is unusual in the locomotive line.

Extensive development, design and laboratory work have enabled Czechoslovak industry to attain outstanding successes also in diesel locomotives with hydrodynamic power transmission of 400, 700 and 2 × 700 b. h. p. All these locomotives possess a number of common characteristics.

In the first place there is the general arrangement with a central cab and an elevated driver's stand, which guarantees both a perfect view of the track and the track signals as well as of the buffers during shunting. Great care has been taken with regard to the equipment and arrangement of the driver's panel and the equipment of the cab, which ensure a perfect work milieu. There is practically no difference in the design of the driver's stand in shunting or line locomotive. Lagging and sound insulation, safety glass, perfect heating and ventilating of the cab and

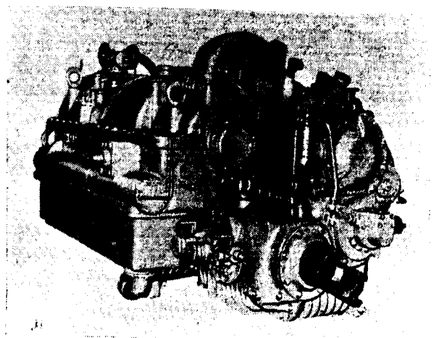
suitable seats are a matter of course. Not only railway specialists, but also doctors are consulted as to the suitability of the general arrangement of the cab. With regard to their machinery equipment Czechoslovak diesel-hydraulic locomotives are characterized by their wheelsets being driven by cardan shafts (even in the 400 b. h. p. diesel locomotive with three driving wheelsets in a rigid frame), the use of two-stage gearboxes with a higher transmission ratio, of bogies similar in design, a two-speed regime, electrical drive of the cooler fans and the use of diesel engines with a 170 mm bore and a maximum of 1400 r. p. m.

For medium shunting and operation on secondary lines the 1435 C 400 locomotive is intended. It is fitted with a hydrodynamic gearbox and a CKD type 12 V 170 DR diesel engine. This is a twelve-cylinder, four-cycle, water-cooled engine with V-arrangement of the cylinders and direct fuel injection whose output with natural suction is 410 h. p. at 1360 r. p. m. The CKD-made hydrodynamic gearbox with two converters connected to the diesel engine by means of a torsionally elastic clutch is combined with a mechanical gearbox containing a reversing and a reduction gear, which enables the locomotive to operate with advantageous tractive parameters both in shunting service at a maximum speed of 30 km p. hr. and in line operation at a maximum speed of 60 km p. hr. All three driving wheelsets of the locomotive are driven through cardan shafts as in the case of the 1435 BN 150 locomotive.

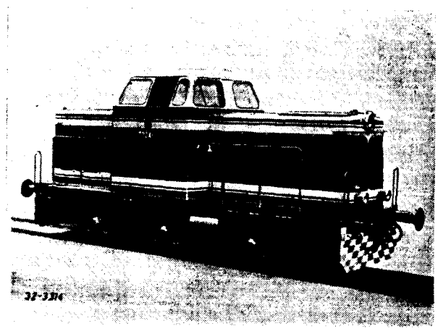
The diesel engine together with the hydrodynamic gearbox and two brake compressors, which can be disconnected independently as required are placed under the forward casing, while the cooling equipment of the diesel engine and of the engine and gearbox oil is situated under the rear casing of the locomotive. Not only during tests but also in heavy railway operation has this locomotive proved its reliability and suitability for all kinds of shunting work.

By the use of a supercharger an output of 700 h. p. at 1400 r. p. m. has been attained with the twelve-cylinder engine of a 170 mm bore. This diesel engine, designated the K 12 V 170 DR, together with a three-converter hydrodynamic gearbox form the basis of both the type 1435 B' B' 700 locomotive with one power unit and of the type 1435 B' B' 1400 locomotive with two power units.

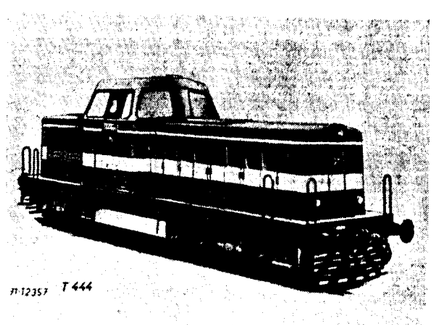
Its low weight and low axle loads (13 tons) predestine the 1435 B' B' 700 locomotive for operation on lines with a low carrying capacity. It is suitable for both medium heavy shunting and for line operation, as the three converter hydrodynamic gearbox is fitted, as in the case of all other Czechoslovak diesel-



Hydraulical gearbox H 650



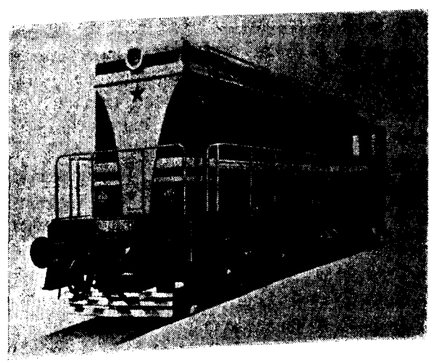
Locomotive 1435 C 400



Locomotive 1435 B' B' 700

hydraulic locomotives, with a mechanical gearbox containing, besides the reversing gear, also a reduction gear making possible shunting at a maximum speed of 35 km p. hr. and in line operation at a speed of 70 km p. hr. with maintenance of the most suitable traction characteristics.

For the 1435 B' B' 1400 locomotive with two power units speed ranges of 50 and 100 km p. hr. have been chosen in view of their intended purpose, viz. heavy shunting and/or goods and passenger service on secondary lines. For special purposes a 1524 B' B' 1400 locomotive has been designed provided with the same machinery, but built for a 1524 gauge. Its total weight is 80 tons, its speed ranges being 35 and 71 km p. hr. The running gear of all dieselhydraulic locomotives of 700 and 1400 h. p. is of the B' B' arrangement. The design of the bogie deserves attention as it is very progressive. It deviates from the classical type and, in spite of its extraordinary simplicity, very good running qualities have been attained. The wheelsets of these two-axle bogies are guided by rocking arms without longitudinal play, but with transverse yielding. This kind of wheelset guiding together with the suspension of the locomotive body by means of vertical links, which replace transverse springing to a certain degree, decrease transversal accelerations in a remarkable way and, in connection with sufficiently soft vertical springing, in which system laminated springs are not used, guarantee outstanding running qualities of the locomotives even at their highest speeds. The output is transmitted from the hydrodynamic gearboxes to mechanical two-stage wheelset drive boxes by cardan shafts at higher revolutions, and, consequently, smaller torsional moments, which substantially decreases their mechanical stresses and ensures their long service life.



Locomotive 1524 B' B' 1400

As a considerable number of rubber elements has been used in the design of bogies, the exigencies of lubrication and the transmission of noise from the running gear to the locomotive body structure have been greatly reduced.

Reliable operation of the locomotive even in difficult operational and climatic conditions is ensured by a sufficiently dimensioned cooling system. Automatic regulation of the diesel engine cooling water temperature is ensured in all locomotives by changing the revolutions of the axial cooling blowers in accordance with the load of the diesel engine, or by switching on or disconnecting of the electrical motors by which they are driven. The cooling arrangement is dimensioned so as to be able to cool not only the diesel engine itself, but also the gearbox oil to such an extent as to guarantee maintenance of the maximum speeds of all hydraulic locomotives in accordance with the purpose of their utilisation.

The spheres of the highest outputs are covered in Czechoslovak diesel locomotives by electrical transmission. For medium outputs only one type of diesel electric locomotive, designated the 1435 Bo' Bo' 750, has been developed and is being built in large series, not only in its original design, but also in a modification designated the 1524 Bo' Bo' 750. These diesel electric locomotives of 750 h. p. belong among the most successful Czechoslovak models. They are intended both for shunting and for line operation, in which they have proved well even when hauling passenger trains, as they run with a maximum speed of 80 km p. hr. being able at the same time to develop the necessary high values of continuous tractive effort for shunting and goods operation. The extensive applicability of these locomotives is favourably influenced on one hand by their being provided with controls in multiple, making it possible to drive several units with a sufficient output from one driver's stand and, on the other hand, by the fact that the nominal axle pressures of the locomotive of basic design do not exceed 15 tons.

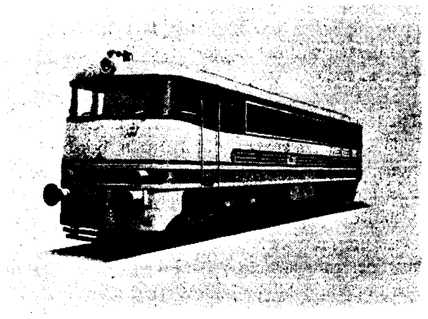
The locomotives are provided with a CKD type 6 S 310 DR diesel engine of 310 mm bore. This six-cylinder water-cooled diesel engine with the cylinders in line and a nominal output of 750 b. h. p. at 750 r. p. m. operates in a. wide range of outputs with a full consumption of less than 165 g. p. h. p. hr. Its robust design guarantees its long service life under difficult operational conditions. The crankshaft of the engine is coupled directly to the main generator, which feeds the four traction motors of both two-axle bogies.

Though the bogies of the locomotive are provided with normal axle hung electromotors and no mechanical or electrical arrangements have been used which would eliminate the unfavourable influence of the change in axle pressures upon the values of the maximum tractive efforts, a tractive effort of 21 tons has been attained during the starting of a 60-ton locomotive, which corresponds to a coefficient of adhesion of 0.35 in relation to the total weight of the locomotive and 0.46 in relation to the most relieved wheelset. This outstanding result has been achieved due to control of the power stages being affected by a servomotor and automatic control of the starting currents by simple means, covered by a Czechoslovak patent. Not only the tractive qualities but also the economic qualities of this locomotive surpass the common level. The high efficiency of the diesel engine and of the electrical traction machines together with the low passive resistances of the locomotive have enabled attainment of a total thermal efficiency exceeding 30.5 per cent in relation to the wheel rims.

The satisfactory experience gained with the 6 S 310 DR engines of 700 h. p. has enabled the development and use in diesel locomotives of higher outputs of the K 8 S 310 DR engine, an eight-cylinder version, which attains with low pressure supercharging 1650 b. h. p. in 1435 Co' Co' 1650 locomotives and which, with medium pressure supercharging is designated the SK 8 S 310 DR 2000 in the 1435 Co' Co' 2000 locomotive.

The 1435 Co' Co' 1650 locomotive is intended as a general line service locomotive and can be built with different gear ratios of the wheelset drive.

In express train traffic it attains, with a corresponding gear ratio, a maximum of 120 km. p. hr., in goods traffic 85 km p. hr., maintaining a continuous tractive effort of 19450 kg. This locomotive is provided with multiple controls permitting the control of two coupled locomotives from one driver's stand.



Locomotive 1435 Co' Co' 1650

In the design of the bogies a number of the same elements has been used as in the bogies of the hydraulic locomotives. In the first place there is the guiding of the wheelsets by means of rocker arms and the manner of suspension of the locomotive body on the bogies.

With regard to utilization of the diesel engine in the maximum range of starting speeds group connection of the traction motors in a ratio of 2 to 3 has been used, besides shunting, both being carried out automatically. Regulation of the output is effected in a technically perfect manner by changing the excitation of the main generator by means of a very sensitive hydraulic governor which receives impulses from a tachometer dynamo. This kind of regulation guarantees adjustment to the condition of the diesel engine and thus prevents overloading.

Though very good results have been obtained with this locomotive during tests and in operation (maximum tractive effort over 31000 kg, maximum speed 152 km p. hr.), it has proved necessary, in view of the anticipated traffic requirements, to modernize the 1345 Co' Co' 1650 locomotive. Besides an increase of the power of the locomotive to 2000 b. h. p. the results of this modernization have been some changes in its design influenced by operational experience and by the endeavour to attain the greatest possible simplicity and reliability. The modernized 1435 Co' Co' 2000 locomotive is provided with driver's cabs at both ends. Its maximum radius of action is 1000 km. By an increase of the wheelbase of the bogies a very low load per metre has been obtained. Simplification of the regulating gear has contributed to increased operational reliability. The increased shunting of the traction motors has made it possible to abandon their connection groups, a power compensator in co-operation with a main generator exciter replacing the previous much more complicated and, with regard to maintenance, more exacting regulation.

The Czechoslovak industry was not unprepared for the changeover to modern systems of traction. On the contrary, in a short time it has taken a good step forward in the building of diesel locomotives and that is why its contemporary state enables the Czechoslovak industry to build reliable and highly efficient traction vehicles which meet all, even the most exacting requirements of modern transport. This is fully confirmed by the successes of Czechoslovak diesel locomotives in Egypt, the USSR, Germany, China, and a number of other countries.

SPECIFICATION OF CZECHOSLOVAK DIESEL LOCOMOTIVES

Type	1435 B 150	1435 C 400	1435 B′ B′ 700	1435 B′ B′ 1400	1524 B′ B′ 1400	1435 Bo′ Bo′ 750	1524 Bo′ Bo′ 750	1435 Co′ Co′ 1650	1435 Co′ Co′ 2000
Power Transmission	mech.	hydr.	hydr.	hydr.	hydr.	elec.	elec.	elec.	elec.
Wheelset arrangement	B	C	B′ B′	B′ B′	B′B′	Bo′ Bo′	Bo′ Bo′	Co′ Co′	Co′ Co′
Rated output of diesel engine according to UIC b.h.p.	165	410	700	1400	1400	750	750	1650	2000
Maximum speed km.p.hr.	40	30/60	35/70	50/100	35/70	70	80	85/120	100
Tractive effort at starting coeff. of adhesion 0.25 *kp.*	5600	10500	13000	16500	20000	15000	18500	27000	27750
Continuous tractive effort *kp.*	—	—	—	—	—	10400	10400	19450 13850	19800
Minimum curve radius m.	60	80	100	100	100	70	70	120	120
Length over buffers mm.	7240	9440	12640	15840	17420	12560	13260	16000	18000
Total wheelbase mm.	2800	4200	9600	12800	12800	8700	9100	11540	13500
Bogie wheelbase mm.	—	—	2400	2400	2400	2400	2400	3500	4000
Distance between bogie pivots mm.	—	—	7200	10400	10400	6300	6700	8230	9560
Diameter of driving wheels mm.	1000	1000	1000	1000	1050	1000	1050	1000	1000
Weight in service/tolerance ± 3 per cent Mp.	22	42	52	66	80	60	74	108	111
Axle pressure/tolerance ± 3 per cent/Mp.	11	14	13	16.5	20	15	18.5	18	18.5
Fuel tank capacity litres	350	1000	4000	3000	6000	1500	3500	2500	6000

Electronic Computer Speeds Alco Products' Renewal Parts Service to Railroads throughout the World

By An Engineering Correspondent

ALCO Products, Inc., an American firm with more than a century of experience in the manufacture of locomotives, has introduced a new concept into the business of locomotive renewal parts service. It is an electronic computer designed to process orders and keep up-to-date inventory for 15,000 different locomotive spare parts.

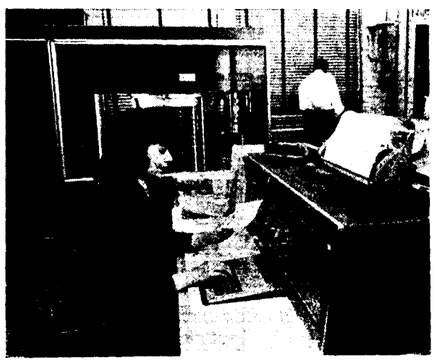
Railroads in Europe, Asia, Africa and Australia, as well as in North and South America, are supplied with locomotive parts from three widely separated ALCO warehouses in the United States. On the Atlantic Coast is the warehouse at North Bergen, New Jersey; 3,000 miles away on the West Coast is ALCO's renewal parts center at Los Angeles, California, and on the Mississippi River, midway between, is the warehouse at St. Louis, Missouri.

A "rush" order to any one of these warehouses can now be accurately and efficiently processed and on its way back to the customer in a matter of minutes. The regular routine orders are normally processed through the same system in 24 hours.

Compare this with the old-fashioned manual method of handling orders, which could consume several days' time.

CONTROL CENTER—This is a general view of the RAMAC control center at Alco Products' offices in Schenectady, New York. It is the headquarters for the firm's modern system of supplying locomotive renewal parts from three strategically-located warehouses in the United States.

The operator in the foreground here is using a tape-to-card machine to transfer the order information received by Teletype from a warehouse to cards that can be fed into the RAMAC computer (center rear). At right, RAMAC Supervisor Thomas Manogue checks page copy on a machine that relays shipping directions back to the renewal parts warehouse.



MODERN INVENTORY CHECK—At ALCO's new RAMAC computer control center in Schenectady, New York, Mrs. Mary Carbin, RAMAC operator, feeds inventory inquiry into computer (background). Computer will disclose, in an instant, the stock balance for a given locomotive renewal part at ALCO warehouses in North Bergen, New Jersey: St. Louis, Missouri, and Los Angeles, California. The system is first of its type in railroad-equipment supply industry.

The heart of ALCO's new system is an IBM RAMAC 305 electronic computer located at the Schenectady, New York headquarters. This control center is linked with the three warehouses by Teletype printer and tape connections over lines leased from the American Telephone and Telegraph Company.

The RAMAC (which stands for "random access method of accounting and control") computer can store up to 5,000,000 electrical impulses of informa-

tion on 50 " memory " discs, which rotate at 1250 revolutions per minute.

The memory unit is six feet high, three feet wide, and with its supporting card-handling and paper-tape equipment is nearly 36 feet long. The installation is enclosed in an air-conditioned room under constant temperature and humidity control, in order to assure maximum efficiency.

The electronic computer " knows " just how many parts of every kind are in each ALCO warehouse, even to the specific bins in which they are located. An order received at one of the warehouses is transmitted over teletype to the control center at Schenectady. The information is then fed into the computer, which produces a punched tape that is relayed back to the warehouse to direct the shipment of the necessary part.

At the same time the RAMAC performs two other vital functions which normally would be slower in manual order-processing. It produces the invoices and other papers needed for billing the customer, and it continually adjusts its inventory to account for each part shipped.

R. B. Fairman, marketing manager for ALCO's transportation division, said :

" The inventory-control feature of the system is of immense value to railroads because it adds to the effectiveness of ALCO's regional warehouse network. The system does not require the customer to change his method of ordering parts, nor increase the cost of his procurement program."

The new ALCO electronic inventory-control and order-processing system benefits the customer by giving him speedier parts service, and also—equally important—minimizes the possibility that the part he has ordered will be out-of-stock. ALCO benefits obviously because of the accurate, efficient renewal parts service that it has been able to pass along to the railroads of the world, which are its customers.

INDUSTRIAL LIGHTING FITTINGS WITH METAL REFLECTORS

The Indian Standards Institution has just published IS : 1777-1961 Specification for Industrial Lighting Fittings with Metal Reflectors, which covers a range of general type of industrial lighting fittings with metal reflectors for use with incandescent, mercury-vapour and fluorescent lamps. The standard lays down requirements with regard to material, sizes of reflectors, accessories in fittings for tubular fluorescent lamps, finish, luminous output and distribution of light, and sampling inspection of these industrial lighting fittings. Consequent upon the publication of this standard, opportunity is now available to the manufacturers of industrial lighting fittings to apply to the Indian Standards Institution for licences under the ISI (Certification Marks) Act, 1952, for marking their products with ISI Standard Mark to indicate that the products bearing the Standard Mark conform to the provisions laid down in the standard.

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CAPACITORS FOR ELECTRIC DISCHARGE LAMPS

The Indian Standards Institution has formulated a draft Specification for Capacitors for Electric Discharge Lamps which lays down the basic mechanical and electrical requirements and methods of tests for such capacitors when used with mains voltage not exceeding 250 volts (preferred voltages being 230 V and 240 V) and at a frequency of 50 c/s. This draft standard, however, does not cover the requirements of interference suppression capacitors.

Performance of Electric Discharge Lamps such as Fluorescent Lamps and Mercury Vapour Lamps is dependent on the characteristics of the auxiliaries with which the lamps are used. Capacitors are used in the circuit of electric discharge lamps as the series reactor for limiting the current through the lamps with minimum power loss, as a power factor correcting device and to assist the starting of the lamp.

This draft standard will shortly be put in wide circulation to all interested parties for eliciting technical comments. These comments will then be taken into consideration before this draft standard is finalized and published as an Indian Standard.

ITALIAN BOGIE LOCOMOTIVE

General-purpose diesel-hydraulic design for secondary standard-gauge railway with 12.5-ton maximum axle load

THE large use of diesel railcars and locomotives on the Italian State Railways has been supplemented since before the war by many railcars on the numerous Italian private railways both on the mainland and in Sardinia. Within the last four or five years diesel locomotives also have been introduced on the standard-gauge and narrow-gauge private lines, and now go up to a peak output of 1,000 b. h. p. In all cases they have a low axle load, and a resulting low total weight, for a double-bogie four-axle layout is universal. Both diesel-electric and diesel-hydraulic locomotives have been constructed, but it is noteworthy that in the most powerful range so far built the same engine model is used with both types of transmission.

GENERAL PARTICULARS

Latest of the more powerful line-service locomotives is a 920 b. h. p. B-B diesel-hydraulic unit of 1,435 mm. (4 ft. 8½ in.) gauge built for the Reggio Emilia system (officially the Consorzio Cooperativo Ferrovie Reggiane), an 80-km. (50 mile) line having about 20 railcars and three other diesel locomotives, by Reggiane Off. Mec. Italiane S. p. A, better known as Nuove Reggiane. This is a diesel-hydraulic unit equipped with one M. A. N.-type L 12 V 17.5/21B engine built under licence by Reggiane, and driving all wheels through one Twin Disc hydraulic torque converter, friction clutch, intermediate gearboxes and cardan shafts. This locomotive weighs 46 tonnes empty and 48.6 tonnes with all supplies on board, those supplies comprising 1,500 kg. (3,300 lb.) of fuel oil, 550 kg. (1,210 lb.) of water, 250 kg. (550 lb.) of lubricating oil, 100 kg. (220 lb.) of converter oil, and 200 kg. (440 lb.) of sand. The normal traction output of the engine is 920 b. h. p., so that the power : weight ratios are equivalent to 19 b. h. p. per tonne of service weight or 52.8 kg. (116 lb.) per b. h. p. No train-heating equipment is installed.

Wheel dia. is 1,000 mm. (39.4 in.), bogie wheelbase 3.0 m. (9 ft. 10 in.), bogie pivot pitch 6.76 m. (22 ft. 1 in.), and length over headstocks 11.96 m. (39 ft. 4 in.) Height and width are normal for Continental diesel locomotives at 4.02 m. (13 ft. 2½ in.) and 3.0 m. (9 ft. 10 in.) respectively. Starting tractive effort at 30 per cent adhesion is 14,600 kg. (32,100 lb.). Because of general track conditions top speed is limited to 82 km. p. h. (15 m. p. h.), but in order to get the best possible performance throughout the whole track speed range an alternate-step set of gears has been fitted, a freight-train ratio giving a top speed of 54 km. p. h. (33.5 m. p. h.) and a passenger-train ratio giving a top speed of 82 km. p. h. (51 m. p. h.). The speed-tractive effort characteristics given by this arrangement are shown in Fig. 4. In its general layout the locomotive is of central cab type with machinery compartments at each end; one housing the engine, engine-driven compressor, battery and other details, and the second one has the cooling group and other items.

ENGINE EQUIPMENT

The engine has a dozen cylinders 175 mm. by 210 mm. arranged in two banks at an angle of 60 deg., and is pressure-charged by a single turbo-blower group at the driving end. The one-hour output in this installation and with the latest form of M. A. N. pressure-charger is 920 b.h.p. at 1,400 r.p.m., and the continuous output 825 b. h. p. at 1,300 r. p. m.

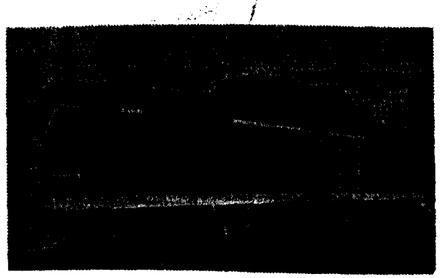


Fig. 1—49-tonne B-B diesel-hydraulic locomotive of 50 m.p.h. top speed for local traffic.

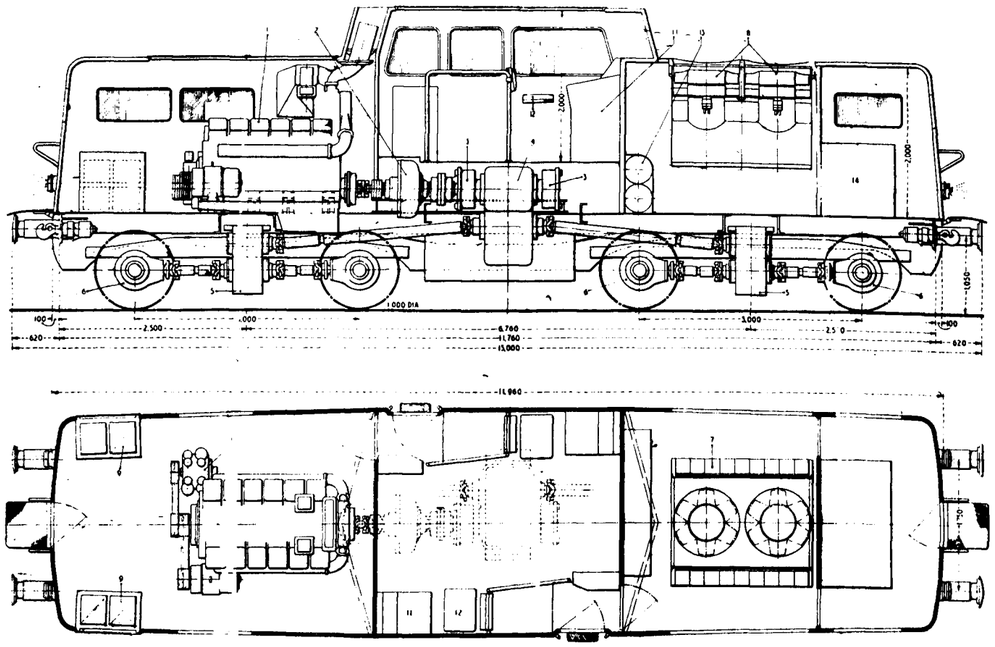


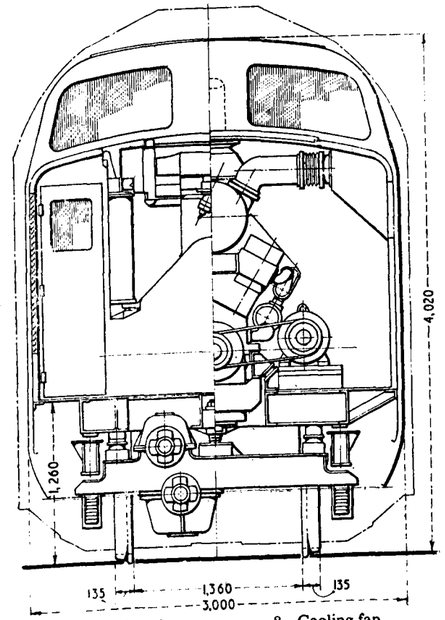
Fig. 2—General arrangement of 920 b.h.p. B-B diesel-hydraulic locomotive for the Reggio Emiliana District Railways (key on opposite page)

Specific fuel consumption at the one-hour rating is 173 gr. per b. h. p. hr. and the optimum consumption is 168 gr. at 1,075 r. p. m. and 770 b. h. p. Dry weight of the engine alone is 3,060 kg. (6,740 lb.), or 3.33 kg. (7.35 lb.) per b. h. p. against the one-hour output.

This four-valve head engine is the M. A. N. forerunner of the L12V18/21 engine and, as many details are similar, nothing further need be said here about its construction. Starting is by a 15 h. p. motor fed with 64-volt current from a battery, charged by a 1,500-watt engine-driven dynamo. Lubrication is along normal lines, but there is an electrically-driven pre-lubrication pump to build up pressure in the main rail before the engine actually starts; an Auto-Klean strainer is fitted in the oil circuit along with a felt-type filter. The 1,780-litre (390 gal.) main fuel tank is located between the bogies, and an electrically-driven transfer pump lifts the fuel from it to a service tank above the engine, from which the flow is by gravity to the injection pumps in the neck of the V between the cylinder banks. The engine is carried on a welded steel subframe which is mounted on the locomotive frame through four rubber blocks.

Two side radiator banks and two roof fans comprise the cooling group, and the whole is mounted as one block in the machinery casing remote from the engine. Air is pulled in through the side grilles and ejected upwards. The two fans are driven hydrostatically with one engine-driven pump and two motors, and the regulation is under thermostatic control. In addition to cooling the engine water, which also passes through the engine-oil heat-exchanger, the radiators cool the transmission oil and the gearbox oil, in a separate water circuit. There is a double centrifugal pump unit on the engine to maintain the water circulation in both circuits.

Protection is given to engine and hydraulic transmission operation by the usual devices covering lubricating oil pressure and temperature, water temperature, water level, engine overspeed and torque-converter oil temperature. All of these devices give visual indication at the driving position and



1—Main diesel engine
2—Torque converter
3—Main clutch
4—Reduction-reverse gears
5—Alternate-speed gears
6—Axle drive
7—Radiator
8—Cooling fan
9—Battery
10—Air compressor
11—Driving desk
12—Drop seat
13—Air reservoirs
14—Cubicle

Fig. 3—Cross-section of Reggiane locomotive

either shut-down or idling of the engine; too high a temperature of water or oil gives only a visual warning by the lighting of a lamp in the cab.

TRANSMISSION

Arrangement of the whole transmission is shown clearly in the locomotive arrangement drawing and transmission diagram reproduced with this article. The torque converter, from the Twin Disc works at Rockford, U. S. A., is the model 1F-16000, the largest so far used in traction applications. This has a maximum input capacity of 1,000 h. p. or more at 1,400 r. p. m., and so is easily rated compared with what can come to it from the particular engine installed. Actually this converter in being closely matched to the engine has been provided with the blading to give Twin Disc's Ms-450 torque rating, equal to 850 h. p. input at 1,400 r. p. m. thus taking the engine output less 70 h. p. absorbed by auxiliaries. This rating is equal to a maximum torque of 450 × 10.5 = 4,720 lb.-ft.

The converter is of the usual three-stage type favoured by Twin Disc for traction applications. In these the impeller consists of a pump wheel, pump ring and pump blades riveted into a complete assembly; a turbine comprising a wheel, a ring and three sets of blades made up into a permanent assembly; and a turbine housing consisting of an outer housing and two sets of stator or reaction blades, the second-stage stator blades in the size 16000 converter being riveted into a sub-assembly which in turn is assembled in the housing by flat-head machine screws. The purpose of the impeller is to absorb the power output of the engine into the converter, where it can be transmitted to the load by the turbine at the correct speed-torque ratio, the turbine wheel being the member which transmits the proper speed-torque ratio to the driven shaft. In the housing, the purpose of the reactor blades is to re-direct the flow of the fluid between the stages of the turbine so as to direct it against the next succeeding set of turbine blades at the proper angle to secure the necessary speed-torque ratio.

In converters of this type the torque capacity varies in relation to the square of the input speed; horse-power capacity varies in relation to the cube of the input speed; and torque and h. p. capacity vary in

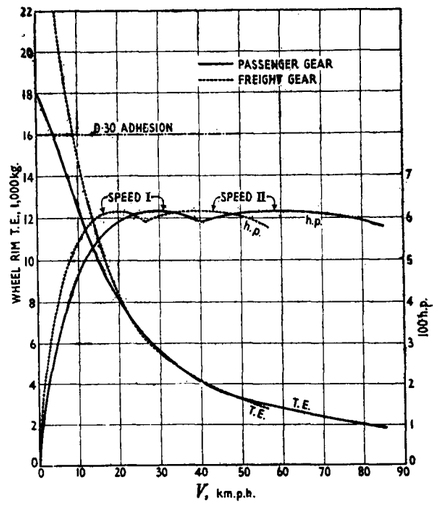
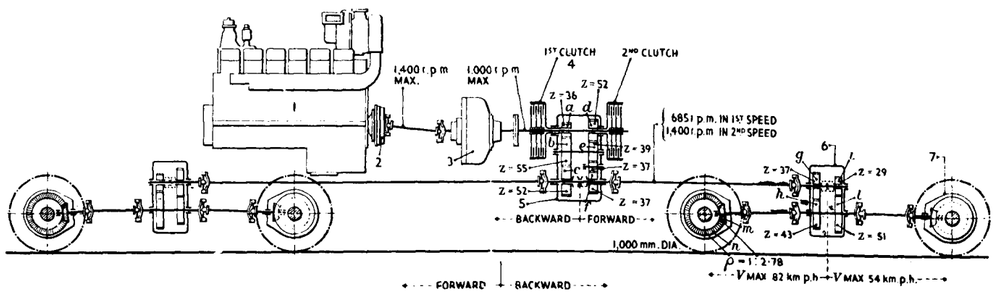


Fig. 4—Speed-tractive effort curves of 920 b.h.p. 49-tonne B-B diesel-hydraulic locomotive



1—Main engine 2—Flexible coupling 3—Torque converter 4—Main friction clutch 5—Reverse/reduction gearbox 6—Alternate-speed gears 7—Axle drives

Fig. 5—Arrangement of hydraulic transmission, reduction gears and cardan-shaft drive to all axles of Reggiane 920 b.h.p. locomotive

	Wheel sequence		Top speed km.p.h.
Freight gear	IA Forward	$\frac{a}{b}\times\frac{e}{f}\times\frac{i}{l}\times\frac{m}{n}=0.141$	26.5
	IIA ,,	$\frac{d}{f}\times\frac{i}{l}\times\frac{m}{n}=0.287$	54.0
	IA reverse	$\frac{a}{c}\times\frac{i}{l}\times\frac{m}{n}=0.141$	26.6
	IIA ,,	$\frac{d}{e}\times\frac{b}{c}\times\frac{i}{l}\times\frac{m}{n}=0.288$	54.3
Passr. gear	IA Forward	$\frac{a}{b}\times\frac{e}{f}\times\frac{g}{h}\times\frac{m}{n}=0.213$	40.2
	IIA ,,	$\frac{d}{f}\times\frac{g}{h}\times\frac{m}{n}=0.435$	82.0
	IA Reverse	$\frac{a}{c}\times\frac{g}{h}\times\frac{m}{n}=0.214$	40.3
	IIA ,,	$\frac{d}{e}\times\frac{b}{c}\times\frac{g}{h}\times\frac{m}{n}=0.436$	82.2

relation to the fifth power of the pump or impeller diameter. Converters have to be matched to the engine for full-throttle top speed operation, and it is general practice to have the converter absorb this power at a point where converter output torque is equal to input torque, which is the point of the specific torque, or Ms, rating mentioned previously. The stall torque ratio, or torque ratio when the output shaft becomes stalled, is commonly 5 to 1 or more.

A feature of all Twin Disc standard converters, including the 16000 model used in the Italian locomotive, is that seven different specific torque ratings are possible, for the rating or capacity of the pump wheel can be changed by varying the number of blades and varying the blade angle. The whole converter is built to interchangeable limits, and all the possible modifications of blade length and angle are also production standards made to the same interchangeable limits. An extension in the capacity range can also be made by using either short or long blades in the third stage of the turbine blading, and actually in the series 16000 the long blading is used throughout.

A particular feature of this Italian transmission, which was engineered throughout by Twin Disc in Europe, is that the torque converter is separated from the engine and is driven from it through a cardan shaft; in most Twin Disc installations of smaller size, for example, with the series 11,500 converter, the converter is attached to the engine, but with the large 16,000 size this is not practicable even if locomotive design permitted it, and the present layout is in line with what is found in most diesel-hydraulic locomotives. On the output side of the converter, and mounted with it on a common subframe, is first a friction clutch by means of which the converter (and so, also, the engine) can be disengaged from the remainder of the transmission and from the wheel-and-axle sets; and, secondly, a two-speed gearbox and reversing gears. Change from one step to the other of these gears can be made while the locomotive is running, and with little drop in tractive effort or speed. The gear-change clutches are of friction type. The reversing gears are shifted by compressed air, but

this can be done only with the locomotive at rest. To facilitate maintenance and erection, the main friction clutch is outside the gearbox. The subframe carrying the converter and change-speed/reversing box is supported to the locomotive frame through elastic mountings.

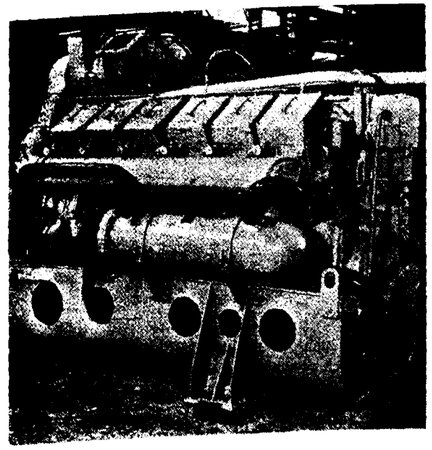


Fig. 6—Reggiane/M.A.N. model L12V17.5/21B engine of the type installed in the C.C.F.R. Italian locomotive

This converter-gearbox assembly is followed in the transmission line by alternate-speed (freight and passenger) gearboxes on each bogie, and driven from the preceding two-speed box by cardan shafts. This combination means that in either freight or passenger range there are two speeds available to carry the track speed from zero up to the highest speed in the step, i. e. to 54 km. p. h. or 82 km. p. h. (33.5 or 51 m. p. h.), so that the converter can always operate in a belt of high efficiency. The ratios of these gears and the track speeds at which change-over can be effected are shown against Fig. 5. The alternate-speed gears can be shifted only with the locomotive at standstill. Final cardan shafts take the torques to the bevel axle drives.

Bogies are of swing-bolster type, with the bolster supported on an inverted laminated spring at each side, with open-link Rangers to the bogie frame longitudinal. The roller-bearing axleboxes have a helical spring group at each side, the two groups for a box being supported on a beam pivoted at its centre to the bottom of the axlebox. The axlebox guide surfaces are in a plastic material. Traction and braking forces between bogie frame and bolster, and also the transverse forces, are transmitted through thrust faces having friction-plastic linings. The body weight is supported on the bogie through the centre pivot and through two side sliding surfaces running in an oil bath.

Westinghouse straight and automatic air brakes are fitted, the air being furnished by a compressor belt driven off the engine at a top speed of 1,300 r. p. m. and having an aspiration of 1,285 litres per min. Pressure in the storage reservoirs is 10 kg. per sq. cm. (142 lb. per sq. in). The rigging for each wheel is actuated by an individual 7-in. cylinder, which applies two blocks per wheel. The auxiliary brake reservoirs are carried on the bogies and the main reservoirs on the locomotive frame. Air from the main system is applied also to the sanding, for which there are two boxes on each bogie; and the air also operates the reversing and alternate speed gears.

Superstructure construction is normal, with welded cab and machinery-casing sub-assemblies above an underframe welded up of rolled sections and plates. The interior of the large cab is fully lined with heat and sound insulation; and the floor contains large inspection covers to give access to the main transmission constituents beneath. The cab is reached through two side doors, inside of which are steps leading up to the raised floor. The forward side windows are of sliding type, otherwise all cab windows are fixed, and pneumatically operated windscreen wipers are placed on the end windows.

All the control handles and instruments are to the standards used by the F. S. (Italian State Railways). As usual in diesel-hydraulic locomotives, there is only one traction control handle regulating the fuel injection to the engine. The passage from one step to another in the two-speed box behind the torque converter is made automatically in accordance with the rotational speed of the converter output shaft. After position O of the traction control handle, at which the engine is idling and the main clutch is disengaged, there comes position 1 at which the engine is idling, the main clutch is engaged and the lower of the two speed steps engaged. Thereafter movement of the traction handle gives infinitely-variable control by electro-pneumatic apparatus.

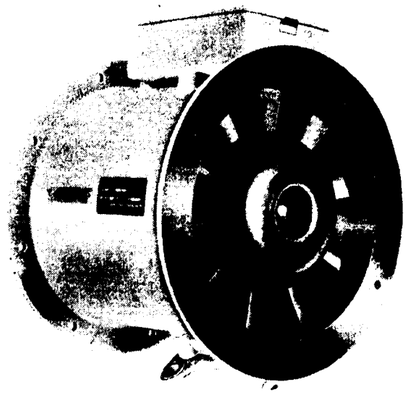
(By kind courtesy of Diesel Railway Traction, London)

PLANNAIR'S CONTRIBUTION TO INDUSTRY

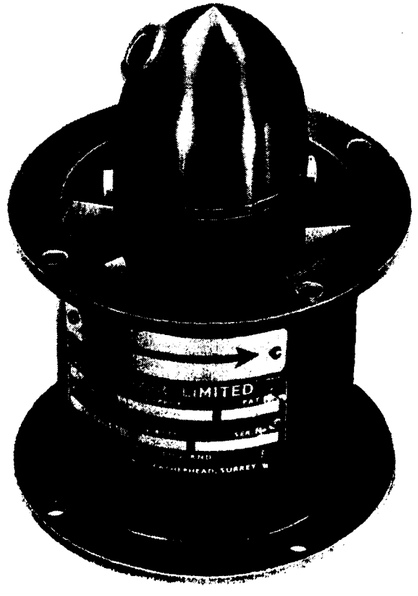
By An Engineering Correspondent

THIS introduction to the products of Plannair Limited will emphasise the very wide fields in industry, commerce and home where applications for ventilating, cooling and temperature control of air are currently being fulfilled. Wherever electronic or auxiliary plant is installed the problems of heat dissipation and transfer are continually solved by our range of axial and centrifugal blowers.

Applications in this sphere submit the equipment to the most severe climatic, unstable temperature and pressurised conditions and it is within these parameters that Plannair components are designed. Manufacture of equipment to these standards demands continued research and development into new materials, processes, and more rigorous environmental tests, and it is in this respect that Plannair have come to the fore as manufacturers of air flow and air control plant. Due to the constant miniaturisation of components in the electronic and allied industries, great emphasis is placed on obtaining the optimum size-weight-performance ratio; allied to this trend for compactness, is the requirement for higher precision and stress free components, and to meet these, Plannair use extensively cast structures in the alloy base materials to avoid any fabrication with its inherent failures.



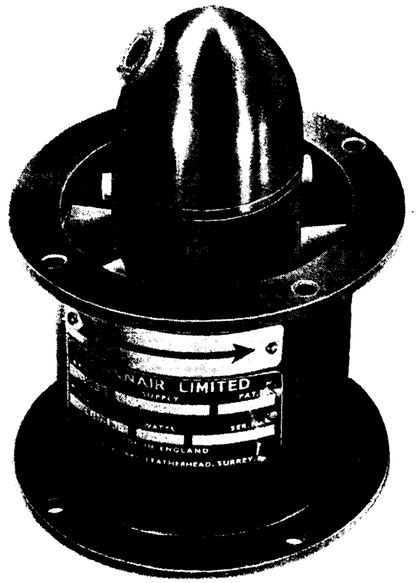
This 28 volt D.C. axial unit will give 440 C.F.M. at 2.8" W.G. weighing 10½ lbs. it is available in either standard or silenced form as are all Plannair axial units.



A 2PL81-135 axial blower unit operating from a 400 C.P.S. supply and giving an air displacement of 35 C.F.M. at .85" W.G. This unit weighs only 12 ozs. and is tropicalised for either airborne or ground use.

In the field of nuclear and marine engineering, our equipment is used for boosting and regulating gas flow over test channels. These applications reach temperatures of 350°C. and blowers with gas and liquid cooling systems have been developed. Pressure ranges are from atmospheric to 300 p. s. i. with flows up to 8,000 lbs. per hour; to avoid high pressure and flow reductions our blowers are capable of providing a 30 p. s. i. pressure rise to the system. As with all radio active test rigs and plant Plannair equipment maintains zero leakage.

Centrifugal and silent air blowers are well suited for installation in public transport utilities where the



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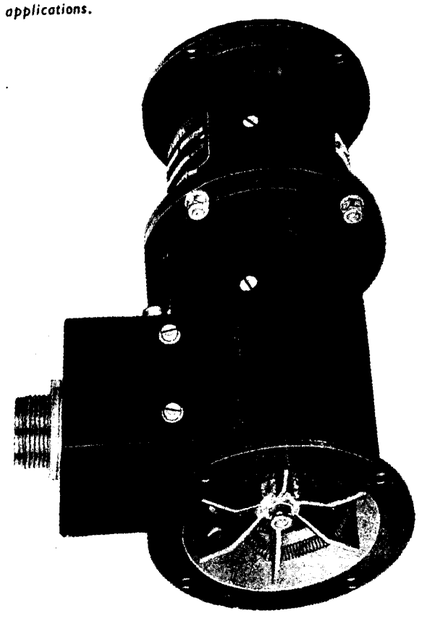
A versatile heater blower, this 2PL82-111H unit gives 35 C.F.M. at 1.75" W.G. and provides 1,000 watts on either D.C. or 50 C.P.S. supply. Weighing less than 3 lbs. and being 3" dia. x 5" length this unit has a multiplicity of applications.



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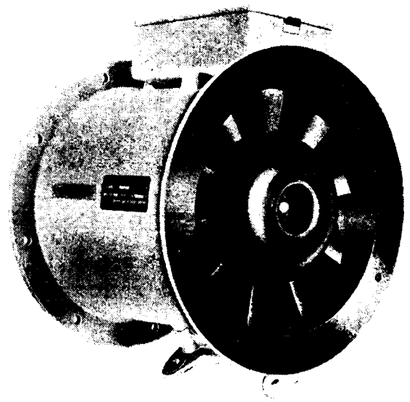
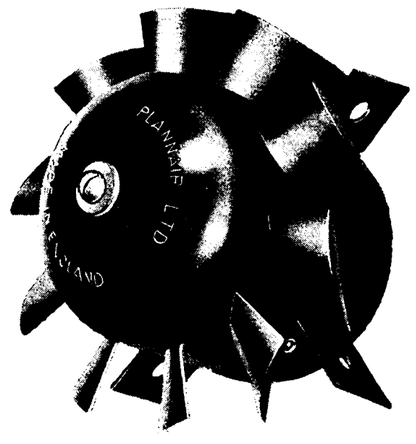


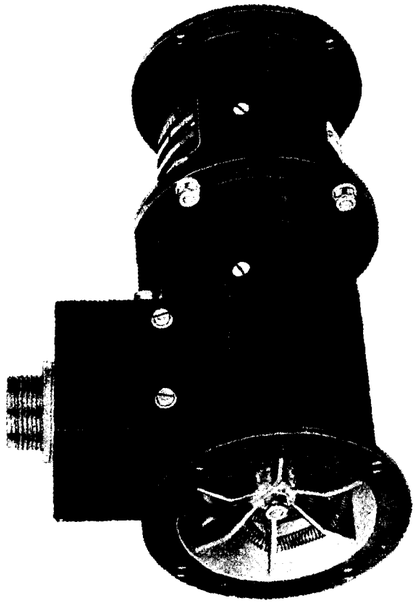
The 3PLW Wafter fan weighing 12 ozs. and giving 40 C.F.M. in free air from a mains supply, is a unit of sturdy construction with a trouble free life.



PLANNAIR LIMITED

Windfield House, Leatherhead, Surrey.

Tel: Leatherhead 4091/3, 2231



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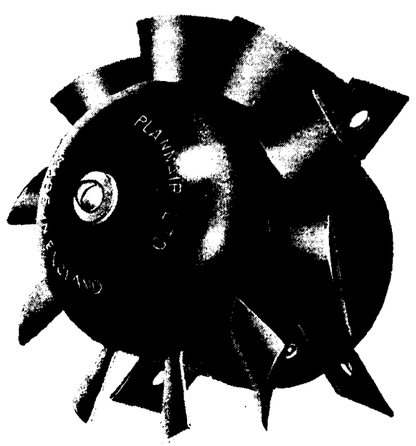
need for large volume air change is apparent. In the aeronautics field and pressurised passenger cabins our range of axial blowers are currently installed in the majority of civil and military aircraft. Special blowers for camera and film projection apparatus are catered for, together with temperature controlled air supplied for the stability of large lenses used in meteorological telescopes. Our current range of axial blowers are available with noise reduction features, consisting of a laminated shell giving 15 dB attenuation in the critical frequency range. Commercial and domestic fields are covered by Plannettes, Wafters and Grilles. These components offer a versatile system capable of cooling and temperature controlling any confine, with the added advantage of extreme quietness. Cabinets suitable for the assembly of precision components are manufactured by Plannair, the air being filtered and dried to avoid any change in humidity.

Dynamic balancing of all impellers and rotor assemblies is to fine limits, with the consequent reduction of vibration and noise level, and increase in bearing and lubrication life. Currently blowers are being manufactured to give 10,000 hours continuous running before service or re-greasing becomes necessary, this is achieved by using the best quality instrument bearings in stainless steel, with full regard to axial and thrust loads being applied. Lubricants used vary according to the temperature and climatic conditions, and for specific purposes lubricants are suitable for operation in a radio-active medium. Allied to these important technical advances the problem of presenting an attractive and efficient component has been achieved by applying the most exacting standards. This is witnessed by Plannair Limited receiving the design award presented by a leading American publication.

Overseas interest are fully received by our representatives operating in India, Sweden, France, America, Australasia, and most of the European countries. Manufacturing licences are issued for our equipment with Lear Incorporated of America and the Societe Air Equipment in France.



The 3PLW Wafter fan weighing 12 ozs. and giving 40 C.F.M. in free air from a mains supply, is a unit of sturdy construction with a trouble free life.

Representative in India is PERMESHRI DASS PADAM CHAND, Laxmi Bazar, Cloth Market, Delhi 6, who has Branches in Bombay, Bangalore, Hyderabad, Madras and Poona.

The development of a special double-anode mercury-arc rectifier with rare gas filling for rectifier locomotives

By H. Werz
Manager, Traction Division
Sécheron Works Co. Ltd., Geneva, Switzerland

INTRODUCTION

ELECTRIC traction has taken long strides throughout the world in recent years. As a result of extensive research and firm determination by the engineers of the French National Railways (SNCF), the single-phase system utilising the industrial frequency of 50 c/s has emerged as the best, particularly for countries with large scale future plans of electrification of their railway networks. India occupies a place of considerable importance amongst such countries and has undertaken extensive electrification of its railways on the 25 kV—50 c/s system.

Among the various technical solutions for Rolling Stock for 50 c/s, the one with current converting equipment (from a.c. to d.c.) and using the already well proved conventional d.c. traction motors is now regarded as the best. In such locomotives, the rectifiers are a very important part. Indeed, the term "*rectifier locomotive*" is now commonly used and it can be said that the present day rectifier locomotive owes its success mainly to developments and improvements in the design and construction of the rectifier. Over a period of years, numerous types of rectifiers have been developed, the two main types being the mercury-arc rectifier (ignitron or excitron) and the semi-conductor rectifier.

Fig. 1. Glass welded insulators and cathode wells.

Secheron, active in the field of electric traction since 1883, have been engaged for a long time on the development of an "*excitron*" type rectifier suitable for being mounted on locomotives. These efforts were

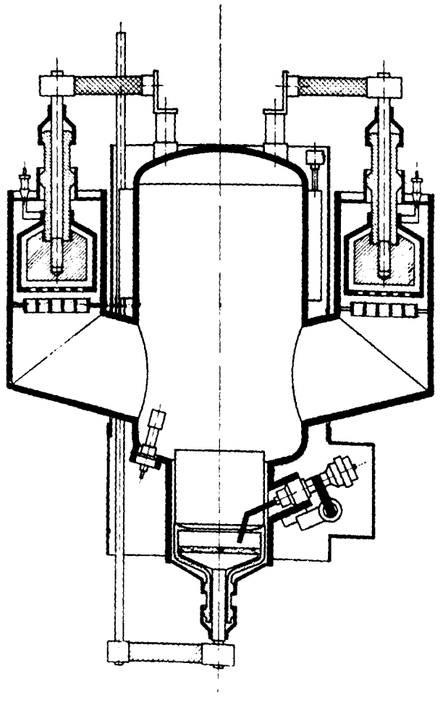


Fig. 2. Cross-section through a Secheron double-anode locomotive rectifier.

rewarded with success when in 1959 the Swiss Federal Railways, on the basis of experience acquired with 2 dual-frequency rectifier shunting locomotives, decided to order 10 four-system rectifier shunting locomotives. This was subsequently followed by an order from the French National Railways for 9 dual-frequency locomotives. It will not be out of place to mention that since then, Secheron have been entrusted with an important order for *rectifiers for 42 Freight Locomotives* for 25 kV—50 c/s for the Indian Railways, who preferred Secheron rectifiers to all other makes.

In view of the above, we have devoted the present article to considering some of the salient features of "Secheron" rectifiers which would be of interest to readers.

A LOCOMOTIVE RECTIFIER WITH EXCEPTIONAL QUALITIES

Contrary to a rectifier for stationary installations, a locomotive rectifier must have the following qualities:

Small overall dimensions and low weight, considering the restricted space available on a locomotive and the axle-load.

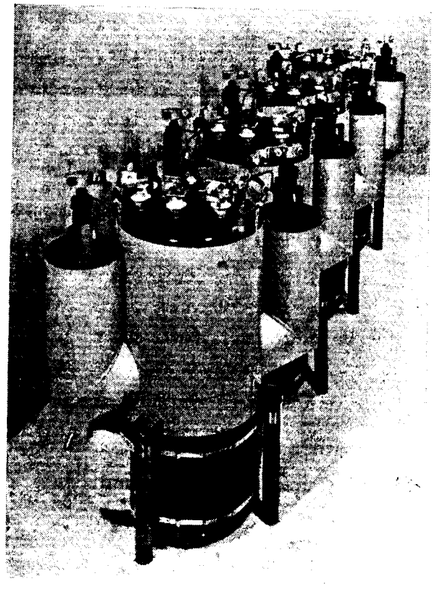


Fig. 3. Set of type A24 double-anode rectifiers for locomotives.

Mechanical sturdiness against shocks and vibrations.

The possibility of grid-control for varying the supply voltage of the traction motors and for regenerative braking.

Faultless operation under widely varying ambient conditions particularly that of temperature.

The following discussion is mainly concerned with the last mentioned condition.

THE SENSITIVITY OF MERCURY-ARC RECTIFIERS TO AMBIENT TEMPERATURE VARIATIONS

Owing to its sensitivity to ambient temperature variations, the mercury-arc rectifier in its original form was considered unsuitable for installation on locomotives, for a long time. Its operation is satisfactory only within a narrow temperature range. Even in Europe, considerable temperature control and preheating devices are required to be in operation before the locomotive is ready for service, which is undesirable from the point of view of operational delays.

Designers thus had a strong temptation to solve the problem of sensitivity of the rectifier to temperature variations by increasing their time constant through *water-cooling*. The designers of "*ignitrons*" have adhered resolutely to this solution although it is realised that water-cooling is an unnecessary complication on a locomotive. The ignitron reached its peak

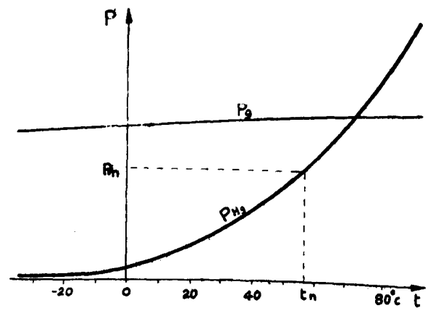


Fig. 4. Variation of pressure of the mercury vapour PHg as a function of the temperature of the mercury.

Pg = Pressure due to rare gas only
tn = Rated working temperature
Pn = Vapour pressure under rated working conditions

of success towards 1958 but is less in favour at present, since other mercury-arc rectifiers less sensitive to ambient temperature variations have been developed.

CONSTRUCTIONAL FEATURES OF AN IDEAL TRACTION EXCITRON

Over a period of years, mercury-arc rectifiers of various origins and types have been tried out on locomotives. These have been of the single or poly-anode type with glass bulb or metal tank, with vacuum pump or sealed tank, with air or water-cooling. Secheron undertook exhaustive studies and came to the conclusion that the modern traction rectifier is:

— of the double-anode,
— metal tank
— sealed
— air-cooled type

On a.c. locomotives, the push-pull connection between the transformer and the rectifiers is frequently used for single-phase rectification. A *double-anode rectifier* is the most suitable for this and is certainly less cumbersome than two single-anode rectifiers. Poly-anode rectifiers are often too bulky and difficult to mount on locomotives.

An important problem with *metal tank rectifiers* is the through type insulator (main anodes, ignition and excitation anodes, cathode and the grids) which must be perfectly tight. Secheron have developed insulators with welded joints of steel-glass-ceramics which are insensitive to sudden temperature variations (Fig. 1).

In a *sealed rectifier*, the vacuum must last indefinitely even with long interruptions of service. The tanks are checked for tightness by introducing gaseous ammonia into the tanks and applying a very sensitive reagent to the exterior, which by alteration in its colour reveals the slightest pores or cracks.

Air cooling of rectifiers is obviously simpler than water-cooling which is an inherently complicated solution.

THE SECHERON DOUBLE-ANODE RECTIFIER WITH RARE GAS FILLING

Engineers are well aware of an inherent drawback of most mercury-arc rectifiers; when cold they are prone to dangerous *overvoltage*. Starting on overload or even rated load should be avoided whilst cold. In addition, rectifier installations have to be protected by *surge diverters* connected to the anodes and completed by *pre-heating* equipment. In order to avoid this, Secheron carried out exhaustive studies and developed the interesting technique of introducing small quantities of *rare gas* into the rectifier tanks, which gives them some very remarkable properties. Due to the presence of rare gas, the rectifiers may be started from cold at full load, without any pre-heating and surge diverters. Fig. 2 shows a cross-section through a double-anode locomotive rectifier and Fig. 3 shows a set of type A 24 double-anode rectifiers for a four-system shunting locomotive of the Swiss Federal Railways.

In order to prove the operating possibilities of our rectifiers, particularly at low temperatures, we undertook in 1958, in the presence of representatives of the Swiss Federal Railways and French National Railways, a series of spectacular tests which had wide spread repercussions.

STARTING AND LOAD TESTS AT LOW TEMPERATURE (—44°C)

Tests for working under cold climatic conditions

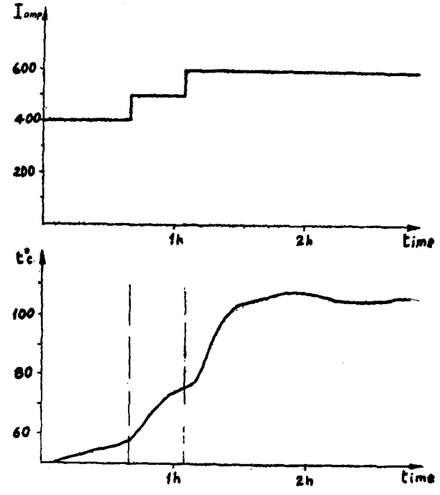


Fig. 5. Heating tests of an A 24 type double-anode rectifier
Above: current supplied by the rectifier as a function of time.
Below: temperature rise curve of the dome.

were conducted by placing the rectifiers in a refrigerating chamber where the mercury cathode acquired a temperature of — 44°C. In spite of the fact that the mercury was solidified at this temperature, an arc could be struck and the rectifier could be immediately loaded to 250% rated load. Oscillograms were taken which showed that the working of the rectifier was absolutely normal and no over-voltages were revealed. These remarkable results have been achieved only by filling the tanks with *rare gas.*

EXPLANATION OF PHYSICAL PHENOMENA DUE TO PRESENCE OF RARE GAS

In order that an arc discharge may take place in high vacuum, it is necessary—contrary to an electronic tube—that a certain atmosphere of vapour or gas be present. At 18°C the pressure of mercury vapour is of the order of 1/1000 mm. column of mercury (≈ 1 millitorr). But this pressure decreases rapidly (approximately as an exponential) reaching values 100 times smaller when the temperature drops to below 0°C.(Fig.4)

Generally, the mercury vapour pressure at 18°C is not sufficient for the flow of the rated current, which explains the necessity of pre-heating and progressively increasing the load. If it is desired to pass more current than the limit corresponding to the existing vapour pressure, the rectifier does not permit this, and the current is chopped at a frequency of 1 to 10 k c/s which causes dangerous *overvoltages.* Rare gas does not condense at low temperature and replaces the mercury vapour. It is this quality which permits Secheron rectifiers to be switched on to full load even at very low temperatures without any risk of overvoltage.

PERFORMANCE AT HIGH TEMPERATURE

The determining factor for this is the maximum temperature admissible at the coldest point of the tank, being the point where mercury vapour condenses. For an ordinary mercury-arc rectifier, this temperature is approximately 70°C and it is reached after the rectifier supplies its rated current at an ambient temperature equal to or below 35°C. Above 70°C, cut-off by thermostat becomes necessary. If the ambient temperature rises up to 45 or 50°C, the rated current of an ordinary rectifier must be considerably reduced. In order to limit such reduction, Secheron have endeavoured to raise the upper temperature limit of their rectifiers to bring it into the vicinity of *100°C.*

A type A 24 rectifier rated for 400 A was loaded up to 600 A. This current was maintained for several hours, as shown in the upper part of Fig. 5, the lower part of which shows the temperature rise of the different parts. The temperature curve of the dome shows that its time constant is relatively small and thus the temperature stabilises rapidly after each load variation. After operating for 3 hours, the dome, which is the coldest part of the tank where mercury vapour condenses, reached 108°C for an air out-let temperature of 38°C.

Fig. 6. Dual-frequency rectifier shunting locomotive of the Swiss Federal Railways, equipped with Secheron double-anode excitron rectifiers.

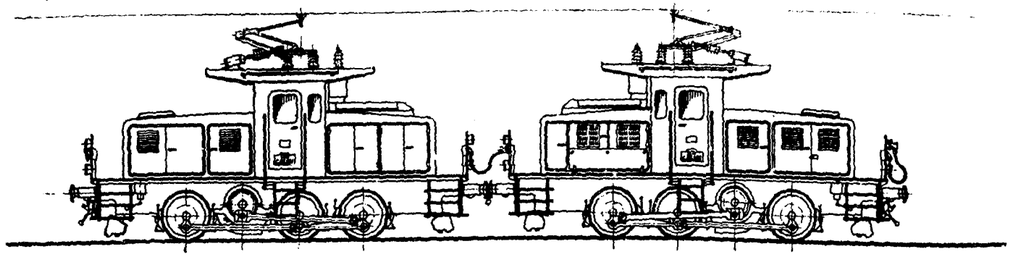


Fig. 7. Dual-frequency rectifier shunting locomotives of the French National Railways, equipped with Secheron double-anode excitron rectifiers.

The load limit of a mercury-arc rectifier depends essentially on the period of de-ionisation following the flow of current. For satisfactory operation of a rectifier, it is indispensable to have a grid of sufficient negative potential during the blocking period, otherwise there is a danger of *back-firing.* To obtain as short a period of de-ionisation as possible, Secheron equip rectifiers which have to operate at high temperatures with several *de-ionisation grids* which allow a reduction of ion concentration around the anode following the flow of current.

In brief, it may be stated that Secheron rectifiers for locomotives, owing to their special design, are capable of operating satisfactorily at very high temperatures of the order of 180°C, unlike ordinary rectifiers with the maximum temperature restricted to 70°C.

CONCLUSION

The double-anode excitron rectifier has been specially developed by Secheron for heavy traction service. It is not, as is sometimes the case, a hurried adaptation of an existing rectifier (for stationary installations), to new functions on rolling stock. Its performance

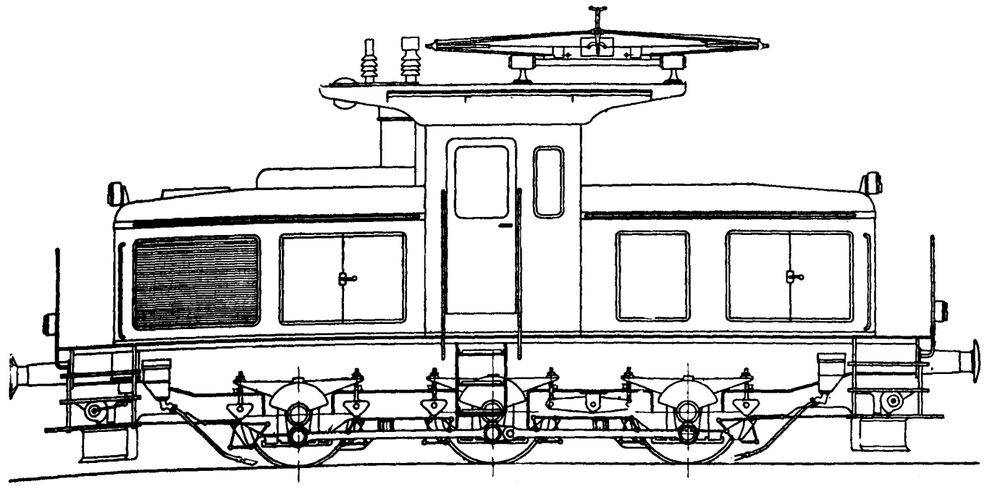


Fig. 8. Four-system rectifier shunting locomotive of the Swiss Federal Railways, equipped with Secheron double-anode excitron rectifiers.

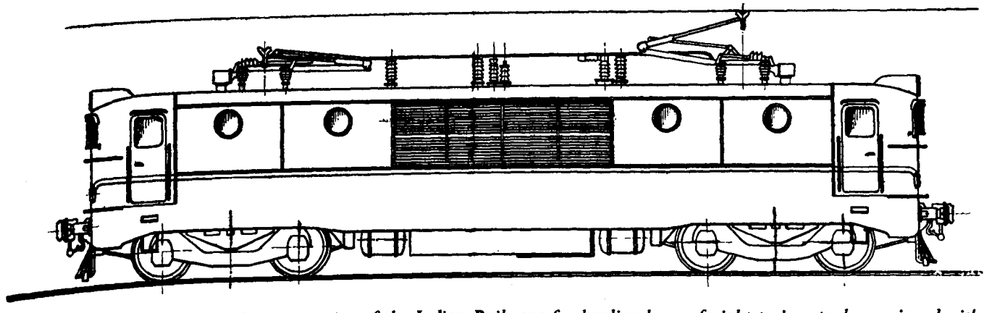


Fig. 9. 25 kV–50 c/s Rectifier locomotive of the Indian Railways for hauling heavy freight trains, to be equipped with Secheron double-anode excitron rectifiers with rare gas filling, provided with grid-control of rectifiers for regenerative braking.

in actual service on the dual-frequency shunting locomotive (Fig. 6) of the Swiss Federal Railways has been as remarkable as on the test bed. These locomotives have been in uninterrupted service since 1958. Fig. 7 shows an illustration of a similar dual-frequency shunting locomotive of the French National Railways. Fig. 8 shows an illustration of a four-system shunting locomotive of the Swiss Federal Railways, equipped with 2 type A 24 double-anode rectifiers.

As mentioned earlier, a first instalment of 42 rectifier locomotives for 50 c/s of the Indian Railways (Fig. 9) will be equipped with Secheron double-anode excitron rectifiers. A large number of these standard freight locomotives will be manufactured later in India. The fact that *Secheron excitron rectifiers* have been preferred by the Indian Railways is all the more remarkable when considering that a large number of 50 c/s locomotives now running in India are equipped with ignitrons. It is, indeed, a matter of pride for Secheron to be so closely associated with the extensive electrification plans of the Indian Railways.

BRITISH EQUIPMENT FOR CALCUTTA ELECTRIC RAILWAY

A British firm has been chosen to supply and install equipment for electrifying over 250 track miles of suburban railway in the Calcutta area. The Indian Railway Board has awarded a contract worth £ 1,000,000 to British Insulated Callender's Cables (BICC).

With this latest order—the third of its type BICC have received since December 1958—the group will be responsible for nearly 1,000 track miles of 25kV 50c/s alternating-current (AC) electrification in India at a cost of £ 4,700,000.

The first contract, announced in December 1958, was for the electrification of a 400-mile section near Calcutta of the main line between Calcutta and Bombay on the South-Eastern Railway. This section, between Tatanagar and Rourkela, with a branch from Rajkharswan to Dongoaposi, links the iron-ore fields in Bihar with the steel plants at Tatanagar and Rourkela. Rapid progress has been made on this contract, which was the first to be awarded in India for high-voltage AC operation. A trial section was put into operation 12 months from the date of the order, and the major portion of the scheme is already in commission.

Under the second contract awarded to the BICC group (announced in June 1960), some 300 miles of the Eastern Railway system between Delhi and Calcutta are being electrified. This section lies between Gaya and Moghalsarai. Both this contract and the previous one were for freight services, and intended primarily to provide the rail link that is essential for India's expanding steel programme.

The new contract will facilitate the carriage of both freight and passengers to and from the developing suburban areas of Calcutta, particularly those to the north and north-east. South of the city, Sealdah station, which is embraced within the overhead electrification scheme, will eventually be able to handle a greatly increased volume of rail traffic. BICC have also secured the order—amounting to some Rs. 15 lakhs—for the switching stations on the Calcutta suburban electric railway system.

The three orders, taken in conjunction, represent an important contribution by the BICC group towards the implementation of the Indian Railway Board's decision to standardize the country's electric traction systems.

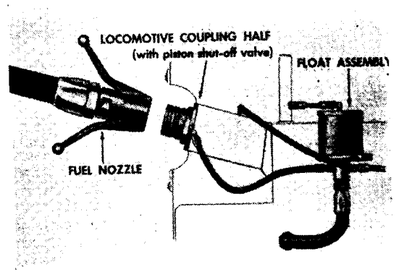
The latest contract, when completed, will constitute the first suburban railway section in India to be equipped for overhead high-voltage AC operation.

For all three contracts, specialist traction engineers from the BICC Construction Co. are to work with a large force of local engineers and field personnel.

Among other recent contracts fulfilled by the BICC group in India has been the supply and installation in September 1960 of 9,500 yds. of three-core 105 kV oil-filled cable in Bombay for the Tata Power Co. The BICC group have operated in India for more than 50 years.

Aeroquip's locomotive fueling methods solve a major problem for the railroads

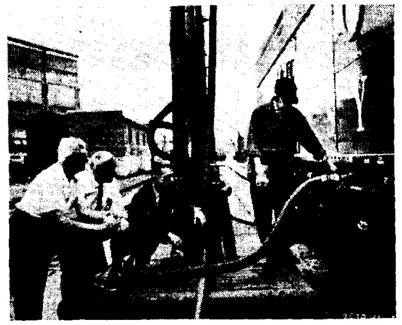
THREE major U. S. railroads are reporting safer and cleaner diesel fueling practices, thanks to installation of Aeroquip's Automatic Railroad Diesel Fueling Unit, which has eliminated costly, hazardous fuel spillage. All of the installations have been made in the past 18 months, climaxing an intensive development and market research program by Aeroquip railroad sales engineers and distributor organizations.



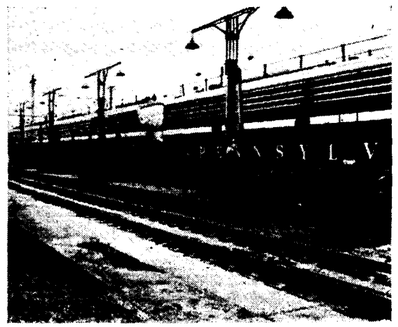
Aeroquip Fueling Unit

The first railroad to convert its locomotives and fueling stations to use of the Aeroquip unit was the Great Northern, which was also among the first to become interested in the possibility of automatic fueling. And next came the largest conversion program, when the giant Pennsylvania Railroad ordered fueling units for its entire fleet of 2465 locomotives. The Atlantic Coast Line Railroad, the major road in the Mid-South, followed through in the late summer of 1959.

Fuel spillage was a problem that came about with the advent of the diesel locomotive. In the old days, railroad beds were mottled with bits of coal from



Observing the operation are: Harry Fisher, engine house foreman at Harrisburg; George Young; Jack Irvin, assistant engineer of motive power on the Pennsylvania.



passing locomotives, but in more recent times the spillage usually occured at the fueling platforms, where devices were not available to regulate fuel flow into locomotive tanks. Hence, tanks often overflowed, spilling waste oil into drainage systems and causing contamination of local sewage plants.

Fuel spillage also created fire hazards and property damage (such as in one case, where spilled diesel fuel was found to be attacking the asphalt foundation of a half million dollar bridge). And in actual fuel loss, it was estimated to cost between one and four per cent of the railroads' fuel purchases.

Aeroquip first approached the problem in 1955, when initial tests were conducted on the Great Northern. The Self-Sealing Coupling principle, effective in Aeroquip's aircraft and industrial couplings, was obviously the answer to the railroads' requirement for a leakproof shut-off mechanism. But a complete fueling system was needed, one which would automatically shut-off fueling operations when the tank

James Dunsmore, fueling platform operator in Harrisburg, prepares to connect the fueling nozzle to the locomotive coupling half.

was full, at a level sufficiently high to assure a full fuel supply without danger of overflow. Also, the system had to be compatible with other types of fueling connections, to permit fueling during the interval when railroads were making the conversion to the Aeroquip units. A further requirement was that fueling nozzles be relatively untended during the actual filling of the tank.

With these needs in mind, Aeroquip engineers developed the Aeroquip Automatic Railroad Diesel Fueling Unit. It consists of a fueling nozzle (which is attached to the platform fueling hose), a locomotive coupling half (installed in the inlet port of the locomotive tank), and the float assembly, which is mounted on the side of the fuel tank. The float assembly actuates a piston shut-off valve in the locomotive coupling half, halting the fueling process when the tank is full. Both halves seal automatically when disconnected, but permit full flow when mated.

To demonstrate the applicability of the Automatic Diesel Fueling Unit, Aeroquip railroad sales engineers developed a mobile demonstrator which toured the major railroads throughout the eastern half of the U. S. The mobile unit consisted of actual locomotive tanks, which duplicated the same fueling methods followed at railroad fueling platforms. Currently, a number of other major U. S. railroads are considering the new program. (Courtesy: 'THE FLYING')

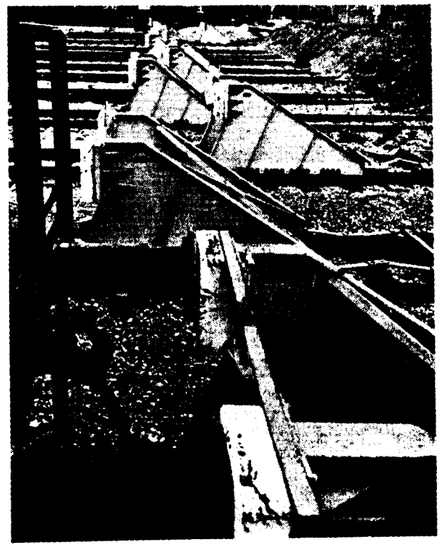
BUFFERS, BRAKES, BUSHES, COUPLERS & SHOCK ABSORBERS SUPPLEMENT

FRICTIONALLY CONTROLLED BUFFER STOPS

By T. C. Cameron-Cooper

EARLY in 1959, Godwin Warren Engineering Ltd., Bristol, England commenced manufacturing, under licence, frictionally controlled buffer stops and rail brake shoes which have been used on the Continent for many years. Since the introduction of these buffers into their country the demand has been remarkable, and many large steel works and the British Railways have installed these units as the latest means of preventing the many accidents caused by trains and goods wagons hitting fixed buffer stops at a speed they cannot withstand.

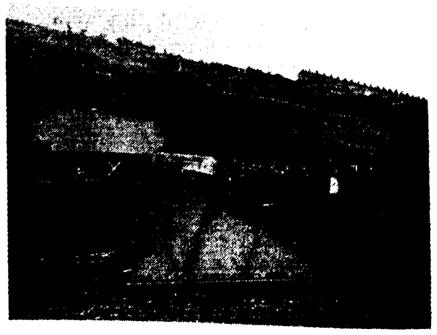
Trains and engines approaching buffer stops are very rarely out of control, but there is always the possibility of an error of judgment in applying the brakes, or some local circumstance, such as unusually greasy rails, resulting in the striking of the stops. Even if the speed is low the kinetic energy involved in a heavy train is considerable.



Goods Type Friction Buffers in Marshalling Yard.

Collisions can result in the immobilisation of badly needed stock and react most unfavourably on the traffic working. In some termini in Great Britain special buffer stops of the hydraulic type, and sand drags, have been provided to bring an over-running train to rest with the minimum of shock, but little attention has been paid as a rule to other locations, while even in stations fixed types of stop are frequently to be seen.

On the Continent, however, especially in Central Europe, much thought has been given to this subject and what have become known as braking type buffer stops, making use of friction to provide a retarding effect, have become widely installed. On some systems such as the German Federal Railway, simple fixed stops have long been prohibited except in unimportant sidings where only a few vehicles are placed. Everywhere else the braking type has become the rule, as elimination of damage to stock and contents and harm to people are considered to justify this.



Frictionally Controlled Buffer Stop. Goods type, at Richard Thomas-Baldwins Ltd.

The first suggestions for a retarding type buffer stop using the frictional principle were advanced over 50 years ago by Franz Rawie, whose family had founded the firm of A. Rawie, of Osnabruck, Germany, in 1855, for general forging and engineering work.

OPERATION OF FRICTIONAL ELEMENTS

The fundamental principle has remained throughout the same: to make use of a frictional hold of some kind, either constant, or made to vary, should circumstances necessitate, as a function of the weight of the front part of the train—as, for example, where a locomotive is used—or by causing the frictional elements themselves to come into operation successively. A combination of both these methods also can be used.

There are two principal types of these Buffer Stops in use at the present time. One is for Goods Yards and industrial yards and the other is the Passenger type for terminal stations. Each can be modified or supplemented by altering or adding components as conditions may render advisable.

The Goods type is the simplest and is called the rail brake design. In this type, friction grips or shoes, provided with bronze inserts, are bolted to the rail head in such a manner as to give the desired brake power in tons. When the stop is driven forward they bring the train or vehicle to rest under a safe rate or retardation.

The whole assembly, after slackening off the bolts is then pulled back to its original position, when the shoes are re-tightened. If required, additional shoes can be fitted to the rails behind the Buffer Stop at definite intervals. They are linked so that at first only one pair is functioning, then they pick up the second pair and so on, thus progressively increasing the retarding action.

The Buffers can only be used on Flat Bottom rail and it means that a length of this type of rail has to be laid for the distance over which the stop may be required to travel. The reason for this is because the shoes would foul the chairs used with Bull-Head rails.

RESULTS OF TESTS ON GOODS TYPE

The following figures give the results of tests made with this type of stop :—

Test No.	Weight of Train	Impact Speed	Travel of Stop	Average Stopping Resistance	Retardation	Work done by stop
			ft.	tons	ft/sec²	ft/tons.
1	400 tons.	5 mph.	6.92	48.3	3.89	334.0
2	705 tons.	6 mph.	12.08	70.3	3.21	850.0

The Passenger type consists of the Buffer Stop being mounted on a wooden raft which is situated under the running rails, so that the weight of the locomotive

Smashed Earth & Timber Bank to Stop Trains in Marshalling Yard. Friction Buffers have now been installed without any damage to wagons or stops.

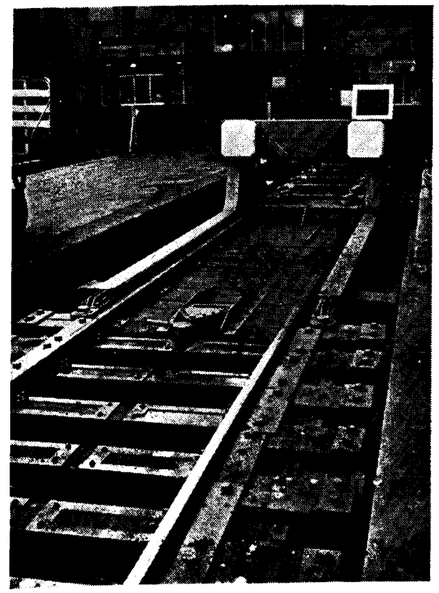
helps to increase the retarding effect. Additional retarding shoes are fitted behind the Buffer Stop to assist the braking effect and are the same as those used on the Goods type Buffer Stop. Sliding sleepers are fitted to the front end of the Buffer to take the weight of the train when the Buffer has been moved back after being struck by the locomotive. The bolts on the retarders have to be loosened to allow the whole unit to be pulled back to original position. Twelve of this type of Buffer Stop are being installed at London Road Station, Manchester, which is being re-built in accordance with the British Railways modernisation scheme.

RESULTS OF MANCHESTER TESTS

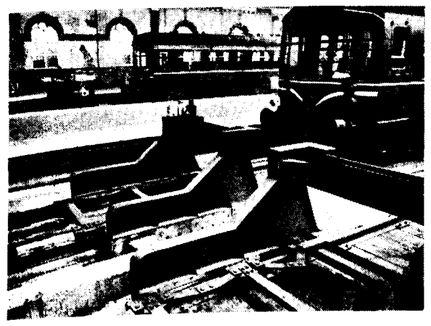
Weight of Train	Impact Speed	Travel of Stop	Average Stopping Resistance	Retardation Rate
tons.	m.p.h.	ft.	tons.	ft/sec² Average.
285	7.3	15′5″	32.8	3.7
565¼	4.75	6′5″	66.7	3.8
565¼	6.0	10′7½″	64.1	3.65

The last two tests were with Loco and 15 coaches.

The Buffer Stops used in the above tests are the Passenger type 5004/2 and are designed to absorb impacts of 100 tons to 1,200 tons.



Passenger Type Buffer Stop in Main Terminal Station.



Four of the Twelve Passenger Type Buffers installed at Piccadilly Station, Manchester.

TEST PARTICULARS PASSENGER TYPE

In order to determine the speed of the train impact the train was timed over a distance of 88′ immediately in front of the Buffer Stop. The velocity calculated by the following:— Velocity (M. P. H.) = $\frac{60}{\text{time (secs.)}}$

THE 285 tons TEST

10 coaches were used, total weight 285 tons, the leading coach 28¾ tons. This was to simulate the effect of an electric multiple unit fully laden and it came in at 7.3 m.p.h., moved stop 15′ 5″ and gave a retardation rate of 3.7 ft./sec².

Then 2 tests were made with a 2—8—0 class 8 F steam locomotive weighing 125¾ tons hauling a train made up of 15 coaches (439¾ ton weight) making a total weight of 565¾ tons. The train ran freely into the buffer stop—no brakes being applied.

So we had :—

(1) 565¾ tons travelling at 4.75 m.p.h. moved stop 6′ 5″ giving a retardation rate of 3.8 ft./sec².

(2) 565¾ tons travelling at 6.0 m.p.h. moved stop 10′7½″ giving a retardation rate of 3.65 ft./sec².

TESTS—GOODS TYPE

	Weight of Train	Impact Speed	Travel of Stop
(No. 10 at Dorman Long, Ltd., Middlesbrough)	150 tons.	8 m.p.h.	5′ 6″
(No. 12 at Richard Thomas & Baldwins, Ltd., Ebbw Vale.)	150 tons.	20 m.p.h.	9′ 0″

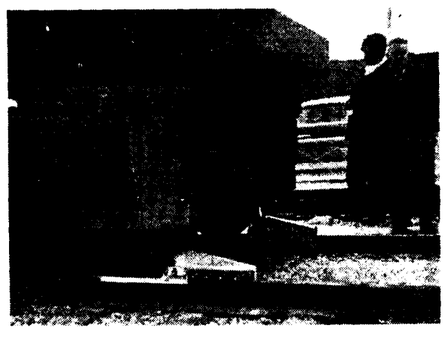
	Weight of Train	Impact Speed	Travel of Stop	Retardation Rate
(No. 12/4 at Steel Company of Wales Ltd. Port Talbot.)	400 tons.	5 m.p.h.	6.92 ft,	3.89 ft./sec²
	705 tons.	6 m.p.h.	12.08 ft.	3.21 ft./fec².

RAIL BRAKE SHOES

A modification of this form of stop is seen in the rail brake shoe. This, in its ordinary form, requires a flat-bottom rail, but the hinged design can be used with bull-head track, as it is carried on a separate piece of flat-bottom rail laid parallel with the running rails and hinged to come over the latter only when required. With this device the leading pair of wheels of a vehicle bear on the shoe itself, so increasing the frictional effect proportionally. It is intended for use in certain siding and similar tracks and is valuable where it is desired to prevent collisions with vehicles on which staff may be at work, or to protect men engaged on the permanent way.

A trial made at Port Talbot with this brake shoe gave the following result :

Weight of Train	Impact Speed	Travel of Brake Shoe
100 tons.	3 m.p.h.	2 ft. 5 ins.



Fixed Rail Brake Shoe.

Frictionally Controlled Buffer Stops are designed to cope with speeds of 10 m.p.h. for main terminal Buffers and about 15 m.p.h. for shunting in goods yards. The situation is simpler where trains arrive with locomotives in front, as their weight helps to increase the retarding effect.

Where, however, lightweight trains and railcars also are used, it becomes preferable to have less braking effect to begin with and use supplementary rail brake shoes to build up the retarding action progressively. An adequate braking distance must always be allowed, though this may sometimes mean increasing the length of the platforms and adding to the distance passengers have to walk. It becomes a matter of reconciling all the known requirements to the best advantage, having regard to local conditions. There are designs for all known requirements.

Hinged Type Rail Brake Shoe.

These various types of braking stops are in use throughout Great Britain, Germany and in terminal stations in Austria, Switzerland, Holland, Belgium, Luxembourg, Italy, Spain, Portugal, Finland, Russia, Denmark, Poland, Serbia, Roumania, Turkey, Persia, and Israel.

Metcalfe-Oerlikon Modern Brake Equipment used on British Railways

By An Engineering Correspondent

DURING the past five years British Railways have been supplied with Metcalfe-Oerlikon Brake Equipment on over 800 Main Line Locomotives. These Locomotives range from 800 H.P. to 2,500 H.P. Diesel Electric or Diesel Hydraulic Locomotives and also include Main Electric Locomotives 25 K. V. and 600 Volt D. C. The principal style of Brake Equipment consists of Direct Air Brake on the Locomotive which is operated by an independent Driver's Air Brake Valve at the Driver's Desk position. This Driver's Brake Valve allows the Driver to obtain any desired brake cylinder pressure up to the maximum for which the locomotive is equipped, by simple movement of the Brake Valve Handle.

The Locomotives are also equipped to haul vacuum braked stock, and for this purpose the Metcalfe Driver's Vacuum Brake Valve is fitted in the Driver's Desk. With this Valve braking, lap, running, release and emergency positions of the handle are provided. The LST2 Locomotive Triple Valve is fitted on the Locomotives, and this Valve is sensitive to the changes in the vacuum train pipe produced by the Driver's Vacuum Brake Valve and relays a proportionate brake cylinder pressure to the Air Brake Cylinders on the Locomotive. An Anti-Slip feature is built into the Triple Valve, which is operated by means of a Push Button Switch on the Driver's Desk and an Electro-Pneumatic Valve which allows the Driver to apply a brake cylinder pressure of about 10 p.s.i. to the Locomotive in order to minimise wheel slip. In addition a Deadman's feature is included which is controlled by a Foot Pedal Switch in the Driver's position. Release of this Pedal Switch causes compressed air to be admitted to a Timing Reservoir, and when the pressure has sufficiently built up, this causes the Oerlikon Deadman's Valve to open the vacuum train pipe to atmosphere with a resulting brake application.

The auxiliary features of the brake system include for supply of compressed air to the Control Gear, operating the Diesel Engine Speed Controls and Warning and Sanding Equipment. The Brake Equipment generally includes such items as Sand Traps, Operating Valves for Sanding and Warning, Pressure Reducing Valve and various Strainers and Isolating Cocks. To provide for multiple working a Main reservoir pipe is included on the Locomotives which are connected by suitable Hoses and End Cocks at the buffer beam. To control the air supply to and from the main reservoir equalisation pipe the Metcalfe-Oerlikon Duplex Air Valve is provided which protects the Main Air Reservoir from a loss of pressure below a specified limit. So long as the in-put pressure to the Valve is above the minimum limit a free flow of air through the Valve is maintained.

On certain classes of Locomotives the brake system is devised so that the Locomotive can handle both vacuum braked stock and fully automatic air brake stock. In this case the Direct Driver's Brake Valve FD1 is provided at the driving positions, for the purpose of applying the brakes on the Locomotive only. The Locomotives are also provided with a Metcalfe-Oerlikon Driver's Automatic Air Brake Valve FV3, which controls the air train pipe pressure. When hauling air braked stock, brake applications are made by means of this Driver's Brake Valve and the Locomotive Triple Valve LST3 is sensitive to this change in the air train pipe pressure and relays a proportional brake cylinder pressure to the locomotive brakes. When hauling a vacuum braked train, the Exhausters are running and by means of an Air Vacuum Isolating Valve and Air Vacuum Relay Valve DV3, the changes in the Locomotive Air Train Pipe produced by the Driver's Automatic Brake Valve FV3 are relayed in proportion to the train vacuum pipe, thus making brake applications or releases on the train. At the same time the Locomotive Triple Valve LST3 which has been automatically isolated from the locomotive air train pipe is now sensitive to changes in the vacuum train pipe and makes a proportional change in the air supply to the Locomotive Brake Cylinders.

Numerous small Shunting Locomotives have been fitted with Metcalfe-Oerlikon Brake Equipment, the simplest of which are fitted with Direct Air Brake Equipment only. Other Shunting Locomotives are fitted with Direct Air Brake Equipment to the Locomotive and also with an Air Vacuum Control Valve DV1a, and a Driver's Vacuum Brake Valve. The Air Vacuum Control Valve DV1a is sensitive to the

changes in the vacuum train pipe pressure and causes a corresponding proportional application or release of the Locomotive Air Brake Cylinders.

In some cases the Two-Stage Deadman's System is employed which operates through special Metcalfe–Oerlikon Deadman's Valves.

To many of these Locomotives the Metcalfe-Oerlikon Compressors have been fitted. The Compressor is designed specifically for use on Locomotives and is of comparatively small dimensions and weight. It is a Two-Stages Compressor with a built-in Intercooler between the low pressure and high pressure stages. The Compressor and driving motor are air cooled by means of a built in Fan which draws cooling air through the Motor, the Intercooler and on to the exterior of the Cylinders. The Motor and the Compressor are mounted integral on one bedplate and form a single compact unit. The small size Type 2A115 having an air delivery of 30 cu. ft. per minute has met the requirements on British Railways Locomotives and have proved very satisfactory in service. Larger sizes are available for Locomotives where it would be appropriate.

The main reasons leading to the success of this equipment are due to the demands made by the Locomotive Industry for a modern Brake having none of the disadvantages associated with the complication and maintenance difficulties associated with so many of the different types of Brake Equipment on the market today.

Perhaps the greatest advantage of the Oerlikon Brake lies in the fact that unskilled personnel may overhaul the individual units, there being no necessity for grinding, lapping or bedding-in operations so closely associated with other Brake systems. In those countries, therefore, whose locomotive industry and Railways have been accustomed almost entirely to the Steam Locomotive, a Brake of this description is of inestimable value if running and maintenance costs are to be kept to the minimum. The new Diesel or Electric Locomotive is an expensive piece of machinery, available to the Railway Authorities only so long as every item of equipment on it, is functioning correctly. Such Locomotives fitted with the Oerlikon Brake do not suffer from maintenance problems so closely associated with the older type equipment. No falling off in performance of the principal Valves renders it necessary for frequent attention due to the inclusion of synthetic rubber in the construction of the Valves themselves. Even when the occasion arises for Valves to be removed it will be found that no pipe connections need ever be disturbed, and provided the major components are mounted with reasonable access, all these may be exchanged on a locomotive within 60 minutes. The question, therefore, of a locomotive being a "casualty" due to Brake failure is an extremely uncommon experience with the Oerlikon Brake.

It was for these, and many other reasons, therefore, that British Railways chose Metcalfe-Oerlikon Brake Equipment.

MORE TRACTORS

THE licensing committee of the Government of India is reported to have recommended another licence for the manufacture of 1,000 agricultural tractors a year to the Bombay Firm of Tractors and Bulldozers Private Ltd., having its plant in Baroda. The Company has already obtained a licence for an annual production of 1,000 tractors and the new licence will enable the company to double its capacity.

The company has achieved satisfactory progress in implementing the first licence, with the technical collaboration of the Czech State-owned organisation of Motokov, and the first lot of India-made tractors are likely to be off the assembly lines in December this year. In the initial stages these tractors will have to use imported components to the extent of 50 per cent but in about three years almost all the components are planned to be produced locally so as to make the tractors entirely indigenous.

The projects are presently financed by the company's own and borrowed resources, but it is said that as the company expands its activities and steps up production, it might be converted into a public company and equity capital offered to the public.

An Important Announcement

WE have great pleasure in announcing to all our readers and advertisers that we are incorporating a special supplement entitled INDIAN RAILWAYS CHITTARANJAN LOCOMOTIVE WORKS SUPPLEMENT along with our January-March 1962 edition. We need not very much stress the international importance of this gigantic locomotive 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 engineering works 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 locomotive engineering to our above Supplement.

The last date for receiving technical contributions is 5th January 1962. Advertisers desirous of buying advertising space in the above Supplement should intimate the fact to the Technical Editor on or before 5th January 1962 as there is very limited advertising space available.

TECHNICAL EDITOR

Flats 17 & 18 "ASHOKA" (Second Floor)
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Foundry, Castings, Forge, Furnaces & Heat Treatment Supplement

Gaseous Annealing of Malleable Castings

By C. G. W. Overton, B.Sc.(Eng.), A.M.I.Mech.E., A.M.I.E.E.*

TYPES OF MALLEABLE IRON CASTINGS

THERE are in the main three types of malleable castings in common use :—

1. Standard or Ferritic Blackheart.
2. Pearlitic Blackheart.
3. Whiteheart.

All the three are cast as hard white iron, the as-cast structure consisting of iron carbide and ferrite with no free graphite. The annealing treatment in every case is aimed at eliminating the excess carbide, so making the material ductile, shock resistant and machineable. The annealing method by which this is achieved, however, and the final metallography are different in the three cases.

GASEOUS ANNEALING PROCESS OF MALLEABLE CASTINGS

The 'Gaseous Annealing Process' patented and introduced by A. E. I. Birlec Ltd., is perhaps the most modern and quick method of annealing Blackheart and whiteheart castings. It dispenses with the cans and packing material invariably associated with the older methods, thereby greatly reducing the dead weight within the furnace. The castings are instead placed on suitable supports, and annealed in contact with atmosphere capable of promoting or effecting the desired change, namely graphitisation in the case of blackheart and decarburisation in the case of whiteheart. As a result, an extremely rapid rate of heating and cooling is achieved, which directly reduces the annealing cycle to a fraction of that possible by older methods. The speed and efficiency of heating or cooling are further increased by the special fans which keep the atmosphere within the furnace in vigorous circulation. The atmosphere circulation also ensures uniform heating of the entire charge and in consequence results in outputs free from distortion due to uneven heating.

GASEOUS ANNEALING OF BLACKHEART CASTINGS[1]

The object here is to decompose the combined carbon in the castings to ferrite and graphite without decarburisation. Accordingly an inert and static atmosphere to ensure non-decarburisation is required. This is very simply obtained by allowing the small amount of air within the gas tight furnace to react with the carbon of the castings. The resulting atmosphere containing a mixture of Nitrogen, Carbon monoxide and Carbon-dioxide has the required characteristics, and is left within the furnace undisturbed throughout the anneal. In continuous furnaces which cannot be completely sealed a small amount of externally generated atmosphere may be necessary to combat inward air leakage.

The complete annealing cycle comprises of three definite stages, (See Fig. 1 below) starting with (A) controlled preheating followed by (B) final heating to top temperature and soaking for the required time, and finally (C) controlled cooling to the discharge temperature. The duration of the full cycle largely depends on the composition of the castings. For normal grades of blackheart the annealing cycle is of the order of 48 hours.

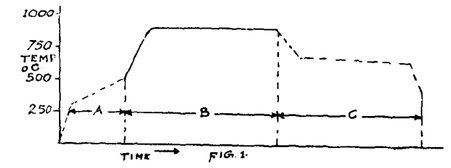

FIG. 1.

The entire cycle may be carried out in either a single furnace or in two separate furnaces. The twin-

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furnace scheme, incorporating separate high temperature and low temperature furnaces and three hearths, forms a very economical installation for the production of blackheart castings. It must be noted that the total time for preheating and final controlled cooling both carried out in the low temperature furnace, is approximately equal to the soaking time within the high temperature furnace. In the twin furnace scheme therefore, by correctly manipulating movements over the cycle, to bring the appropriate hearth and furnace together, an output could be obtained every 24 hours. Both the furnaces would be more or less kept in continuous operation, except for the change-over time, and consequently furnace utility would be high.

Where financial considerations prohibit the installation of a twin furnace scheme all at once, it is quite possible to achieve it progressively in two stages. The first stage would consist of a single dual temperature furnace in which the entire annealing cycle could be carried out. This could later be supplemented by a high temperature furnace, the first one being converted for low temperature work. The second stage equipment would approximately cost 60—70% of the first stage equipment and would double the output.

The first gaseous annealing equipment to be installed in India was supplied on the above basis, and is of the bell type. This furnace was commissioned and put into operation at a well-known foundry in Bombay.

Due to the necessity of closer compositional limits and lower carbon content, the as-cast condition for Blackheart malleables cannot be conveniently made from the cupola. A holding furnace either of the rotary oil fired or electric mains frequency coreless induction type is therefore essential. If, however, the scrap involved contains phosphorous in excess of the permissible limit, obviously a direct arc furnace would have to be used.

GASEOUS ANNEALING OF PEARLITIC BLACKHEART CASTINGS

The material has an as-cast structure similar to standard blackheart, but is annealed in such a way as to retain some combined carbon in the final structure, usually in the form of spheroidised carbide.

Continuous furnaces are best suited for the production of Pearlitic Blackheart castings, but the initial cost of such a layout is comparatively high. Batch furnaces could also be employed for this purpose, and have been successfully used. In this case, however, it is very important that provision should exist for rapid initial cooling immediately after the soak, since the final properties largely depend upon it.

Among the few methods available for Pearlitic Blackheart production the following one is perhaps the most economical and suitable for large scale production of standard grades.

Metal of standard blackheart composition may be submitted to an anneal, in which the second stage has been modified and cut short so as to retain some combined carbon. The required cycle is as shown in the diagram. (Fig. 2)

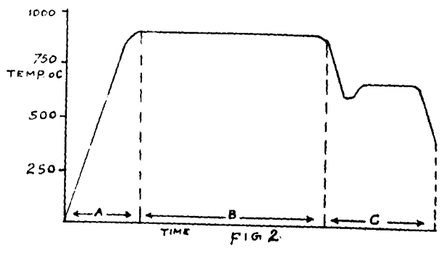

FIG 2.

As before, stage (A) is that of heating to top temperature. Since second stage graphitisation is to be suppressed, there is no need for retarded heating in the 300°—500° C temperature range which is desireable for standard Blackheart, and heating may be as rapid as is consistent with avoidance of cracking.

Stage (B) is the high temperature soak, as for standard blackheart. On conclusion of this, the castings must be cooled rapidly to well below the critical range (say to 650°C), and finally reheated to about 700°C for four to six hours to allow spheroidisation of the free carbide (stage (C)). As explained earlier, the initial rapid cooling is all-important, since final properties are largely dependent on it.

The atmosphere requirements are precisely as for standard blackheart.

GASEOUS ANNEALING OF WHITEHEART CASTINGS[2]

In the case of whiteheart castings, since annealing is effected primarily by decarburisation, the atmosphere for gaseous annealing of whiteheart must be strongly decarburising, and considerable quantities

are necessary to remove the required 50—70 lbs. of carbon per ton of castings. Further, scaling must be avoided, i. e. the atmosphere must not contain free oxygen, and the ratios of $H_2 : H_2O$ and of $CO : CO_2$ must at no time be less than the equilibrium valves for the oxidation/reduction reactions involved. For the temperature range employed, and allowing a margin of safety, both ratios should be not less than $2\frac{1}{2} : 1$.

There is a wide range of atmosphere compositions satisfying these requirements, which may be generated in many different ways. However, the only practical solution, from the economic aspect, is that in which the atmosphere is derived entirely from reaction of air and/or steam with the carbon content of the castings themselves.

In batch furnaces, the method operates in the following manner. When a new charge of castings is inserted into the gas tight furnace, the residual air in the chamber reacts with the iron castings to form a thin layer of oxide, which in turn, as the charge is further heated, reacts with a small part of the carbon in the castings to form CO and CO_2. Thus, by the time full temperature is reached, a reducing atmosphere, containing N_2, CO and CO_2 is established. This is then circulated throughout the furnace, usually by high temperature fans in the furnace roof, and continuously "regenerated" by a controlled addition of air and/or steam.

By regulation of the amount of steam or air added in relation to the amount of carbon available for removal from the castings at any stage of the cycle an atmosphere which is strongly decarburising but non-oxidising may be maintained throughout the soaking period.

A typical whiteheart annealing cycle would be as given below. (Fig. 3)

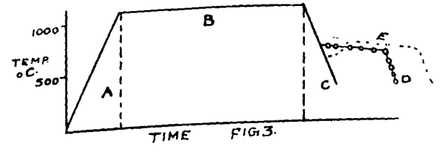

FIG 3.

The basic cycle is as indicated in the diagram. The heating up to top temperature ((A) in diagram) may be as rapid as is practicable having regard to the size of furnace employed, the only metallurgical limitation being the avoidance of cracking in individual castings, if of complex shape. On batch furnaces, of between 2 and 8 ton net charge capacity, the time may be between 5 and 12 hours according to the size and density of charge and the furnace rating. On continuous furnaces it may be as little as 2 hrs. The top temperature soak ((B) in diagram) is limited in the conventional ore-annealing process to a maximum level of 980°—1000°C., since at higher temperatures the ore sticks to the castings. With gaseous annealing processes, however, higher temperature can be used, up to the incipient melting point of 1100°C., being limited only by the necessity of avoiding excessive distortion of the castings. Temperatures in the range 1020°—1060°C., are commonly used.

At a temperature of 1050°C., the required soaking time varies according to the section of the casting, thicker sections requiring more time for an adequate degree of decarburisation and/or graphitisation. Typical soaking times would be :—

Section	*Time*
Thin—less than 3/16″	30 hrs.
Medium—3/16″—3/8″	45 ,,
Heavy—over 3/8″	60-80 hrs.

With regard to cooling, thin section castings which have been thoroughly decarburised (residual carbon content .5% or less) may be cooled fairly rapidly at 100° C./hr. or faster, down to a convenient temperature for discharge into air, of 300°—500°C. as indicated by the solid line (C) in the diagram.

On medium or heavy section castings, however, which retain a higher residual carbon content, this treatment would leave the castings too hard, and the cooling rate must be retarded, to about 5° C./hr., through the critical range of 760°—700°C., as indicated by the dotted line (D) in diagram.

If the best possible combination of tensile strength, ductility and elongation is sought, e. g. to meet the test bar values specified for Grade II of B. S. 309, or if optimum machineability of heavy sections is required, a modified cooling cycle of the "spheroidising" type is necessary. In this case, the castings are cooled as rapidly as possible from the top temperature to below the critical range, i. e. to 650°—700°C., then reheated to above i. e. to 760°—780°C., and finally cooled again at about 5°/hr through the critical range (line E in diagram). The structure so produced has the combined carbon present as spheroi-

dised carbide, instead of pearlite as in the case of straight cooling.

Practical overall annealing cycles thus vary from about 40 hrs. for thin section castings rapidly cooled, to 120 hrs. for the heaviest castings requiring an 80 hr. soak followed by a spheroidising slow cool. The average run of castings can be satisfactorily annealed in a total cycle of about 70 hrs.

EQUIPMENTS FOR GASEOUS ANNEALING[3]

Batch Furnaces

In the main there are four types of batch furnaces in normal use, all of which are essentially gas tight chambers with refractory lining to suit the particular application. In every case provision is made for the fitting of a boiler, CO_2 recorder etc., to adapt the furnace for whiteheart annealing. The differences between the various types of gaseous annealing plant otherwise lies only in the manner of bringing the hearth and furnace together, and hence in constructional details, from which the different type names are derived.

(1) The Elevator Type

A rectangular box shaped furnace with the bottom side open is mounted in a raised position on columns. The hearth moves transversely on rails from the loading station to a position directly below the furnace. It is then elevated into place to close the open side and thus form a gastight furnace chamber.

(2) Bell Type

The charge is loaded on a fixed hearth on to which a refractory lined rectangular bell furnace is lowered by means of a crane.

(3) Pit Type

A cylindrical rectangular pit sunk into the ground is lined with refractories and carries the heating elements to form the furnace. The castings are placed in charge baskets and lowered into the pit by a hoist or crane. The floor-level lid is then closed.

(4) Bogie Hearth

This is the common type of single ended furnace with bogie moving in and out on rails as required. The door is lifted up vertically to allow the bogie in.

It is also possible to do away with the bogie and just stack the castings in drum containers and place them in the furnace by a charging machine. This has the advantage of reducing the bogie dead weight within the furnace and consequent reduction in the furnace rating is possible.

CONTINUOUS FURNACES

These generally are of the straight-through tray-pusher type, in which trays carrying light open containers holding the castings are pushed along one or more parallel tracks through the furnace by means of a pusher mechanism located at the entry end. It is also possible to have other types of conveyors e.g driven roller hearth, but these are likely to be much greater in first cost as compared to the track and pusher type mentioned above. Continuous furnaces are mostly used for the production of Pearlitic blackheart castings.

POSSIBLE USE OF SINGLE INSTALLATION FOR BLACKHEART-WHITEHEART

A question is often raised on the possibility of using a single furnace for both whiteheart and blackheart. This is theoretically possible but usually inconvenient in practice. The atmosphere used for whiteheart with water vapour results in a 'wet' furnace and needs extensive drying out before the furnace can be used for Blackheart, even traces of water vapour being harmful for this latter type. The considerable drying time involved in the drying out of course causes much loss of production time.

RELATIVE PROPERTIES AND USES

Physical properties of standard blackheart and whiteheart are laid down in British Standards 310 : 1958 and 309 : 1958 respectively, and are as given below.

No British standards have yet been issued for pearlite blackheart, but American (A.S.T.M.) specifications list seven grades, ranging in properties from 29 tons/in² U.T.S. with 10% elongation to 45 tons/in² U.T.S. with 2% elongation, as determined on the standard 9/16" tensile test bar.

B.S.S No.	Grade, Type, Designation, etc.	Dia. of test bar ins.	Min. Tensile strength tons/sq. in.	Yield point tons/sq. in.	Elongation %
309 (1947)	Grade 1 W'ht. secns. over 5/16 ..	0.564	22	12	4 on 2"
	,, secns. 3/15 to 5/16 ..	0.357	20	11	6 on 1.25"
	,, secns. under 3/16 ..	0.252	20	11	6 on 1.0"
	Grade 2 secns. over 5/16 ..	0.564	24	13	8 on 2.0"
	,, secns. 3/16 to 5/16 ..	0.357	22	12	10 on 1.25"
	,, secns. under 3/16 ..	0.252	22	12	12 on 1.0"
310 (1947)	Grade 1 B'ht all sections ..	0.564	18	10	6 on 2.0"
	Grade 2 ..	0.564	20	11	10 on 2.0"
	Grade 3 ..	0.564	22	12	14 on 2.0"

With regard to uses, whiteheart is generally chosen for light thin section castings such as pipe and conduit fittings, cycle frame parts, window fittings etc. Standard blackheart, having more uniform properties and excellent machineability, is preferred for engineering castings, particularly where large scale production is involved as in the motor trade. Many other types of casting can be made satisfactorily in either materials. Pearlitic is useful where high tensile strength with lower, but still acceptable, ductility is indicated. The latter material also has the advantage of a structure suitable for surface hardening by flame or induction methods. The relative usage of pearlitic is rapidly increasing.

MALLEABLE CASTINGS FROM INDIAN RAW MATERIALS

The normal pig iron and scrap obtained in India has a phosphorous content beyond the permissible limits for malleable castings. It therefore becomes very essential to resort either to a melting equipment in which phosphorous can be eliminated or to careful grading and selection of scrap low in phosphorous level.

In a normal malleablising foundry it is estimated that approximately 50% of the production comes back to the melting unit as foundry returns. Therefore once production is got under way, foundry is then automatically provided with about 50% of its melting requirements in right specifications from the foundry returns. The remaining 50% will still have to be—

(1) From selected scrap, or
(2) From a suitable refining unit.

In case (1), a duplex process involving a cupola as a primary melter and a rotary oil fired or an electric Mains Frequency coreless induction furnace for holding would be quite suitable. But where phosphorous has to be eliminated (case 2), and low grade scrap is concerned, a Direct Arc Furnace appears to be the only practical solution for Indian conditions.

Associated Electrical Industries (India) Private Ltd., Head Office, Calcutta are in a position to supply all types of electric melting furnaces. There is a special point about the direct arc furnaces though, in that, the Government of India have granted A.E.I. (India) Private Ltd., a licence to manufacture 3 and 4 ton Direct Arc Furnaces to their associates' designs. A major portion of these furnaces would be manufactured in India, the remaining few essential parts being imported on a own quota licence. This enables A.E.I. (India) Private Ltd., to offer the above two sizes on a complete rupee basis.

Sizes other than these would still have to be imported, but A.E.I. could arrange for part local manufacture of any size of Direct Arc Furnaces, whereby the customer would have to procure an actual users import licence for the imported parts only.

A.E.I. (India) Private Ltd., will be glad to be favoured with enquiries and to supply any information or assistance which may be required. A specialised and experienced team of engineers hold themselves ready, should any discussions or visits be desired.

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Arc Welding Transformers Part II—Multi-Operator Type

The Indian Standards Institution has prepared a draft Indian Standard for multi-operator type welding transformers. This draft standard lays down the electrical performance characteristics, methods of tests and constructional requirements for the welding transformer to withstand rough usage, and the special feature of this standard is the adoption of 'duty cycle' basis for specifying the transformer ratings. The draft standard has been prepared with a view to guiding the manufacturers of this item to ensure good quality, sufficient degree of safety and correct performance.

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POLYCRYSTALLINE SEMI-CONDUCTOR RECTIFIERS

The Indian Standards Institution has prepared a draft specification for Polycrystalline Semi-Conductor Rectifiers covering polycrystalline rectifier units of selenium and copper oxide used for supplying DC power from AC sources and laying down ratings, tests and general requirements, for such rectifiers.

The polycrystalline semi-conductor rectifiers are being widely used owing to the fact that they have been found more convenient and economical as compared to vacuum tube or mercury vapour rectifiers.

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SPECIFICATION FOR PRECISION, AND TURNED HEXAGONAL BOLTS (6 to 39 mm) WITH NUTS AND HEXAGONAL SCREWS (6 to 39 mm)

The Indian Standard Institution has just published IS : 1364—1960 Specification for Precision, and Turned Hexagonal Bolts (6 to 39 mm.) with Nuts and Hexagonal Screws (6 to 39 mm.), covering the requirements of such bolts and screws of coarse and fine pitches. This standard belongs to a series of Indian Standards on threaded fasteners, three other Indian Standards in the series having already been published.

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RAPID DEVELOPMENT OF SOVIET GAS INDUSTRY

The present rates of growth of the Soviet gas industry enable it to surpass the United States' absolute annual increase of gas output this year, the *Gazovaya Promyshlennost* (Gas Industry) magazine reports.

The Soviet Union is second only to the United States in the volume of gas output and transportation. The USSR leads the world in the amount of potential gas resources. It has 60 trillion cubic metres, or 38 per cent of the world's total of 155 trillion cubic metres.

With greater emphasis on geological prospecting, within two years (1959 and 1960) more than 40 new gas fields have been discovered in various parts of the country. This, in turn, resulted in the wide application of gas practically in all branches of the national economy.

The magazine stresses the great social and economic significance of gasification of cities and populated centres. In 1960 the population of more than 700 towns and populated centres of the USSR was supplied with gas for fuel.

Dealing with the prospects of the development of gas industry in 1961 the magazine writes that for the volume of fuel produced, the gas industry will approach the 1955 level of the oil industry and thus, within one year will cover the path which took the oil industry three years to cover. Such great rate of increase is without parallel in the economic branches of the Soviet Union.

Duplexing in Foundry for Special Cast Iron

By An Engineering Correspondent

CONSIDERABLE study has been made of the use of Cupola in Foundry along with other systems of melting and the findings have been reported in Technical Journals in Italy as well as in other countries. In spite of all these studies we are still not in a position to determine exactly the correct operation of Cupola either normal or hot blast. For example, the temp. obtained at the spout largely depends on a number of variable factors like the shape and size of the metal charged, the coke to metal ratio, the quality of the material charged, quantity of air supplied to the cupola and the humidity X% of the air supplied. It is not possible to carry out a practical test on a large or a proper scale chiefly because of the financial difficulties. For this very reason, we have not arrived definitely at the Technical data regarding the optimum performance of the cupola.

In the service of the foundrymen is therefore offered a suitable alternative to overcome these difficulties. Some of the modern foundries have a superheating furnace for C. I. in the form of an Induction Forehearth. In essence it is a Low Frequency Induction Furnace with a capacity varying from 2T to 30T which not only serves to superheat C. I. in very little time but at the same time, acts as a reservoir for holding the molten metal. This application is very easy and the extra cost for superheating of C. I. by such means is negligible (it is reckoned at 0.8 nP./Kgm).

In order to illustrate briefly the great advantages obtained by means of a forehearth we would take the case of a foundry producing special C. I.—G 30, G S Ni hard.

For production of C. I. with Ni & Cr alloys to give definite mechanical properties of castings, special material is charged in the Cupola to give at the spout material of a particular hardness. In foundry operations, the hardness test is of great importance as it is the only method, however emperic, to check whether one type of C. I. as compared to the other, is better and more suitable or not for a particular job. If this test reveals that the casting is not proper, further additions may be made to reach the desired hardness. Since however, between the melting at the spout and actual pouring very little time is available, the most appropriate addition is made with a hope that it will lead to correct result. This uncertainty and inconvenience is completely removed by installing a forehearth and by putting a laddle under the spout for pouring, only after it is ascertained that the composition is correct and that it will lead to good results in the casting. In fact by means of a forehearth we can make any addition in any quantity and a number of tests can be carried out, alterations can be made in the alloy composition, the desired temp. can be arranged without being pressed for time. It is natural therefore, to assume that contrary to the hasty operations mentioned above, with the help of a forehearth, a foundryman can operate easily and surely and obtain a number of other advantages.

In connection with the production of S. G. Iron, it is our opinion that presence of electrical Forehearth is indispensable. It is also known that the maintaining of correct temp. is of prime importance in the production of S. G. Iron. Keeping this in view, we shall briefly review the main advantages obtained by means of an Induction Forehearth S. G. Iron production.

(1) With Induction Forehearth we can melt desulphurised cast iron. In fact it is enough to take metal from the cupola through a desulphurising siphon boiler and pour the same into the Receiver. Consequently we have less losses in alloys during treatment.

(2) By means of an Induction Forehearth we can add Ni-Mg, Si-Mg, Quaternary alloys, pure Mg at constant temp.

It is known that in certain cases the micrographic examination of s. g. Iron reveals that the Spheroids are not enough in number. In most of the cases this is due to the fact that the treatment of Mg with C. I. is carried out at too high a temp. Consequently the efficiency of Mg. as an alloy is inferior and same is the case if the Cast Iron is at very low temp. This can of course, be corrected by adding more alloys but

it may lead to a very serious result of having different compositions in different heats. It should also be remembered that by too much additions of Mg. alloys with rather cold C. I. the reverse effect would be present i. e., we have a melt with residue in Mg. too high, which gives a lot of difficulties in removal of slag and further when silicon is added it results in fragile C. I. In order to get excellent S. G. Iron with definite properties and if in the starting, if the following values are present.

X% S
T Temp. of melting
Z% of alloys for treatment

These values must be maintained till the operation is finally over. It is known that an induction furnace is necessary for melting in order to reach proper temp. without altering the above composition X and Z.

With the Cupola it may be possible to keep the percentage in alloys as well as that of S in correct proportion. But it is impossible to maintain a temp. of 1370° of the melt as const. in the successive melts.

It is also known that if the metal for very thin C. I. Castings is obtained from Cupola there may be a lot of rejections if the C. I. is not sufficiently hot. In such cases too Induction Forehearth is very helpful, as with this equipment, it is possible to superheat the metal above 1450° C (pyrometric reading). The foregoing demonstrates the advantages obtained by Induction Forehearth in production of good S. G. Iron.

From the melting of Ni hard C. I. in a normal cupola, the advantage of an Induction Forehearth is evident. In fact for this operation we have to charge large percentage of Ni Cr alloys to have the guarantee of definite results. In order to get hot C. I., coke in large percentage than normal is required. If Induction Forehearth is available, different qualities of C. I. can be melted without any difficulty. In fact the first melt can be for metal for uniform castings with thickness varying from 15 to 20 m.m. and with Ct. 3.20 to 3.40. This can be followed by addition of thin sheets in Induction Forehearth in order to lower Ct. and then pouring can be carried out for Castings which requires more resistance to shocks. This can further be followed by addition of Ni and metal can be poured for castings with thickness higher than 20 mm. By the installation of Induction Forehearth we have the advantage that there is hardly any loss in alloys.

It will be incorrect to exaggerate the importance of Induction Forehearth by stating that it can solve all metallurgical problems. However, in the last analysis Induction Forehearth does give definite advantages which are as follows :—

(1) Availability of hot C. I. from the beginning to end without the necessity of making ingots.

(2) Melting of C. I. with homogenous composition and regular structure.

(3) Melting of C. I. with controlled analytical properties with possibilities of making additions and corrections before making casting.

(4) Facility and ease in arranging melting of metals with particular advantage as regards the disposal of extra metal.

(5) Preparation of different qualities of C. I. starting from same quality C. I. from Cupola only by additions of different elements.

The application of the new system leads to a lot of simplicity in foundry operation and makes possible, economical production in quality and quantity of various alloys as Induction Forehearth is a complete equipment without costly auxiliary equipment.

FLYING AUTOMOBILE TO BE MANUFACTURED

A "flying automobile" designed by a United States company can travel along a road at speeds up to 60 miles an hour, or take off into the air and cruise at 100 or more miles an hour. The designer of the two-in-one machine is the Aerocar International Corporation of Fort Worth, Texas.

A contract has been signed, it was recently announced, under which Lingo-Temco Electronics, Inc., of Dallas, Texas, will manufacture the new-type vehicle.

A visit to the Ambrose Shardlow Establishment at Sheffield

FOR producing crankshafts by flow production methods for automobile and industrial engines, Ambrose Shardlow and Co., Ltd., Ealing Works, Meadowhall, Sheffield, have a personnel of approximately 1,500 manufacturing upwards of 10,000 drop-forged crankshafts and 10,000 fully machined crankshafts per week.

The factory is claimed to be one of the best equipped in Europe for producing either drop forgings or fully machined shafts, according to customers' requirements. They include many of the main automobile and commercial vehicle manufacturers, also leading makers of oil engines in Great Britain and numerous concerns abroad. Crankshafts manufactured vary from 2½ ft. to 10½ ft. in length, and from one-throw to an eight-throw shaft.

STILL GREATER CAPACITY

It is the concern's intention to increase the range of their crankshaft machining capacity to include shafts up to an overall length of 20 ft. Towards this end, after full world-wide investigation of the latest production methods for this type of shaft, they are proposing to install the necessary plant and adopt techniques which will enable them to compete successfully in this market in the near future.

During our recent visit to the Ealing works we were impressed by the "know-how" employed in the various departments throughout the works. We now give a few particulars of some of the methods and machines inspected during the visit.

The drop forge shop consisted of three bays with oil and gas-burning furnaces and 20 hammers of various types ranging from 1½ tons to 18 tons; 70% of the hammers are of British manufacture and the remainder of American and German makes. In the production of crankshafts full use is made of dies.

One of the latest forges is provided with two Beche double-acting hammers for billets up to 33 in. On these hammers all the work is done in one "heat," and this includes rolling, bending and finishing all in 1½ min. and in one die. Small shafts can be made by the three-machine method two being hammers and one a press. The process consists of preparation, stamping, trimming, setting and finishing. Another method of making an oil engine crankshaft from a 33-in. billet, comprises its first being stamped out flat, the flash removed. The pins are then twisted into position by an hydraulic twisting machine, then given a final blow to set the shaft.

All dies are designed and made at the Ealing Works. They have an important influence on all the forging operations because it affects both the cost of manufacture and the quality of the product. Matching of the dies is automatic, employing the profile system and all dies are hand finished. Some dies are designed to roll, bend and finish stamp the billets, others just roll and bend, or prepare, or finish stamp, depending upon the style of shaft and quantities in production. A lead proof is made of each die to ensure that both halves match up. For small quantity crankshaft production when the cost of dies is uneconomical the shaft is forged by means of hand-operated tools under a power hammer.

The die shop is located away from the forge to eliminate vibration from heavy hammer operation. It is fully equipped for the manufacture of any pattern of die required. Amongst the machines installed are Cincinnati, Hiloplane and Hydrotels and four Keller die-sinking machines. Die blocks vary in weight from about 15 cwt. up to 4 tons. It is claimed that a Shardlow die seldom breaks or cracks in service, proving the care that is taken in its design and making.

Included in the machine division are the drawing office, planning department, machine shop, induction and nitride hardening sections, balancing, lapping and finishing sections, jig and tool shop, and the instrument and gauge section. In the machine shop there are a number of special purpose machines designed and made by Shardlow to suit particular types of crankshaft. The main shop is 430 ft. long by 390 ft. wide, divided into 13 longitudinal bays.

For crankshafts for four and six-cylinder engines there are between 30 and 50 machining operations. Shafts hardened by nitriding process take more machining than those which are induction hardened. For a particular six-throw crankshafts the machining operations are carried out on three vertical lathes which form a unit. The first machine does the outer pins, the second the two intermediate pins and the third machine the centre pins.

SPECIAL-PURPOSE PLANT

Another example is a Le Blond lathe which can turn six crankpins of a special type of crankshaft at one operation. A Drummond Maximatic centre-drive lathe accommodates two crankshafts at the same time. It turns all the main journals, web faces, web bevels, timing wheel diameter and flange diameters. Drilling of the oil galleries and holes is done on a six spindle Farmer automatic drilling machine. The feed is hydraulic and the drills are electrically controlled by means of a time relay. Each spindle is set to drill to a given depth and the drill then withdraws. Also if, for any reason, the drilling torque exceeds the pre-set figure the drill will withdraw. These are only a few of the special machines.

In the heat-treatment department there is a battery of Gibbons furnaces. Forgings are placed in automatic chargers before entering the furnaces. Induction hardening takes place after rough grinding of the crankshaft. A special bay is set aside for this purpose, one section for large quantity production and another section for smaller quantities. A semi-automatic plant provides, where necessary, facilities for hardening the surfaces of the shafts. Nitride hardening takes place in another bay where there are ample equipment items for this process. About 70% of the shafts are induction hardened.

Dynamic, static balancing and super finishing are achieved by means of the latest types of machine, resulting in finished crankshafts up to the highest standards of accuracy and micro finish. Both drop-forged and fully machined crankshafts are submitted to rigid inspection prior to dispatch; the inspection facilities have been approved by the Ministry of Supply, Lloyd's Register of shipping, Ministry of Transport and the Air Registration Board.

The tool room, also the chemical and physical laboratory, play a big part in the production of the crankshafts. All are well equipped with modern plant and apparatus to ensure that the crankshafts are produced economically during the forging and machining processes, and that the materials used are up to standard.

RAILWAY OVERHEAD ELECTRIFICATION SUPPLEMENT

The Alternating Current 25 kV – 50 C/s Mixed Traffic Bo Bo Locomotives for Indian Railways

By Mr. Y. Machefert-Tassin
(Paris - France)

WHEN planning the electrification of about 2 500 km. of the main heavy traffic lines in the West-Bengal and Bihar region, the Indian Railways chose the alternating single phase current, at the industrial frequency of 50 cs. They consequently called for international offers to supply a first row of locomotives to work on the main traffic lines, which are known as "mixed traffic locomotives".

The traffic's characteristics on these lines are: on the one hand an equal distribution of the trains during the day, as well for freight trains as for passenger trains, on the other hand the high tracted load, the average value approaching the maximum granted load with a preponderance given to the freight traffic. The loads of the freight trains are effectively the following, for a maximum speed of 72 km/hour:

—2340 tons on the Calcutta (Burdwan)—Varanasi (Moghal Sarai) involving 5% grades.

—2030 tons in the district of Calcutta-practically on the level.

—1830 and 3660 Tons in double-heading on the mining line from Asansol to Rourkela with 10% grades.

In passenger traffic, in addition to the great suburb of Calcutta, the normal load of the main lines trains is also high: 675 or 815 tons, according to the line, with a maximum speed of 112 km/hour.

After a very arduous technical competition between about thirty suggested models of locomotives, the Indian Railways chose,—as the Portuguese Railways previously did for their 50 C/s electrification, Bo Bo type locomotives with 4 motors and ignitron rectifiers—hundred of these locomotives were built and run regularly, starting from 1959, by the Group for study and electrification of railways at single-phase 50 cs, and the totality of the locomotives is now in India. (fig. 1).

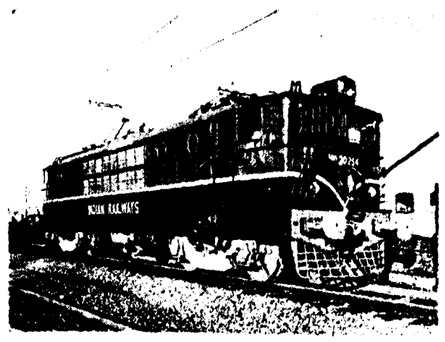

Fig. 1. General view of the locomotive with normal coupling.

This Group actually includes the most famous and experienced European firms since the beginning of the electric traction in the new alternating 50 cs system—since more than 1200 locomotives and railcars built by the participating societies run by this traction method in the entire world.

The locomotives especially built for the Indian railroads answer first of all to the difficult general temperature and dampness conditions characteristic to the local climate; maximum surrounding temperature of 50° C. and dampness degree sometimes reaching 100%.

This made it particularly necessary to study the whole of the electrical equipment for a reduced heating of 20° C. in relation with the

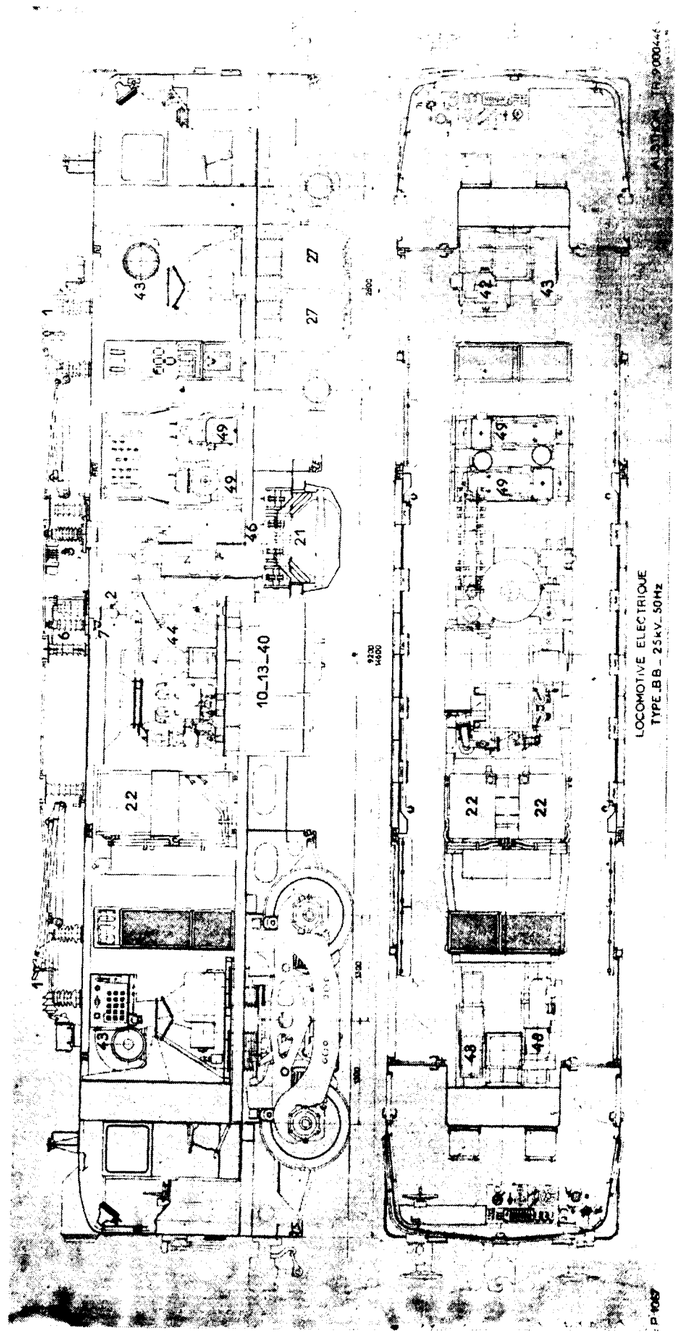

Fig. 2. Elevation showing main dimensions and cuts on the equipment.

1. *Pantograph*
2. *Pantograph switch*
3. *Circuit Breaker 25 kV*
6. *Bushing*
7. *Current transformer of overload relay*
10. *Tap changer*
13. *Main transformer*
21. *Smoothing reactor*
22. *Ignitron tubes*
27. *Traction motors*
40. *Auxiliary transformer*
42. *Arno convertor*
43. *Traction motor motor-blower*
44. *Main transformer motor-blower*
46. *Smoothing reactor motor-blower*
48. *Compressor*
49. *Exhauster*

maximum authorized by the rules of the International Electrotechnical Commission (I. E. C.) taking into account the exceptionally high surrounding temperature. Moreover, all the electrical apparatus were provided in "tropicalised" type, to take into account the condensation and mouldness risks. When possible except these absolutely necessary fixings, it was called upon carefully tried locomotives components, and the electrical apparatus usually deriving from existing patterns.

However, the limitation of the total weight loads—as for the architecture of these machines, right away built in mass production—to look for the lightest equipment possible answering to the necessities of the foreseen service.

The main characteristics will be given on the following table, but we have already pointed out that in the outlines, the bogies derive from the S. N. C. F. B. B. 12 000 locomotives, and the body and plant both from the B. B. 16 000 and 16 500, also running for the S. N. C. F. These engines have a rating of 2148 kW at 460% of the maximum speed of 112,6 km/hour, with a total adhesive weight of 74 t, which is remarkably weak, making allowance to their total length of nearly 16 m, and to the gauge of 1676 mm; they represent a very successful accomplishment of powerful and light locomotives, as their elders from the Portuguese Railways had led the way, but here with an increased power allowing a better use of the adhesive possibilities of the engine.

MAIN MECHANICAL CHARACTERISTICS

General diagram on fig. 2

Gauge	1676 mm
Overall length	15932 with normal coupling 15 676 with Henricot central coupling
Distance between center of bogies	9 200 mm
Bogies wheelbase	2 608 mm
Maximum height of roof	3 510 mm
Maximum width of trunk	3 160 mm
Diameter of wheels (half used)	1 105 mm
Gear ratio	4.06
Total weight in service	74 t
Maximum weight per axle	18 t 5
Weight of mechanical part	41 t 8
Weight of electrical part	32 t 2

MAIN ELECTRICAL CHARACTERISTICS

Nominal feeding tension	25 kV
Type of current	50 Hz
Tractive effort speed diagram on fig 3.	
Nominal power at continuous rating	2 148 kW 2 920 H. P.
Corresponding speed	52 km/h
Corresponding tractive force at the rim	14 t 8
Power in one hour rating	2240 kW 3040 H. P.
Corresponding speed	51 km/h
Corresponding tractive force at the rim	15 t 7
Maximum starting tractive force at the rim	26 t 2
Maximum speed	112,6 km/h

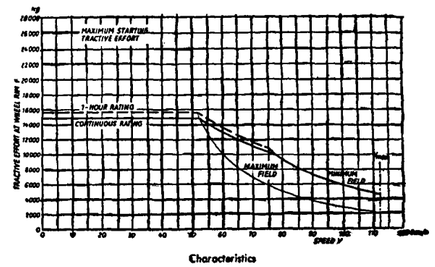

Fig. 3. Tractive — Effort — Speed characteristics with weakened field curve corresponding to the 19th step of the tap — changer.

ELECTRICAL EQUIPMENT

The electrical diagram, of which fig. 4 gives the rating and auxiliary circuits basic weft, is derived from the one used for B. B. ignitron rectifiers locomotives made by the same builders.

However the question lies here on simplifying the number of the main apparatus, to feed the 4 motors by two groups of 2 water-cooled ignitrons in diametric one phase connection, also called bi-valve or push-pull connection. Each Group of 2 paralleled motors and the corresponding ignitron, forms an independent section up to the transformer's secondary winding common to two sections. The latter involves a voltage change tapchanger on the primary side.

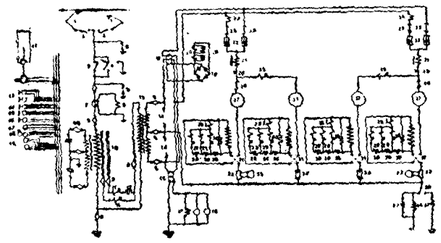

Fig. 4. Main and auxiliary circuits diagram.

1. *Pantograph*
2. *Pantograph switch*
3. *Circuit Breaker 25 kV*
6. *Bushing*
7. *Current transformer of overload relay*
10. *Tap changer*
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48. *Compressor*
49. *Exhauster*

We shall now follow more circumstancially the different peculiarities of the equipment, starting from the 25 kV—50 Hz feeding.

ROOF PLANT

It involves 2 AM Faively type pantographs with only one jointed strut, used on the most recent European speed equipment. The pantographs disconnections, the roof-line, the grounding device disconnecting switch and the insulators are big height types ones, derived from those worked out for the 25 kV Portuguese lines, subject to sea-board influence, therefore to an extra-strong insulation.

The circuit breaker is of an ultra-quick compressed air type, called DBTF, practically wide-spread on all mass-production 50 c/s existing engines, and its breaking power is 250 MVA. It involves both a breaking space and an outdoor disconnection switch, mechanically associated to the interlocking frame.

TRANSFORMER AND TAP-CHANGER

A classical 25 kV roof terminal, in a three parts condenser brings the high tension to the transformer supporting the 2 last parts. The transformer is a BOT 3000 core-type, oil immersed and cooled by forced oil circulation. It includes a regulating

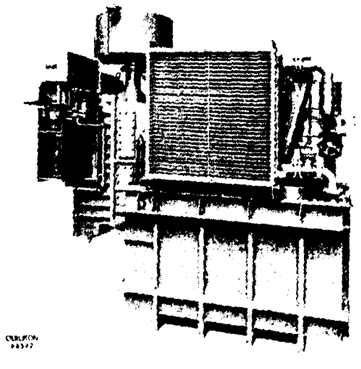


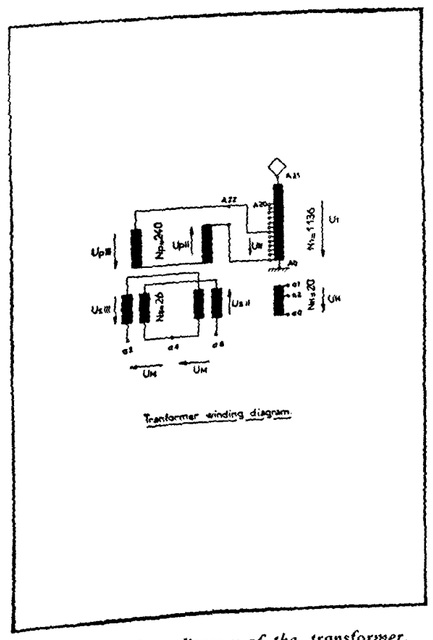
Fig. 5. Transformer set on the oil cooler side — Between tap — changer on the left and oil cooler is the 25 kV bushing.

auto-transfomer with a variable ratio on 20 connections, a traction transformer with fixed ratio but variable voltage feeded by the former, and an auxiliary winding with fixed ratio.

The magnetic circuit consists of a laminated core of interleaved construction including 3 legs connected to its ends by two yokes. One of the extreme legs supports both the auto-transformer winding, and the auxiliaries feeding. The traction transformer windings are distributed symmetrically both on the two other middle and extreme legs; the extreme legs have the same iron-core section and the intermediate leg a 1,77 more important core-section, because it secures the back flux common to the extreme legs.

The first auto-transformer leg involves a 1 136 turns winding taps allowing both the voltage regulation over 20 equidistant tap every 40 turns from 0 to 17,5 kV for 25 kV at the primary terminal, and the regulating tap-changer feeding at the convenient maximum voltage.

Electrically separated from the former winding, a "tertiary" winding secures 380 and 630 V voltage and is not influenced by the flux on the traction



Transformer winding diagram

Fig. 6. Winding diagram of the transformer.

side. The transformer remaining legs involve the symmetrically interleaved winding of the traction transformer following the diagram on fig. 6.

The 9,25 voltage ratio leads, for example, for 22,5 kV at the primary on tap 19 of the transformer, to an effective voltage above the 1 630 V rectifier. The flux variations in each leg in proportion to the tap-changer feeding tap are such that at tap 6 the induced flux of the external traction leg is of no account, and the return leg-flux only includes the constant one from the auto-transformer leg.

This allows to profit on the iron-core sections, as if the flux at tap 0 of the tap-changer, for instance stand in a succession of proportionality of + 1 — 0,5, + 0,5, at tap 20 we have about + 1 + 2, + 1. The medium number represents the induction in the back yoke.

On the output point of view, the primary rating necessary to the motors is of 3 000 kVA, the secondary rating on the rectifier side of 4 250 kVA, and the auxiliaries of 150 kVA. This leads to take the same example of tap 19—to a medium traction current of 1 840 A, that is to say the continuous rating of the motors. The transformer, contrarily to what is often done for easier working cycles, has here an output ratio close to one. On a mechanical point of view, the composition of the transformer tank is classical, and the legs and windings are tightened by an independent metallic underframe fastened to the cover of the tank to make the removal of the active parts easier. The connections with the tap-changer are quite accessible by bolted access plates set up on the tank junction between the two apparatus.

Following an interesting experience with the 50 Hz the transformer constitutes an homogeneous block with all its fittings, fixed on the cover of the tank: oil pumping set composed of a centrifugal pump driven by a three-phase, two-pole, squirrel-cage, motor oil-immersed without joint, oil-cooler with centrifugal fan and motor, cylindrical oil-conservator with level gauge, dry air inhaler with "silicagel" and safety valve. This set stands above the tank junction between transformer and tap changer and is connected to the main high parts of the group. At last the block also

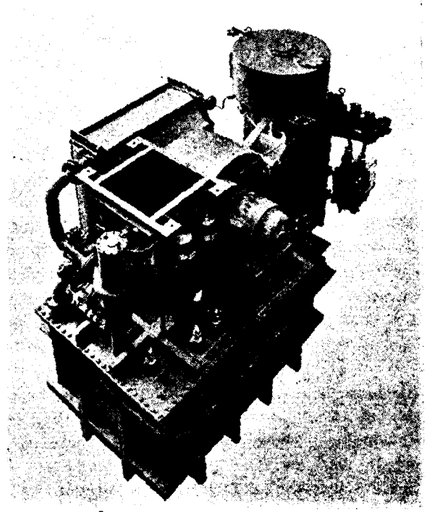


Fig. 7a. View from tap of transformer set and its accessories. Below are: oil conservator with safety valve and blind flange above the tap-changer, oil cooler and motor-fan, supports for transfer resistance, surge-suppressors and their protecting cylinders, then oil-pump, piping and valve, and secondary terminals.

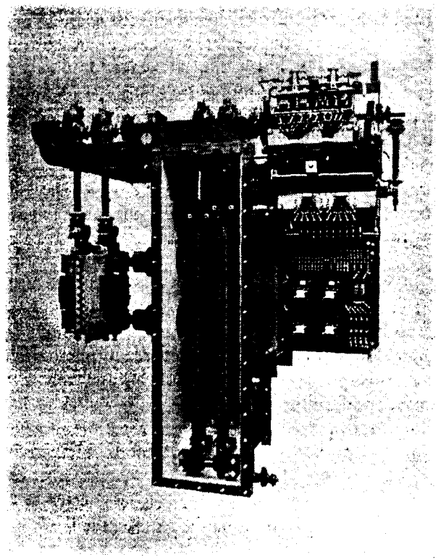


Fig. 7b. Tap - changer without covers - from left to right are contactors, selector, servomotor (above) and control switchboard (below).

includes surge-absorbers and their accessories, series resistance of the tap-changer, bushings, cocks and valves, terminals and connections necessary to the self-running of the transformer set.

The tap changer lies side by side with the transformer, and belongs to the N 40 h type with 20 main notches, with a straight oil-tank in which a selector having chain driven rollers and going from one tap to another on two linear paths and series of terminals corresponding to the autotransformer taps.

The outside breakers, against the selector tank, insure the load cutting or connecting at each tap changing. These two breakers are driven by cam-shaft and eccentric half straps, together with the selector chains on the same shaft worked by an electro pneumatic servo motor.

If the tap changer is henceforward of a classical type, the compressed-air servo-motor is not a common one and the appliances are more recent. Here the apparatus set includes a compressed-air motor with 4 cylinders and valves under the 4 stroke-cycle. The air inlet and outlet are separately controlled on each cylinder through 4 magnetic valves. Each notch of the tap changer is made with one half revolution of the servo-motor. The working method is the following : the air motor electropneumatic valves are coupled in pairs but the windings can be separately fed, so they can fill respectively cylinders 1 and 2 or 3 and 4, or either on all 4 cylinders. There are consequently 4 balanced positions whence the rotation by means of quadrants of revolution of the servo-motors crankshaft. As for the BB 12000 of S.N.C.F., the tap-changing enables either notch to notch running of the 20 voltage steps, or the same number of intermediate half steps on transfer resistance. This resistance can stay continuously running but is only used as intermediate notches while the locomotive starts. The intermediate step then corresponds to a nominal quarter of revolution on the pneumatic servo-motor and the voltage gets more or less near to the next notch according to the current going through the traction motors, the half voltage being approximately attained for a normal starting current.

IGNITRON RECTIFIERS

During the survey of the locomotive, and although it were simpler to feed individually each traction motor by two single-anode rectifiers, we looked for the lightest and cheapest solution. This practically commanded the most experimented type of rectifier on the locomotives, that is the sealed single anode water-cooled "ignitron", as true 50 cs unidirectional electronic static-device. On the other hand, the investigation for a smaller and cheaper equipment also commanded the highest possible voltage for the working of the rectifiers and the traction motors, with two objects: On the one hand, to increase the efficiency as much as possible, and to reduce the losses, that is to say the calories to remove which offers an increasing advantage when the difference between the 50°C surrounding temperature and that of the rectifier is smaller. On the other hand, when decreasing correlatively the motor current it became possible to reduce the number of ignitrons from 8 to 4, as on the BB 16 500 of the S.N.C.F. That is why it was interesting for the equipment to go up to 1 250 V nominal voltage. The benefit acquired on the rectifiers has not been completely absorbed by the "overinsulation" of the motors, and there is a profit if the working voltage does not go over 1 300 V. This choice allows to feed the two paralleled motors with only two G type ignitrons, or 12 inches diameter, that is 300 mm. inside, especially surveyed for this application. This tubes, called SGT, were derived from those made for the first time in the form of F diameter or 10 inches,

for the BB 16 000 locomotives of the S.N.C.F., with a continuous rating over these machines of 1 000 A—1 000 V for two tubes. Each SGT ignitron weighs 94 kg, the rectifier set is still now without equivalent in the world, except the semi-conductors as to the small space taken up and to the continuous specific power : here 5,7 kW by kg, or 0,17 kg/kW.

When studying the BB 20 200 locomotives for INDIA, it was found during trials that for 3 000 H.P., even between a 52 and 55° surrounding temperature (60 to 61 ° for water) these ignitrons can easily give in continuous rating 900 A—1 200 V, enough for 2 paralleled motors. Besides, the test was extended up to 850 A—1 600 V on continuous rating at 54° surrounding temperature. Following the needs of coordination of the transformer-rectifier-motor characteristics slightly modifying the initial characteristics in the meaning of an increased performance, the present continuous rating stands at 920 A—1 250 V for two SGT ignitron tubes and two paralleled motors, that is 460 A for each motor. You can easily see that if a 6 or 700 V voltage had been kept, 8 tubes instead of 4 would be wanted for the locomotive, the necessary current for the same power being nearly twice as high, and going up from 1840 to 3 100 or 3 600 A. As the calories to withdraw by the rectifier are the square of the intensity values, you can immediately see the advantage of the high voltage water cooled ignitron for this application. It is enough to say that the mercury vapour voltage inside the rectifier tank goes up from 3 to 30 microns for a surrounding temperature change of only 30°C, to realize one among many solved difficulties. The trials surveyed on the first SGT ignitrons, at the surrounding temperature of 54 to 55°C heat room, have shown the possibility to keep a one hour rating of 960 A—1 375 V, that is 1 320 kW for two tubes—Successive cyclical overloads are possible in the same surrounding temperature from 2 000 A—4 minutes, then 1 250 A—1 100 V, that means 1 375 kW. for 9 mn. followed by 1 260 kW. 20 mn. to 1 200 V and 1 150 kW.—1 hour at 1 250 V. The safety allowance in normal use is therefore quite satisfactory, and you can appreciate the improvements made as the complete rectifier block with all its fittings and including an important cooling system only weighs 15 kg. only 1,9% of the locomotives total weight (fig. 8 & 9).

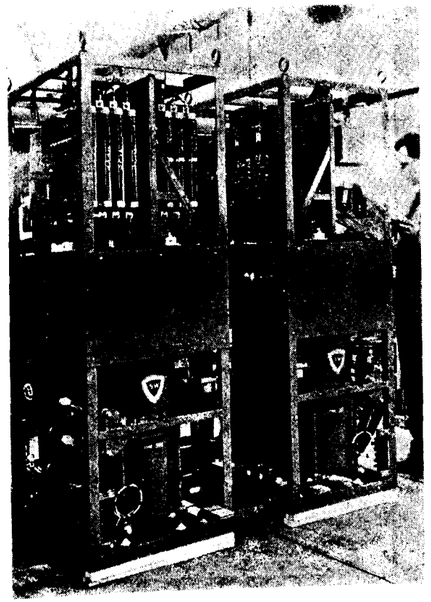


Fig. 8. Complete ignitron - rectifier cubicles as assembled in the locomotive - Below are the four 12 inches ignitron tubes, Above the whole of fining and auxiliary circuits.

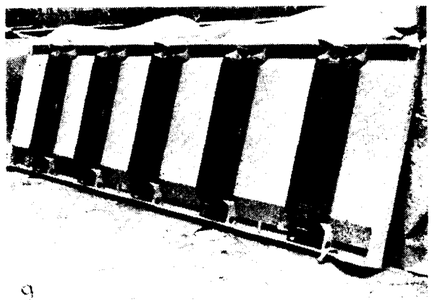


Fig. 9. One of the side flanges of the body including the 5 rectifier water - coolers housed just beneath the air filters and shutters.

The water coolers are placed on the side wall of the body and do not need any particular ventilation or special fan sets. The firing circuits and auxiliaries include semi-conductor Silicon rectifiers and form two drawers with the two corresponding ignitrons.

The cooling system is quite classical and you may notice that the pre-heating—although put up is practically useless here.

It is furthermore interesting to point out here that during the special operation tests of the inverter-ignitrons enabling the regenerative braking, the electric characteristics still give the possibility of sending back 900 A under 1 100 V on the steady state feeding line side and 1 200 A under 600 V in 1 hour working conditions.

An immediate application in series has been carried out in 1959 on the locomotives manufactured by Members of the group, for the 50-cycle railway networks intended for U.S.S.R. and popular CHINA. These railway networks still put their exclusive confidence in this rectifier type for the mercury vapour classes.

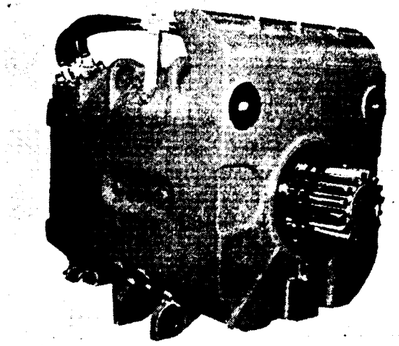


Fig. 10. The MG 710 A traction motor before placing in the bogie.

TRACTION MOTORS

The traction motors designed and manufactured in common by various firms of the Group are of the fully suspended type in the bogie and individually drive each axle by a gear-work whose ratio is 65 : 16, namely 4.06 with an intermediate cog wheel provided with 35 teeth enabling to bring the motors as close as possible to the bogie centre of gyration. The motor is of the MG-710 type, with 4 non-compensated poles and class B insulation for a maximum voltage of 1,375 V during operation. The definition of the motor continuous output corresponds to a temperature rise of 100°C only of the armature and for a 460 A current at the voltage of 1 250 V, 537 kW. continuous (730 H.P.) at 1 020 r.p.m. are obtained at the shaft. The torque-speed characteristics are given in fig. 11. Shunting the field coils giving a field weakening of 22,5%, 36,5% and 47% on three steps enables the maximum voltage to still use possibilities of increasing the speed of 2 200 r.p.m. From the viewpoint of design, the motor includes a maximum number of simple solutions provided to facilitate its maintenance namely one armature made of varnish-enamel maintained at both ends by 2 moulded steel flanges and assembled on to a wrought hub slipped on to the shaft made of treated steel alloy. This operation allows to replace individually either the shaft or the armature. Slots simply include 2 layers of 3 superposed conductors of equal section. The armature insulation is made on the conductors with asbestos and silionne and on the windings with mica and silionne tape. Insulation is of the same type for equipotential connections. The commutator is of the flexible clamping ring type just like on the latest motors for the S.N.C.F. 50 cycle high-speed locomotives. The reader is aware of the advantages offered by this assembly when compared to the conventional bolting. This assembly enables to obtain a flexible centrifugal distortion in speed with return to the initial position

Fig. 11. Torque - Speed traction motor curves under 1250 V voltage. The motor speed in km/h corresponds to 0,0511 with respect to the speed in rpm.

without any variation in the clamping values, and with a particularly uniform distribution of prestresses on the commutator blades.

Made of moulded steel, the frame is of the octogonal type with nearly square cross-section facilitating the use of spaces in the bogie. The 4 main poles and the auxiliary poles are of laminated sheet 1 mm. thick. The field coils are insulated with mica tape or with

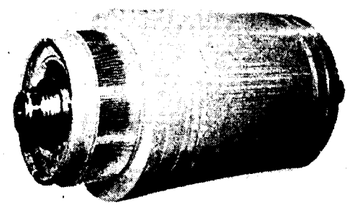


Fig. 12. Traction motor armature on the commutator side with the flexible ring.

asbestos per conductor, then externally for the whole with silionne, asolite or micanite tape. The various connections are brazed with phosphorous silver welding. Finally, the brush-holders are fixed on to a ring turning in the frame by means of a fork enabling each of the 4 brush-holders to be brought opposite the commutator inspection door at the motor lower part. At the upper part, is the ventilation opening designed for 1.5 m3/sec and 150 mm water-pressure at the commutator. The traction motor weight is 2 735 kg. which gives a specific weight of 5 kg./kW to the continuous rating as compared with the weight of even more recent motors whose nominal voltage is lower, and in any case much lower than what is given by the 50 cycle direct motors, which ought to be much more powerful. The supply of motor with wave current is carried out for each pair of motors by means of a dual smoothing coil having its own ventilation system and giving for each motor a characteristic of 12 mH. for 460 A and 9 mH at the starting current of 680 A. The wave value is consequently about 30% in nominal working conditions. The smoothing coils weigh 690 kg. and 750 kg. respectively with their ventilation system.

AUXILIARIES—VENTILATION—BRAKING

Considering the number of auxiliaries including in particular 9 rotating sets, a single three-phase 150 kVA ARNO convertor feeds these auxiliaries with a three-phase 50 cycle current at 380 V. This convertor weighs 900 kg. with the auxiliary d.c. generator for the circuits on battery. The main three-phase auxiliaries are evidently the ventilating sets and the braking air sets.

The ventilation system in accordance with the diagram of fig. 14 includes:

—2 motor-fans, each blowing two traction motors with 19 kW. (26 H.P.) at the shaft of each fan for 3,4 m3/sec. of air at 280 mm. pressure. They are motor-fans turning at 3 000 r.p.m., each of them weighing 250 kg.

—1 motor-fan at 1 500 r.p.m. for the transformer set of 11 kW. (15 H.P.) supplying 6.2 m3/sec. at 135 mm water through oil coolers and tap changer resistance. The set weighs 482 kg.

—1 motor-fan at 3 000 r.p.m. absorbing approx. 1,5 kW. (2 H.P.) to below 0,8 m3/sec. at 60 mm. water on to the 2 smoothing coils for a total weight of 60 kg.

From the viewpoint of braking, the double requirement for ensuring the vacuum braking of the train and

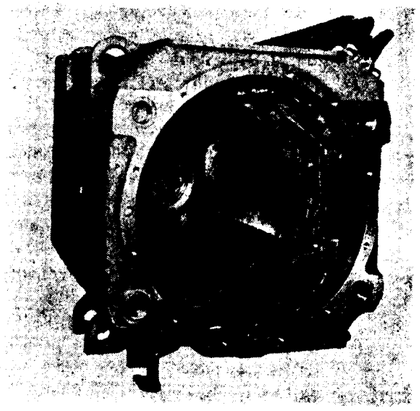


Fig. 13. Traction motor casing with field windings on the pinion opposite side.

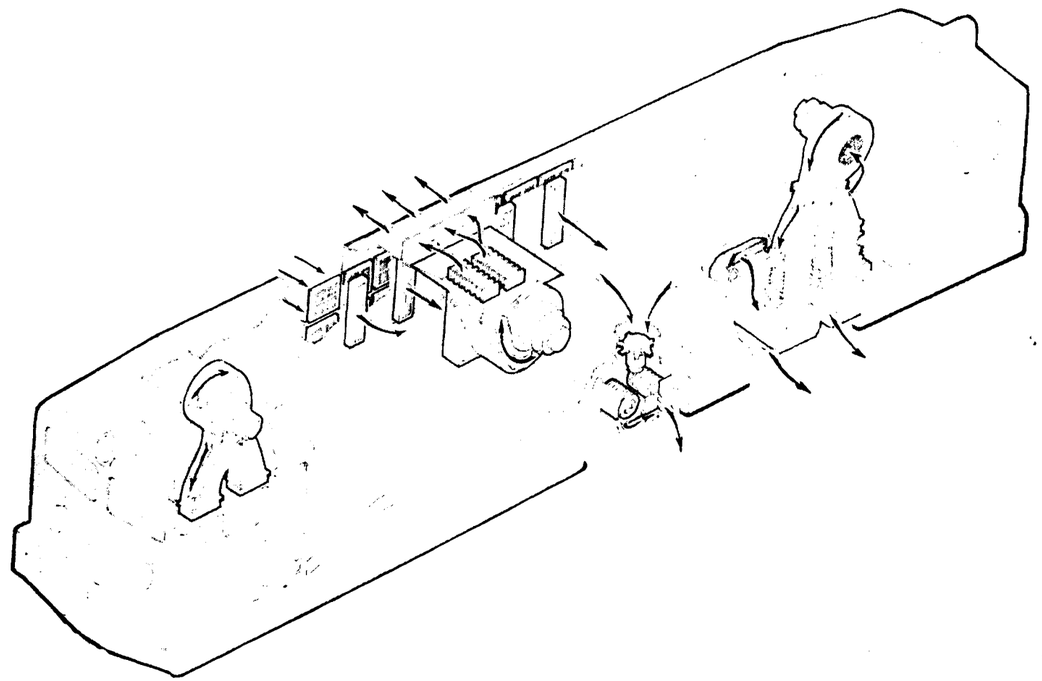


Fig. 14. Ventilation diagram and fan locations in the locomotive.

the compressed air-braking of the locomotive led to provide for :

—2 vacuum motor-pumps type 1A.480.P, two speeds, with rotating motor at 1 465 r.p.m. and 2 910 r.p.m. by changing the poles (4 or 2) with an output of 3.7 kW (5 H.P.) and 7.3 kW. (10 H.P.) according to speed. Always directly started on 4 poles at low speed, the motor, by means of one 21/58 speed reducer, drives a 3 cylinder vacuum pump at 500 or 1 000 r.p.m. discharging 2 675 l/mn in normal continuous working conditions for compensating the brake vacuum losses and a maximum quantity of 5 350 l/mn. when the brakes are being released. The unit consisting of the motor, reducer pump and ventilation propeller of the set is assembled in one piece, including as well an amply designed air-filter. Each unit, complete, weighs 600 kg. (fig. 15).

—1 motor-compressor type 2 A.115 of the same mechanical principle as the vacuum-motor pumps enables the locomotive brake and pneumatic auxiliaries to be supplied with compressed air at 9 kg./cm$_2$. This is a 2-pole 8 kW. (11 H.P.) 2 860 r.p.m. motor which drives by means of a speed-reducer at 1 200

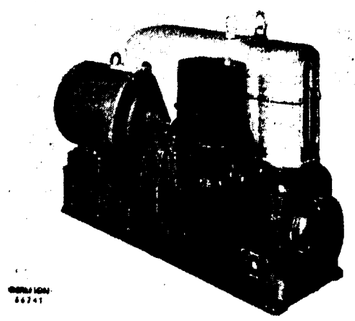


Fig. 15. Vacuum pump and motor set with air filter.

r.p.m. the 2 stage compressor on 2 low pressure cylinders and 1 high pressure cylinder, and normally producing 1 000 l/mn of air. The set weighs 350 kg.

Finally,

—2 small auxiliary motor-pump units of 2,5 kW and 1,5 kW, the first of these units ensuring the oil-circulation for cooling the transformer, the other permitting the water to circulate for cooling the ignitrons. The oil-motor pump is of the cast solid immersed type at 1 500 r. p. m., the water-motor pump at 3 000 r. p. m. separately drives the latter pump by means of a reducing belt.

When all these rotating auxiliaries are running together, it is obvious that the 77 kW output distributed on 9 sets is more advantageous even with a fairly heavy ARNO set having a medium power factor than a composite solution with single-phase started through auxiliary phase and direct current feeded by rectifier motors.

Although it is lighter by approximately 10%, this last solution would have led, in the present instance, to a price higher by 20% and a non-negligible sensitiveness to voltage variations foreseen for ± 20%, whereas the 50 cycle frequency of the three-phase auxiliaries ensures an almost constant speed. Consequently, the ventilation power supplied by the auxiliaries is constant exactly as the tap changer enables to correct the line voltage drops on the traction power.

The other controlling, checking, lighting and signalling auxiliaries are fed with 110 V direct current by means of a battery (consisting of 72 elements and 60 AH) electrically floating on the auxiliary d. c. generator assembled on to the ARNO set shaft.

The diagrams for these auxiliaries are now almost conventional on the recent 50 cycle locomotives and call for the means of modern electronics : semi-conductor rectifiers avoiding certain contactors or relays in return circuits for example.

Fig. 16 shows the distribution of the auxiliaries in the locomotive. Considering the associated apparatus for the auxiliary and power circuits, contactors and change-over switches for example, their grouping in a pre-fabricated and pre-wired cubicles having been carried out whenever necessary.

This layout leads to a thoroughly ventilated installation despite pneumatic incidentals of dual braking, and 2 cubicles only include nearly the whole of the switchgear for the power, auxiliary and control

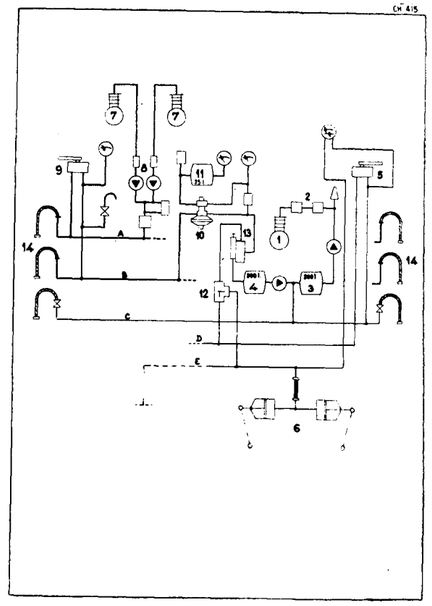


Fig. 16. Pneumatic circuit main diagram

A – Main vacuum pipe
B – Main vacuum brake pipe
C – Main compressed air reservoir pipe
D – Main air brake pipe
E – Brake cylinder pipe

DIRECT AIR BRAKE

1. Main compressor
2. Cooler - oil separator - safety valves
3. Main reservoir 200 l
4. Auxiliary reservoir 200 l
5. Driver's compressed air brake valve and monometer
6. Locomotive brake cylinders

VACUUM BRAKE

7. Exhauster
8. Filter-valves and relief valve
9. Driver's vacuum brake valve and manometer

SYNCHRONISM AIR - VACUUM BRAKE

10. Synchronizing valve
11. Vacuum reservoir 25 l and manometer
12. Two - way valve
13. Insulating relay
14. Train - brake couplings - hoses.

equipments, with the exception of the switchboard for the switches or fuse of 110 V d. c. battery circuits, one auxiliary control switchboard above the vacuum-motor pumps and the inductive shunts for traction motors arranged in the body frame in the vicinity of

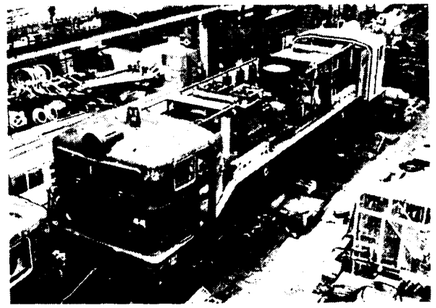


Fig. 17. View from top during completion in the manufacturer's shop - without housing between driving cabs. From left to right : apparatus cubicle, rectifiers set, transformer and accessories, vacuum pumps and second switchboard and apparatus cubicle, and at the end, motor blower for traction motors.

the smoothing coils themselves contained in a polyester housing to take into consideration the magnetic losses inherent in these inductive circuits.

INSTALLATION—DRIVING CABS

The distribution of the devices in accordance with fig. 2 is of the semi-divided type, similar to the distribution applied to both the BB 2500 locomotives (Portugal) and the BB 16500 locomotives (S. N. C. F.). It was possible here to completely liberate the 2 corridors on both sides of the central compartment occupied by the equipment. The ends on the driving cab side are used, one for the pneumatic equipment block, the other having been liberated to contain the tools and the personnel clothes by taking the battery in 4 symmetric blocks along the corridor walls on the side-sill edges of the body frame.

The driving cabs are quite close to those which were more recently carried out with 50 cycles. These cabs include a desk block removable with, on the left, the brake block corresponding to 2 brake cocks (direct air and automatic vacuum).

The master controller is of the impulse-type and signalling is divided into two enabling an easy supervision in double unit. Considering this, the equipment of all engines permits this adaptation to control circuits although it has been effectively carried out on 69 locomotives only.

As far as comfort is concerned, the drivers have at their disposal a wide and ventilated cab with fans placed above the desk, and so as to avoid a too important exposure to the sun, and totally panoramic visibility has been reduced. Two flap-seats enable to drive in the standing or seated position and side windows at the desk height permit to have a good visibility at the rear, enabling the locomotive to run in the direction opposite to the cab in which is the driver. Finally, in case of emergency, the transformer tap-changer can be manually operated by means of a mechanical drive from the driving desk.

PNEUMATIC PART

As we have just stated concerning the electric apparatus, the BBM-20 200 locomotives are equipped with both a compressed air system and a vacuum-system permitting to carry out the following operations :

—direct air-brake on the locomotive at 5-7 Kg/cm 2.

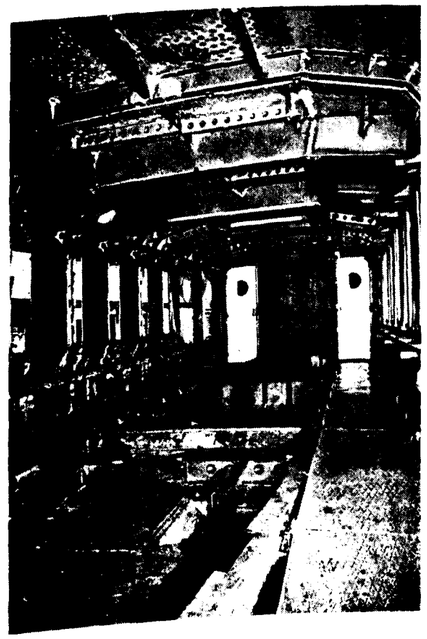
—vacuum-brake for the train at 50 cm mercury

—automatic air-brake on the locomotive, synchronised with the vacuum-brake control for the train.

—compressed air supply of the servo-motors for pantographs, 25 kV circuit-breaker, tap-changer, contactors and control equipment.

—control for accessories such as the equipment for sanding (by pneumatic ejectors), windscreen wiper servo-motors, warning horns, etc... The equipment schematic principle is given in fig. 16, showing in particular the synchronising valve branching used to coordinate the vacuum-brake control of the train with the air-brake control of the locomotive. It is also possible, by means of an isolating relay, to act on the train brake only. Let us also point out that the pneumatic equipment, alike the electric control equipment, enables either the multiple unit running on the control from a pilot-coach in the case of reversal train running.

Finally, for energizing the locomotive without compressed air in the tanks, a small auxiliary motor-compressor set is available, this set being supplied by the battery and permitting to raise the pantographs, close the circuit-breaker and fill an emergency compressed air cylinder at 9 Kg/cm2.



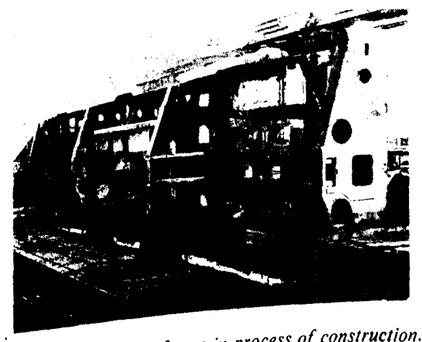


Fig. 18. The Underframe in process of construction.

MECHANICAL PART

Body

The body is based on the same principle as the BB 16 000 locomotive of the French Railways, namely a rigid frame on to which the end-cabs have been fixed and between these latter a series of removable housings. The general arrangement of these organs, the position of the openings and removable housings have been designed carefully with a view to providing an access as quick and simple as possible to the devices when being submitted to maintenance. In particular, the 3 removable housings release the whole central compartment containing the machinery (fig. 17).

The body frame consists, on the one hand, of 2 side-sills made of folded steel sheet 6 mm thick, welded in the shape of a U wall with stiffeners, and on the other hand, of 2 end boxes with a 10 mm. front plate whose angles are strengthened considering the requirements of both the central automatic shock and traction coupling and the side buffers with the use of the normal screw and strainer type.

For this purpose, 2 inclined V-shaped tubes are used to centre the longitudinal stresses sustained by the body side-sills toward the fore end side-sill centre at the place of the automatic coupling.

Furthermore, the side-sills include as well 4 welded holders made of steel-sheet 22 mm. thick used to fix the intermediate pendular beam between body and bogies to permit their longitudinal and rotating motions. On the other hand, the traction efforts transmitted by low traction connecting rods are received by hangers fixed either on the end beam stiffeners or on 2 intermediate beams of welded construction. These beams delimitate, with 2 small side-sills internal as compared with the frame, the place of the central transformer set fixed in the frame designed accordingly. On the sides, between side-sill and small side-sill, intermediate cross-pieces of the cradle type located underneath the floor are also used as carriers for the compressed air-tanks and an additional welded frame on the side of cab No. 1 would eventually permit to fix another larger tank, in case the Indian Railways consider the replacement in the future of the vacuum-brake of the present trains by a compressed air-brake. One should also note that the frame includes 8 welded sand-boxes built on with the body. The bare frame weight thus is 7 300 Kg. (fig. 18).

The parts added to the frame to complete and close the body are :

—the 2 driving cabs fixed at both ends by bolts and made of 2 mm. steel-sheets. A double roofing lined with glass wool ensures the heat and sound isolation of the cabs, the part of which on the equipment side carries the motor fan set for the traction motors.

Beside the 2 broad front bay-windows externally protected by a strong lattered screen and internally by removable anti-sun eye shades, each cab includes 2 doors providing access to the outside, 2 side-windows with vertically sliding pane and finally 2 doors providing access to the corridors running along the equipment. These doors are built up with 2 galvanized steel sheets 5/10 mm-thick compressing a panel 15 mm. thick made of "Okoume" timber, which also contributes to the phonic isolation.

Fig. 19. Inside view of the body in a corridor. The wire netting protects electrical equipment on the left, a quarter of battery set on the right. Looking at the ceiling allows to see the junction between roof and face and their flanges.

Finally for comfort in the cab, we have pointed out the presence of 2 variable position fans, 2 pneumatically operated windscreen wipers and lighting being provided by a roof luminaire.

Between the cabs, the body (namely the side walls and roofing) consists of 3 removable sheet housings 2 mm. thick. The end housings are directly fixed by bolts and nuts on to the upper flangings of the frame side-sills. The central housing (fig. 19) is itself bolted on to a rigid part in the form of a frame carrying the water-coolers (fig. 9), screens between water-coolers, air-filters and rain guard external shutters. These housings are on the roof side, to carry the sliding and latticed door, designed for the protection of the electrical equipment. The possibility of easily removing the housings (fig. 17) provides a noteworthy access to all the devices when being overhauled in workshop. The body, with the inclusion of the housings, each of these weighing between 700 and 800 Kgs, has a total weight of 17 850 Kg. without equipment.

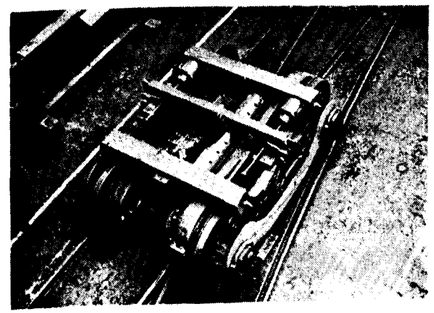
BOGIES

The 2 bogies directly derive from a first-rate type, as the prototype equipped the BB-9004 locomotive, which broke the speed record at 331 km/h and later the BB locomotives which broke the hauled load records on grades for the 50-cycle engines. Let us simply recall their main particulars of construction :

—The bogie frame consists of 2 box type side-sills made of moulded steel and 2 folded sheet beams assembled on the side-sills by welding. The originality of this frame lies in the fact that it includes no pins, but only flange boxes carried by the side-sills and used as side rests for a pendular suspension of the body. The beams receive on the one side the driving gear-case and on the other side the traction motors fastenings furthermore housed, with their pinions, in the gear-case.

—The drive frame, in welded elements, includes the gearing. For each axle the following is provided : a 16-teeth pinion, an intermediate 35-teeth cogwheel and a 65-teeth main cogwheel equipped with flexible blocks and used at the same time to start the Cardan drive of the "Jacquemin" type and to laterally guide the axle. The teeth are splash lubricated in the gear case oil, and the roller bearings are lubricated with grease.

—The axles include wheels with hot-inserted and riveted tyres. These wheels are oil-pressure wedged like the most part of mechanical couplings used on these locomotives. Each axle is driven on one side by the cardan shaft, these cardans being articulated on rubber blocks by 2 tore rings and a connecting hollow shaft (fig. 20) fixed on the 2 lugs projecting beyond each main cogwheel of the gearcase.



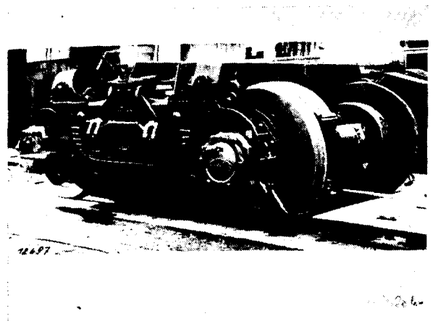


Fig. 20. One of the bogies with the traction motors inside. This view from top shows the pendular load crosstie in the middle of the bogie frame.

There are consequently 8 flexible articulations per drive and the Cardan articulated assembly is interesting as it is practically homoeinetical.

—The primary suspension of axles and the wheel-base connection between the axles is ensured on each side by two pairs of dual helical springs carrying the bogie frame on the one hand, and resting on a conventional equalizing-beam similar to the "Pennsylvania" type. This latter consists of 2 flanges fixing at both ends the axle-boxes of the plain bearing. Athermos type, lubrication being carried out with blade.

The suspension oscillations are damped by 4 friction absorbers and the longitudinal connection between the equalizing-beams and the bogie frame is ensured by small adjustable rods on the horizontal plane.

—Finally remain the tractive effort connection which are directly carried out between the traction motors, consequently bogie frame and body by low-traction-bars passing underneath the axles and arranged symmetrically. They constitute one of the main originalities of this bogie-type: the transmission of the traction effort from a theorical point almost in the rails plane prevents the rearing of the standard locomotives. This arrangement is made with the particular of the articulations for the secondary pendular suspension with small rods and load beam, the oscillations of which are damped by the side supporting pads of the bogie: they consequently give the mechanical assembly of these locomotives anti-rearing qualities enabling to completely use the anti-slipping possibilities of the electric rectifier-equipment, while extending the practical limit due to the mechanical scheme.

As far as braking is concerned, the brake-rods are operated from 1 individual compressed air cylinder for each side of the bogie. The brake is applied to each wheel by means of a dual shoe located on the bogie middle side; with tear and wear compensated by manual adjustment. All the articulations or workpieces submitted to friction in the organs of the bogie or brake-rods are made of treated steel: nitride treated cemented and hardened, or more generally of special manganese-steel affording these workpieces an important long life :

—The weight of each bare bogie and without the traction motors is 12 t., that is complete with motors and secondary suspension brake, about 18 tons.

TESTS—COMMISSIONING

The 100 BBM—20200 type locomotives intended for the Eastern and South Eastern areas of the Indian

Railways are distributed into 2 subclasses practically identical, save on the following details :

—The BB 20200 to 20268 included, namely 69 engines have a body painted in red and black with a yellow stripe and are basically intended for the South Eastern area. They include the multiple unit or reversible drive.

—The BB 20269 to 20299 included, namely 31 locomotives. are painted in green and black with a red stripe. These engines are running in the Eastern area and are equipped for the simple unit drive.

On the other hand, the Henriest type central automatic coupling already required for complete heavy trains carrying minerals and with a view to a future generalisation is equipped in European manufacturing works on the BB 20265 to BB 20268 included, and in India by the Indian Railways on the BB 20244 to 20262 included, with the exclusion of the BB 20251 locomotive which was used for the reliability runs in France on the S. N. C. F. tracks, with normal coupling and axle-bogies for 1.44 m. track. All the other locomotives, namely 76%, are presently equipped with the screw and strainer coupling.

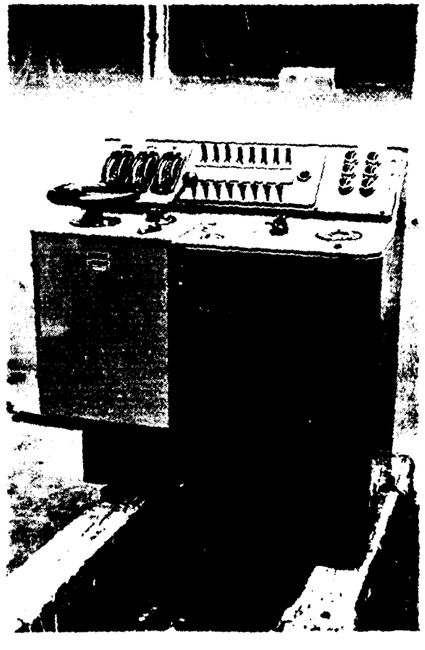


Fig. 21. Control desk of a driving cab.

In view of the very short delivery period and the following monthly cadences which sometimes reached 20 locomotives per month, have led to the use of international means which cannot be used in one place only. This is the reason why the BB 20200 locomotives could be assembled and completed for tests in three different places in Europe, with equipments from about 20 main factories. This situation called for a very important co-ordination of the studies and construction, such a wide co-operation for this latter being indispensable to succeed. As regards the 42 locomotive batch for goods traffic, locomotives in process of construction, the international co-operation furthermore extends to the Indian factories which will carry out one part of the construction and assembling on the spot, in one place only, of these locomotives whose appearance is similar to the present engines.

The first series has been carried out in time according to schedule and in accordance with the requirements mainly concerning the important chapter of weights strictly limited to a total of 74 tons. The 20251 locomotive has run in normal operation on the S. N. C. F. lines of the Eastern area to carry out reliability runs. These runs lasted about 9 months during which the total distance covered reached 61000 kms. Noteworthy trial trains have been hauled and numerous performances carried out during the said time.

One may quote in particular the starting and haulage of 1850 ton trains on the so-called Lerouville grade, with 8.8 o/oo incline, which represents a corresponding starting capability on a 10 o/oo grade for example, of 22 tons for each ton of weight of locomotive.

Let us recall here that the figures corresponding to the most recent French locomotives with individual drive are of the order of 20 to 25 tons per ton of locomotives for the 50-cycle ignitron locomotives and generally of 10 to 15 tons for the standard d. c. locomotives of the BB type.

The verification of the performances stipulated in the tender, namely the starting and hauling of freight trains with 2340 tons on 5 o/oo grade and 3660 tons on 1.6 o/oo grade has also been carried out with the BB M I 20251 locomotive in June 1960. During these tests, the draw-bar tractive efforts reached 27 tons, namely 750 A per motor, 1500 A for 2 ignitrons, and also reached and adhesion value of about 40%.

* * * * * *

Since their commissioning in India where the locomotives are presently in the running sheds of Dongraposi, and, in the near future, Tatanagar, some of the locomotives delivered are daily applying, in normal commercial operation, the performances already carried out, as they are currently hauling 2340 tons on a non-connected grade of 5 o/oo on the 25 kV-50 cycle lines being presently operated. One may consequently hope that, when the electric network is in full operation, the BB 20200 locomotives, after spending the unavoidable curative period of unimportant infancy diseases, will ensure as satisfactory performances as those carried out by the older 50-cycle engines and also avail themselves of the some deserved posterity.

MILD STEEL WIRE FOR GENERAL ENGINEERING PURPOSES

The Indian Standards Institution has prepared a draft revision of Indian Standard for Mild Steel Wire for General Engineering Purposes, IS : 280, which covers requirements for mild steel wire of sizes 0.125 mm to 12.5 mm diameter or equivalent cross sectional area for general engineering purposes. This standard was first issued in 1951, and based upon the experience gained in the use of the standard during the last 10 years, it has now been revised.

The draft revision will shortly be put into wide circulation for three months to all interests concerned for eliciting technical comments which will be taken into consideration before finalizing the draft as an Indian Standard.

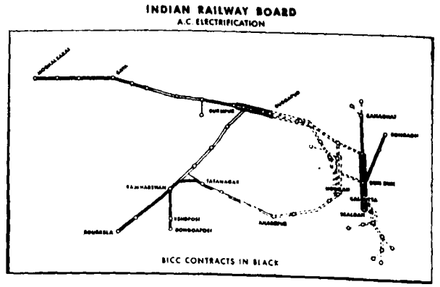
BICC Group's Role in 25kV 50c/s A.C. Railway Electrification in India

BRITISH Insulated Callender's Cables Limited announce that they have been awarded a £ 1,000,000 contract from the Indian Railway Board for the supply and installation of overhead equipment for 25 kV 50 cycles a. c. railway electrification over 250 track miles of suburban railway in the Calcutta area. With this latest contract, the third of its type which BICC have received from the same source since December 1958, the Group will have been responsible for nearly 1000 track miles of 25 kV 50 cycles a. c. electrification in India at a cost of some £ 4,700,000.

The first contract, announced in December 1958, was for the electrification of a 400 mile section near Calcutta of the main line between Calcutta and Bombay on the South Eastern Railway. This section, between Tatanagar and Rourkela, with a branch from Rajkharswan to Dongoaposi, links the iron ore fields in Bihar with steel plants at Tatanagar and Rourkela. Very rapid progress has been made on this contract, which was the first to be awarded in India for high voltage a.c. operation. A trial section was put into operation 12 months from the date of order, and the major portion of the scheme is already in commission.

Under the second contract awarded to the BICC Group, which was announced in June 1960, some 300 miles of the Eastern Railway system between Delhi and Calcutta are being electrified. This section lies between Gaya and Moghalsarai, and includes the largest marshalling yards in Asia. Both this contract and the previous one were for freight service and intended primarily to provide the rail link that is essential for India's expanding steel programme. The new contract will facilitate the carriage of both freight and passengers to and from the developing suburban areas of Calcutta, particularly those to the North and North-East. South of the city, Sealdah station, which is embraced within the overhead electrification scheme, will eventually be able to handle a greatly increased volume of rail traffic. Sealdah is said to be one of the world's busiest major terminals still being operated by steam traction.

These three orders, taken in conjunction, represent an important contribution by the BICC Group towards the implementation of the Indian Railway Board's decision to standardize the country's electric traction systems. The latest contract, when complete, will constitute the first suburban railway section in India to be equipped for overhead high voltage a.c. operation. For all three contracts, a small number of specialist traction engineers from BIC Construction Company is responsible for the work and for training and supervising a large force of local engineers and field personnel. The experience of the BICC Group in Railway electrification is World-wide, and in the United Kingdom BICC are major contractors for overhead electrification equipment under the British Transport Commission's modernization scheme.



The decision by the Indian Railway Board to standardize the pattern of electrification for 25 kV 50 cycles single phase a.c. working has already been referred to previously, lines in the Bombay district were equipped for 1500 volt d.c. operation, and in the Calcutta area lines were equipped for 3000 volt d.c. operation. The overhead equipment for over 500 track miles of the lines in the Bombay area was designed, supplied and erected between 1923—1930 by the BICC Group, who also, in more recent years, supplied and installed the power and communications cables on the 3000 volt d.c. system in the Calcutta area.

Among other recent notable contracts fulfilled by the BICC Group in India was the supply and installation in September 1960 of 9500 yards of three-core 105 kV oil-filled cable between Sewri Fort and Carnac near Bombay for the Tata Power Company. In this connection, it is of interest to recall that it was in the Carnac area, and also for the Tata Power Company, that the BICC Group supplied and installed 16,500 yards of 100 kV Impregnated Pressure cable—the first supertension cable installation in Asia—the switching in of which took place in April 1957.

The BICC Group have operated in India for more than 50 years, and, together with their Indian associates, have an unparalleled record of manufacture and installation in the field of electric power transmission. The technical assistance that the BICC Group have provided to their associates has played a major part in India's industrial development.

GAS TURBINE GENERATORS FOR NAHORKATYA OILFIELDS

The first of three gas turbo-alternator sets was successfully commissioned recently at the Zaloni Power Station of Oil India Private Ltd., in the Nahorkatya Oilfields in Assam. These machines, supplied by the English Electric are of advanced design and are the first gas turbines to be ordered for India for industrial power generation.

Until the first gas turbo-alternator of 1790 kW capacity was commissioned, all oilfield and domestic consumers had to restrict their demand for electricity to the very inadequate supply made available from small diesel generators. The new power station, when complete, will meet not only the existing needs of the oilfields, but will have sufficient reserve to cope with the requirements of a developing industry.

Although the initial cost is higher than the equivalent capacity generated by conventional steam or diesel units the gas turbine is cheaper so install, quicker to start, quieter to run and has the over-riding advantage of using an unprocessed raw material, natural gas, of which there is a plentiful supply.

Each gas turbo-alternator set comprises an "English Electric" EM2 7P type gas turbine driving a salient-pole. 1500 r.p.m. alternator through epicyclic reduction gearing. The alternator is rated at 1790 kW at 0.8 power factor and generates at 11 kV, 3-phase, 50 cycles. The turbo-alternator auxiliaries are arranged for D.C. operation from a battery so that the set can be started without any external electricity supply.

The gas turbine is a two shaft, open cycle, non-recuperative unit. It comprises a 6-stage axial/single stage centrifugal rotary compressor driven by a 2-stage "charging" turbine with mechanically independent 2-stage "power" turbine of speed 7,000 r.p.m. coupled through a flexible drive shaft to the main reduction gearbox and alternator. Air from the compressor is ducted directly to the twin combustion chambers which are mounted on inlet elbows bolted to each side of the turbine casing.

The gas turbine is started by a 110 volt, D. C. protected type, series starter motor which is coupled to the compressor rotor by means of a drive shaft and air operated clutch.

The gaseous fuel is taken from the pressurised supply through a manual isolating valve, an automatic pressure reducing valve, the governor throttle valve and a trip valve to the single premixing type burners in each combustion chamber. A single torch-type igniter, which uses fuel from the main engine supply is fitted to each combustion chamber. The pilot stream of gas is ignited by an HT sparking plug.

The main switchgear at the power station comprises a 13-panel "English Electric" 11 kV metal-clad switchboard, a 13-circuit remote control and relay board, a two-panel desk control board, and a multi-circuit L. T. Switchboard.

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INDIA TO PROCURE—133 DIESEL LOCOS

India will procure 133 diesel locomotives from the United States with the first loan which the President's Special Development Loan Fund will sanction towards the railway development programme under the third plan. Under the last loan sanctioned by the D.L.F. for the second Plan, the Railway Ministry placed orders for 80 diesel locomotives, 40 of which have already been received.

Sources close to the Railway Ministry state that three-fourths of the railway's requirements in respect of diesel locomotives under the third Plan would be procured with the financial assistance made available from the D.L.F. The Railway Ministry is also negotiating with the World Bank its first loan under the third Plan for purchasing abroad electrical components to carry out its ambitious electrification programme.

WELDING SUPPLEMENT

Arc Welding Sets Exported by Rumania

By An Engineering Correspondent

Motor generator welding sets for connection to A.C. network Diesel driven generator welding sets. Transformers for hand welding.

WELDING technique has extended together with the general advance in industry as riveted constructions have been superseded by welded constructions and as welding has begun being used in large volume new work such as: steam boilers for thermo-electric power stations, equipment for the chemical industry, cement mills and kilns, high-tonnage vessels, etc.

As a consequence, the manufacture of welding sets has greatly developed in countries and advanced industry. In Rumania, for instance, such sets are manufactured in large quantities, being successfully sold both in the home and in the international market. Here are some of the arc welding sets manufactured in Rumania today, and exported in large quantities (through the Industrialexport enterprise in Bucharest):

TYPE GES MOTOR-GENERATOR ARC WELDING SET AND TYPE TASM WELDING TRANSFORMER

Type GES arc welding sets made in Rumania consists of a squirrel cage motor for connection to a three-phase network of 220, 380 or 500 V and of a D. C. generator of a special design. The two machines are mounted in a well-ventilated common casing, fixed on 4 metal wheels. The star-delta starting switch of the driving motor and the graduated scale welding current control device are located on top of the casing. The generator's armature and the motor's rotor are have a common shaft.

Simple and accurate control of the welding current, a good dynamic characteristic ensuring excellent stability of the arc throughout the range of the welding current, whatever the temperature of the winding of the control device, convenient commutation and perfect adaptation of the welding qualities to the requirements of the electric arc, are particularly important factors in achieving faultless welding.

Furthermore the design of the generator ensures quick voltage recovery—maximum 0.05 sec.—after the short circuit caused by welding and also lowers the voltage in no-load running.

The arc welding sets are supplied for intermittent welding currents up to 350 and 500 A at a 65 per cent running factor.

TECHNICAL DATA

	GES 350	*GES 500*
— Welding current at a 65 per cent running factor	350 A	500 A
— Welding current for continuous welding	280 A	400 A
— Total current range at rated voltage	80—400 A	100—700 A
— No-load voltage	80 V	90 V
— Generator voltage	30 V	35 V
— Motor's rated power	14 kW	28 kW
— Speed	1450 rpm	1450 rpm
— Dimension of electrodes	0 2–8 mm	0 3–10 mm

The wide current range of the set makes it suitable for the welding of light materials.

If no electric current is available, the GES 350 welding set is manufactured, driven by a 45 HP Diesel engine. The Diesel is directly coupled to the generator by the flexible coupling.

Welding making use of A.C. with transformers is recommended whenever there are simple operations to be performed and which may be effected with normal A.C. electrodes.

To that end, Rumania manufactures *type TASM 300 welding* transformers, designed for hand welding, using single-phase A.C. and a 300 A welding current with an adjustment range between 75 and 480 amp.

The transformer consists of a two column magnetic core made of laminations (on which the primary, main secondary and reactive secondary windings are mounted); a regulation device (consisting of a movable magnetic core actuated by means of a threaded axle and crank) the housing and a carriage provided with two wheels and two legs.

The service voltage in rated working conditions is of 32 V; the service voltage required by the arc depends on the intensity of the welding current. Thus, it varies from 23 to 39 V. The no-load service voltage is of maximum 74 V, respectively 63 V for the two adjustment ranges of the secondary circuit. The active rated power of 18.5 kVA for an efficiency of $n = 0.86$ and a power factor $\cos 0 = 0.56$.

The design of the TASM—300 transformers makes it highly efficient in high grade welding; it is moreover, easily handled and of low running costs.

The up-to-date technical feature of the afore-mentioned sets as well as their faultless construction have led to ever increasing orders coming in from abroad. Thus, Rumania exports a considerable number of arc welding sets to various countries, amongst which : Czechoslovakia, Turkey, India, the United Arab Republic, Iraq, etc.

At present, Rumania's industry is about to turn out new types of welding sets among which automatic welding ones, so that the export possibilities of the Industrial export company will shortly be widened in that sector, too.

ELECTRONICS IN OXYGEN CUTTING

By K. D. S. Semper
Sales Manager
HANCOCK & Co. (ENGINEERS) LTD., CROYDON

IT is only eleven years since electronics appeared on oxygen cutting machines in Europe. Since that date great advances have been made in methods of control. The first machines were designed to operate from a black and white drawing, a spot of light approximately 1/16 in. dia. following the intersection of the black and white by means of a photo-cell looking at this spot and keeping it balanced half on the black and half on the white. Should the spot wander off the line by only a fraction of an inch the steering motor was caused to revolve by the unbalanced signal from the photo-cell thus causing the machine to follow most accurately the outline of the drawing. This system has proved most efficient and reliable, the only fault if any was the necessity of producing a drawing with a high black and white contrast and a line of at least 1/8 in. thick. (This is equal to a silhouette without filling in the centre). Obviously the next step was to make simpler templates, the simplest of all being a pencil drawing.

PREVENTING CONTACT WITH DRAWING

The latest machines work from these pencil line drawings, but in this case the drawing is floodlit and the photo-cell is caused to vibrate backwards and forwards across the line. The electronic control then compares the signal from each side of the line and turns the steering motor accordingly, so that the photo-cell follows the pencil line accurately. It is also essential to prevent damage to the drawings, as the driving wheel can scurf up the drawing as it crosses the line, especially on sharp corners. To prevent this, modern dual carriage machines are fitted with a driving roller on which the driving wheel runs, preventing any physical contact with the drawing and thereby making their life indefinite.

ELIMINATING DUST AND DIRT

Dust and dirt are of course, the major problem with electronic machines. If on the type of control where a spot of light is balanced half black and half white, the white becomes dirty, the machine will of course look for more white. On the type of machine where the photo-cell sees both sides of the line the machine still follows the line accurately although the signal from the photo-cell is reduced as the white has become grey.

It has been found from normal shop conditions that the dust problem has not been so bad as might be expected. It is possible to cover drawings with a thin film of special varnish to protect them or alternatively, sellotape covers the lines adequately. Drawings can also be made on various types of plastic sheet and these can be cleaned with a damp cloth. Placing small drawings under glass is advantageous but of course not so practical with large ones. Perspex is also suitable but is easily scratched and becomes translucent after a time.

TAPE CONTROL

Tape control of course, obviates all these points, but raises its own problems with regard to producing the tape. There are two main systems, the analogue and the digital, both have points in their favour. The digital system makes use of computer to prepare a magnetic tape which is placed in a console to control the machine. First of all it is necessary to prepare a punched paper tape giving certain dimensions from the drawings. This is then fed into the computer which works out and puts in the intermediate points to control the machine. The analogue system is similar to this except that no computer services are required, the console cabinet works out its own points on a parabolic interpolator and of course is a great saving in time and expense, with the added advantage that a punched tape can be read and alterations or corrections made immediately.

Between the 1 : 1 electronics and the computer there are the ratio cutting machines working direct from scaled drawings or photographic negatives and it is in this field that advances will be made during the next few years as this is the simplest form of templates for electronically controlled oxygen cutting machines.

Frogs and Crossing Procedure for Welding

*By Dr. M. C. Bhatia**

IT is much cheaper to repair and recondition or in other words reclaim—the FROGS AND CROSSINGS made of high Manganese Steel—than to replace the same. Indian Railways are already doing this work and giving more and more serious thought to reclamation of worn out FROGS AND CROSSING by the best possible means & in the cheapest possible manner. It is in view of this fact that this note may be of some use to those concerned.

FROGS AND CROSSINGS for points on the Railways that have to stand especially heavy and fast trains, or a considerable daily average number of trains—are manufactured of high manganese steel. The reason for this, of course, is that such steel is much durable and shock resistant than ordinary high carbon steel.

High manganese castings are rather costly and the fact that they can be reclaimed at a cost of 25% to 35% of the original by Arc welding with special Electrodes, is important from a stand point of economy.

FROGS AND CROSSINGS can be reclaimed either on the shop floor or on the open track. In the shop the ordinary electric welding generator is used. For open track work, a petrol driven welding generator set and a portable grinder, both mounted on a truck, are required. The only difference in the two operations is that the welding proceeds a little more slowly of the open track unless water for cooling the casting is available.

Proper preparation is essential for welding high manganese steel by the process of Arc welding. All soft spots should be ground out of FROGS AND CROSSINGS. Any fine cracks on the surface to be built up should be removed. Such cracks will inevitably appear in the weld deposit unless removed. All rust, oil & greaze should be removed before welding commences, or the deposited metal will be porous. A scratch brush with a suitable acid solution should serve the purpose. Murriatic acid solution cut with zinc will serve the purpose.

* Welding Engineer, The Industrial Gases Limited, Calcutta.

It is always better and cheaper to repair FROGS AND CROSSINGS BEFORE the wear becomes too great. When several layers of weld Metal have to be put on, it is more expensive and more difficult for the operator to do a good clean job.

After the casting has been prepared for welding as outlined above, work may commence. The welder should have at hand a light hammer, a straight edge, and a hose with about a peneil stream of cool water flowing. The ends of the FROGS AND CROSSOVER should be lightly dammed up with sand, so that about half an inch of water is always in the trough. The purpose of this is to keep the casting cool, and should not be used for quenching.

Special Manganese Electrodes—3/16"—should be used unless only one layer is to be put, in which case 1/4" rods may be used. With the 3/16" electrodes-130 to 170 amperes are used. With $\frac{1}{4}$"-175 to 225 but the lowest amperage that will allow of steady arc flow and good penetration is best. The cooler that the member being welded is kept the fewer the contraction stresses that are set up.

The bead should be laid with a half moon weaving motion with the two ends of the half moon pointing in the direction towards which the operator is working, viz ;

The bead should be about $\frac{3}{4}$" wide about 3" at a time should be welded. The operator should then immediately take a light hammer and peen the bead thoroughly. The practice of water quenching the bead should not be used since the special manganese electrodes are of such composition that the resultant bead is air toughening.

If the casting has more than one section being built up, as it usually has, it is best for the welder to deposite the next bead on a new section, rather than to keep on at the place where he starts. This allows further time to cool. Each section should be worked on in order before returning to the original bead.

One head having been laid on each section, a second bead should be deposited alongside the first one, rather than to be a continuation of it. The same

procedure follows at each of the sections. When more than one layer is required, the entire first layer should be deposited before starting the second.

After the first layer is finished and if more layers are necessary, the former should be thoroughly scaled and cleaned before proceeding. This is exceedingly important as if any scale or dirt remains, it will cause boiling and porosity in the upper layers.

The operator should frequently use the straight edge, so as not to deposit any excess weld metal as all such excess must be ground off.

If these instructions are carefully followed, the reclaimed FROGS OR CROSSING is just as good as new.

Further technical advice, and information on recommended types of special purposes manganese electrodes, etc. can be given if required.

NEW BRITISH STANDARD FOR RADIATION DOSEMETERS

At a time when X— and gamma rays are being increasingly used as aids to medicine, industry and research of all kinds, the British Standards Institution have issued a new Standard (B. S. 3385) aimed to help authorities responsible for the health and safety of workers exposed to radiation hazards. The Standard lays down requirements for direct reading personal dosemeters for X— and gamma radiation. These instruments — a common type of which looks like a fountain pen — fit into the pocket. They tell the user the amount of radiation dose he has received — if any.

The Standard draws attention to the effect of beta radiation on measurements of gamma radiation dose and recommends that when the dosemeter is used in the presence of beta radiation, an appropriate sleeve should be fitted to the instrument. It also points out that unsealed instruments may be seriously affected by large changes in humidity, changes in atmospheric pressure and by the presence of significant concentrations of radioactive or ionised gases. In such circumstances, it is recommended that a sealed instrument should be used.

* * * * * *

DEVICE FOR WOODWORKING PLANT

A new device which creates a major change in woodworking tool room practice by eliminating trial and error in cutter profile developing and grinding, has been produced by a U. K. firm.

The accurate profile development, grinding and eventual setting of moulding cutters on their parent machines, is one of the problems in many planing and moulding mills and while development and grinding need not interfere with a machine's running time, in the majority of cases a machine is idle while the cutters are being set on its blocks.

After investigating the problem, the firm has produced a device, named the Pro-Set. It cuts machine "down-time" to a minimum by guaranteeing first time accuracy in cutter setting on the parent machine. The Pro-Set provides an ingenious method of mechanically developing the true shape of cutter required for any normal Size of straight-cut block using a drawing or sample section of the original. The shape is developed onto a template which, after being used when grinding the cutters, can also be used as a guide when setting them on the cutter block. The device can be quickly adjusted to suit any size of cutter block and, being small and completely portable one Pro-Set can serve several machines.

* * * * * *

TRAVERSING SPRAY FOR FINISHING SMALL COMPONENTS

A fully automatic traversing spray mechanism has been developed by a U. K. engineering firm for the mass production spraying of a variety of small components. This covers such fields as automobile accessories, the small parts used in domestic equipment, many types of electrical instruments and certain types of furniture.

The unit is suitable for applying a wide range of anticorrosive, protective and ornamental finishes. In addition it can be used for spraying most types of cellulose and latex backings for carpets and linoleums, and is described as having a great potential in the leather trades industry where it can be used for the curing and treatment of hides.

The unit can be used in either the horizontal plane, with work passing below on a conveyor, or vertically to suit existing conveyor systems. A special feature of the design allows numerous spray guns to be fitted to the traverse unit, and if necessary, the traverse length can be increased as required to meet increased production schedules.

SIGNALLING, INTERLOCKING & TELECOMMUNICATIONS SUPPLEMENT

CENTRALISED TRAFFIC CONTROL

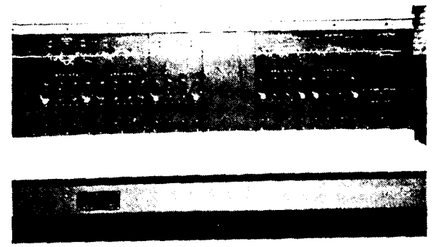
By H. C. Towers, M.I.E.E., M.I.R.S.E., M. Inst. T.

WHEN railways were first constructed telecommunications had not been developed and the crossing of opposing trains, on single lines, and the spacing of following trains, had to be regulated by time table. Good timekeeping was essential if the service was to run smoothly. If a train was delayed other trains were held up and the service was disorganised. One of the greatest difficulties facing those responsible for operation was that they had no idea which train had been delayed or where any of the trains ere on the system.

The discovery of telegraphy and the development of the world famous code brought into successful service at Baltimore in 1844 by Samuel Finlay Breeze Morse introduced a great improvement in train operation. Each station was connected to a telegraph circuit and instructions regarding train crossings and other matters were transmitted from a central coordinating point. In the U.S.A. many thousands of miles of single line railway were worked on the train order or timetable method and these were soon converted to a despatcher system in which instruction to train drivers were telegraphed to fixed points along the line where they could be halted by train order signals to receive the despatcher's instructions.

Shortly after the first World War the traffic control telephone system was introduced and today it is in extensive use on British Railways, the Commonwealth and other countries. This form of communication divides a railway into traffic divisions each having a central traffic control office. Stations, signal boxes, motive power depots, railway officials, etc. are connected to it by omnibus telephone.

For operational convenience each division is separated into two or more sections, according to geographical conditions, each section being supervised by an assistant train controller. These controllers can call individual stations by selective ringing each way station, as they are termed, being allotted a ringing key or push button in the control office. Although an omnibus circuit is used, due to coding, only the bell at the station called responds to the controllers action. Way stations attract the controller's attention by lifting up the telephone handset and announcing the name of the station or indentity of the person calling. The assistant controllers are continually listening to the circuit by means of headphones. The chief train controller, who has a separate office, is provided with



Part of centralised traffic control panel.

a desk type telephone because he is only required to speak to stations on special occasions or to converse with officials out on the line. He can select the section with which he wished to converse by a selective switch.

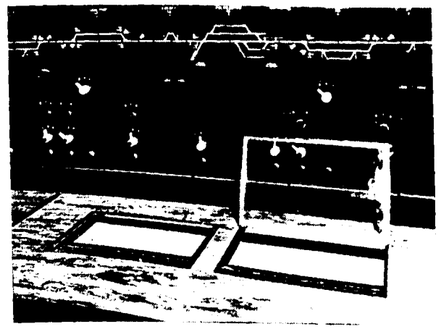
The wayside stations report to control the arrival and departure of trains and the assistant controller records their progress on a graph. On single line sections the traffic control office issues orders regarding train crossings where delays may necessitate departure from timetable arrangements. The preparations made at stations and speed of operation of point switches and signals is entirely the responsibility of local operators and the controllers have no direct supervision of any kind. This difficulty is common to both the telephone and the train order method of control. In the U.S.A. endeavours were made to devise a system which would place the control of traffic on a section, in the hands of a single operator. This system known as Centralised Traffic Control, was invented by S. N. Wight of the General Railway

Signal Company, U.S.A. and introduced on American Railways in the early thirties.

Centralised traffic control, as it is known today, is a supervisory control system whereby all train movements are directly controlled from a central point on the section from a convenient place within it. With this system no intermediate operators are necessary because all points and signals on the section are worked from the central office. Where intermediate signals between stations are required these work automatically. The points are operated by electric switch machines though in some cases they are worked locally by the engine crew after being released from the central control office. Originally the signals were of the semaphore type, electrically operated. The arms moved in the upper quadrant and had three positions corresponding to the red, yellow and green aspects used in colour light signalling at the present time. In the U.S.A. these signals have since been replaced by colour lights. The section is track circuited throughout so that the position of all trains is known to the cTc operator and also complete protection offerded to every train on the section.

The cTc operator has a control panel on which is deposted a plan of the whole section in his charge showing stations, sidings, etc. Each track circuit is shown on the panel and is fitted with a miniature electric bulb which is illuminated when the track circuit is occupied. The operator therefore has a complete picture of the whole section, can see the position of every train and note its progress. Signals and points are operated by miniature thumb switches placed on the panel under the plan and beneath the signal or points they control. The shape of the panel varies with the number of stations controlled. If there are only a few it would be flat and could be mounted on a desk or made as a floor cabinet. cTc sections may be over 100 miles in extent and in such instances it is usual for the panel to be 'U' shaped so that all switches are within the operator's reach and it is not necessary for him to leave his seat.

With a crossing station consisting of a single loop only, two switches are required at each end, the representation of it being depicted on the panel. One switch controls the points and the other the signals. The point switch has two positions, normal and reverse. Two small lamps are placed above it one having the initial 'N' and the other 'R' engraved close to it. These visuals indicate that the points are correctly set and locked, either normal or reverse, according to switch positions. The signal switch is normally central and signals are cleared by turning it either to the left or to the right depending on whether a train is being despatched or received. Visual lights repeating the signal aspects may be provided according to an individual railway's requirements. A small red light over the signal switch would indicate that all



Section of Centralised Traffic Control panel showing stations on a single line of railway. The position of trains is shown by the miniature lamps on the tracks. The small, black switches control the points and the white switches, the signals. A train recording graph is shown on the desk.

exit and admission signals at that end of the station were showing stop. The turning of the signal switch to the left, or right, would extinguish the red visual and illuminate a green visual either at the left or right of the switch. The lighting of this visual indicated that signal is showing one of its Proceed indications (yellow or green) and also that points are correctly set and locked and opposing signals showing stop. Beneath the signal and point switches is a start button which is pressed to initiate point or signal movements.

Each station remains as a separate installation with all the interlocking securities of an individual signal box. The cTc is merely a supervisory control or "Long Arm" and even though the operator may turn a key to cause a certain signal to show "Proceed" the signal will only respond if the line over which it reads is clear, points correctly set and locked and opposing signals showing "Stop". Only two line wires are required throughout irrespective of the number of stations controlled or the number of signals, points or track circuits in use. This is achieved by a system of coding similar in principle to the traffic control telephone system.

The traffic capacity of any section of railway can be represented in train hours. When the running time of a train is known, it is a simple matter to determine the theoretical train capacity. A reduction in the running time increases the train capacity. The more trains that can be run the greater is the tonnage that can be moved. cTc makes this possible because it reduces lost time. Where trains of different speeds are involved, which is ordinarily the condition to be met, various examples of single track operation with cTc have shown that the train capacity and running time have been quite comparable with the usual operation of double track; examples of double track operation with cTc have shown an increased track capacity where one or both tracks have been signalled for either direction running and where directional congestion is an operating factor. Experience and studies show that the track capacity has been, or may be, increased from an average of 28—30 to 50—80 trains per day on single track lines. Actual operation of 42—70 trains had been accomplished on several single track lines without difficulty.

Since the introduction of cTc in the U.S.A. very considerable developments have taken place and year by year more installations have been introduced. At the present time sections of from 100 to 200 miles are controlled by cTc and even longer sections will be used in the future. There are no extensive cTc installations on British Railways at present but several trials sections are in service. Installations in Africa and New Zealand are giving very satisfactory service and cTc is being extended in these two countries and elsewhere.

In Rhodesia, the work of installing centralised traffic control began over ten years ago and the first section was in operation by September 1951. At the present time cTc installations in use are as follows :—

Gwelo (Exclusive) Heany Junction (Exclusive)

(Siemens & General Electric Railway Signal Co. Ltd.)

Gwaai (Inclusive)—Wankie (Exclusive) and Thomson Junction.

(Siemens & General Electric Railway Signal Co. Ltd.)

In 1956 A.E.I.—GRS Ltd. commenced the work of installing cTc on the section Thomson Junction—Zimba—but the work was delayed pending the introduction of new standards for station layouts and shunting movements. Work has now recommenced on this installation.

In 1957 it was decided to standardise the operating procedure at sidings and design a new basic layout. cTc was also to be extended over most of the single line sections of the Rhodesian Railways and because of the magnitude of this task it was decided to divide the work between the main signalling contractors as under :—Zimba-Ndola : (AEI-GRS Ltd.), Gatooma-Gwelo : (Siemens & General Electric Railway Signal Co. Ltd.), Umtali-Gatooma : (Westinghouse Brake & Signal Co. Ltd.), The erection of line wires, cable routes, installation of axle counters, ground frames and ancillary work was to be carried out by the staff of the Signals & Communication Engineer.

Power supply is available at all stations on the section in Southern Rhodesia from Sawmills to Umtali and is obtained from the Electricity Supply Commission. Power supply failure at a station is automatically indicated on the control panel of the cTc section concerned. Diesel generators are used at those stations where a power supply is not available and these are used to charge secondary batteries. These generators are switched on and off by a control code transmitted by the control panel. An indication is provided on the panel that the generator has responded. Low voltage alarms are transmitted from all stations in the event of the battery voltage falling below a pre-determined level.

Trouble with buried cable was experienced on the original installations due to termites. On the new work taped cables are being used where it is necessary to bury them. Usually cables running at stations between location cases, signals, etc. are suspended on poles.

When centralised traffic control on the Rhodesia Railways is complete it will be the largest installation in the Commonwealth comprising some 1,200 miles of railway and ten control rooms. It can be claimed that these railways have pioneered the extensive use of centralised traffic control in Africa.

Railway Signalling and Safety Equipment from the GDR

By H. Schneider
ENGINEER

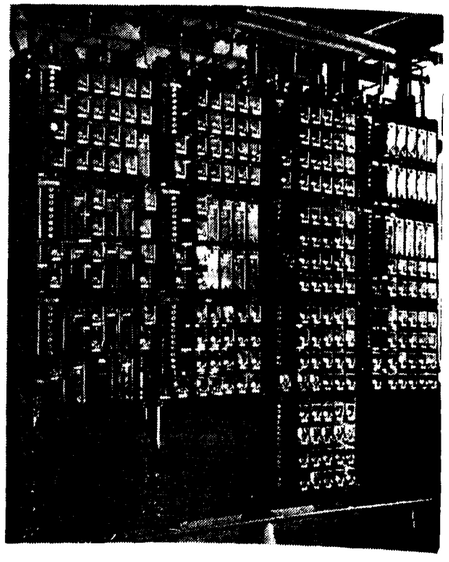
A GROUP of experts of the Works for Railway Signalling and Safety Installations of the GDR is at present touring India in order to acquaint Indian experts and interested persons with their products which can be supplied against payment in Indian Rupees. A complete diagram-operated interlocking installation was on view in New Delhi from June 26 to July 10, which demonstrated the functioning of the various equipments. The exhibition was arranged in co-operation with the Indian Railway Board. The opening ceremony at Baroda House, New Delhi, was attended by the Chief Manager of Northern Railways and a great number of Indian experts and interested persons. The installations of the Works are exported by the GDR foreign trade enterprise "DIA Elektrotechnik" in the framework of the Trade Agreement between India and the German Democratic Republic.

During the last hundred years or so the signalling and safety technique has developed from the most simple mechanical equipment to the present most up-to-date diagram-operated interlocking installation. The present signalling technique, however, does not restrict itself to the safety of railway traffic on the stations and the line against collisions, but also serves the centralisation and stricter control of all railway operations.

By modern signalling installations the effective capacity of railway routes and the efficiency of railway stations as well as the safety of traffic are continuously increased. The following passages shall give you a general idea of the latest type of diagram-operated interlocking installations as they are constructed and installed by "VEB Werk fuer Signal and Sicherungstechnik Berlin". The definition Diagram-Operated Interlocking Installation implies that the actuating devices for switches, signals and the establishment of routes are positioned on a track diagram which reproduces the position of all tracks, switches and signals in a most realistic manner. It also contains keys and control installations for rails, switches, signals and power supply. The route of a train through a station is marked by illumination of the rails. Moreover all occupied rails as well as the position of all switches and signals are indicated by coloured illumination. The operator is thus able to follow all traffic operations at any time.

The pulling of two keys is enough to establish, safeguard and clear the route of a train through the station. All switches on the route are automatically brought into the right position. Switches of adjoining track sections lying on the route are set so as to exclude flank collisions. Faults in the technical equipment such as switches, tracks or signals are indicated to the switch operator by automatic alarm flash-lights.

The establishment of a route takes but a few seconds. Taking into consideration the huge amount of human labour and time which was formerly required to



Relay racks in the relay room

operate the old mechanical switch installations, one recognizes the great leap forward that rail safety technique has made. During the last ten years these installations have reached a high degree of perfection that guarantees maximum safety to rail-bound traffic.

The orders given by the track control table by pulling keys are conducted via cables to the switches and signals and from there back to the switch control table with the help of the relays room. A very precisely working control system guarantees the correct working of the relays dependent on each other and the switch installations.

Far-reaching standardisation warrants a quick assembly of these equipments for which the non-interchangeability is particularly important. Automatic test instruments see to it that eventual switch faults are eliminated during production so that only correctly switched standardized groups are supplied by the works.

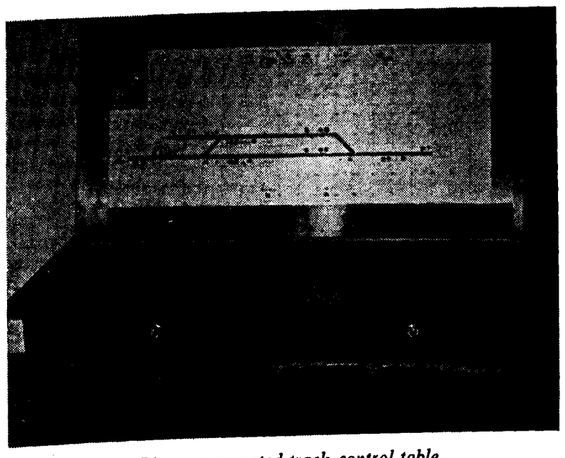
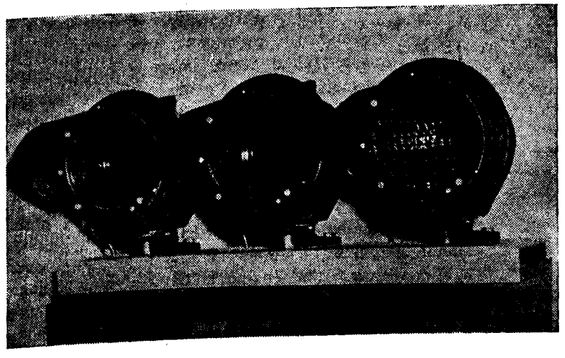


Diagram-operated track-control table



Triple signal lamp

Switch drives are adjusted to the various forms of switches at home and abroad. The drive for those switches where there are no particular blockings of the switch tongues are especially strong and reliable. Switches whose faces are passed by fast trains are equipped with an additional test equipment for supervising the correct position of the switch tongues.

Signals are also adjusted to the signalling systems of the different countries. The caution, wayleave, shunting and repeater signals are made according to local requirements.

The modern diagram-operated interlocking installations require a very efficient and reliable power supply. The power supply installations have the task of providing power from the main as well as of feeding power to the switch installations in case of failure of the main current. All necessary switch operations are automatic so that there can be no interruption and the safety of rail traffic is guaranteed.

In the same way as the safety of trains is warranted to a maximum possible extent in the stations, it is also guaranteed automatically on the routes between the stations. The emergency power supply installations provides the track blocking equipment with the necessary operating current and thus prevents any disturbance caused by eventual failure of main current.

For further simplification the track safety installations of several stations and tracks can be remotely controlled. In a similar way central dispatcher installations can supervise the situation of the switches of one or more tracks.

Train course and number recorders give further possibilities to the supervision and control personnel to control the entire course of operation more exactly and

replace at the same time a considerable number of workers.

Instruments of this kind are not only used in the railway system but also serve the supervision and following up of production processes and the situation of manufacture in industrial enterprises.

The steadily-growing goods transport necessitates a very quick formation of new goods trains on all junctions. In this field, too, automation has progressed to such a degree as reduces the entire course of operations to the minimum time.

Each of the many level crossings constitutes a certain danger both for rail and road traffic. The still existing mechanical level crossing gates are, therefore, being substituted by automatic single and double level crossing gates. The train controls not only the opening and closing of the crossing gates but also adjusts the time of the slowing down of the train's speed. Special control signals show the locomotive driver the proper working of the automatic installations.

The above mentioned railway signalling and safety installations are produced by the nationally-owned Works for Signal and Safety Installations in Berlin-Treptow in the German Democratic Republic. A proof of the excellent equality of the products is the fact that the Works produces these equipments not only for the railway system of the GDR but moreover, for Finland, Greece, Poland, Bulgaria, Czechoslovakia and Egypt where they have met with widespread appreciation.

LARGE INCREASE IN ALUMINIUM USED IN AUTOMOBILES

While the uses of aluminium have been rising steadily in the United States in recent years, one of the most spectacular advances made by the lightweight metal has been its greatly increased use in automobiles. For a number of years aluminium in automobiles was confined largely to pistons. Gradually, it spread to the "bright work," the decorative strips attached to the body's sheet metal, and to radiators and bumpers. Now one major manufacturer has put a six-cylinder aluminium engine on the market. It powers a small, lightweight car. The engine is 68 kilograms lighter than a cast-iron engine of the same type.

Aluminium automobile brakes, already in use in some cars, are expected to be adopted to a steadily increasing extent because they dissipate heat rapidly.

British Equipment for Assam Oil Pipeline

Meters designed to measure the flow rate and amount of oil passing through the new 720-mile pipeline in India are to be supplied by the British company de Havilland, a member of the Hawker Siddeley Aviation group.

The pipeline will carry crude oil from the Assam oilfields to refineries in Gauhati(Assam) and Barauni (Bihar).

The measuring equipment—de Havilland Pottermeter flowmeters—uses a new principle in flowmeter design, in which a virtually friction-free rotor induces alternating current in an adjacent coil; the frequency and number of the induced impulses specify the flow rate and quantity of the fluid passing through the unit with a high degree of accuracy.

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COUNTRIES MAY COMMUNICATE *Via* EARTH SATELLITES

Communication between countries by means of earth satellites is a future development envisaged in the annual report of Cable & Wireless Ltd., publicly owned British company, published in London on August 9. The company reports a profit of over £ 1,000,000 more than last year. Telegraph traffic amounted to 462,000,000 words, an increase of 22,000.000 words.

Referring to the company's prospects, the report states that the sphere and pattern of operation in newly independent Commonwealth countries might change, but it is hoped—possibly through partnership arrangements on the model of that agreed with Singapore—that the company's knowledge and experience will continue to serve those countries.

The report goes on : "International telecommunications techniques are in an era of rapid and revolutionary change. While engaged in the planning and installation of trans-oceanic telephone cables of advanced design and multi-channel radio systems, the company is paying close attention to the possibilities of communication *via* earth satellites and their effects on existing means of communication."

TROPODUR CABLES IN RAILWAY SIGNALLING

*By Dipl. Ing. D. W. CHILIAN**

INTRODUCTION

As per standard practice of the past, Indian Railways have been using mostly rubber-insulated, tough-rubber or lead-sheathed, or paper-insulated, lead-sheathed, armoured cables for Railway Signalling purposes. These cables have also been standardised in relevant I. R. S. Specifications.

Such cables are being used for mostly control circuits of electric signalling equipment, i. e. control of relays, colour light signals, track circuits signal and point machines and also block or station master's control apparatus, the operating voltage being generally upto 110V of D. C. or A. C. 50 cps.

The application of either rubber or paper-insulated cables differs on a regional basis. Central, Western and Northern Railway Administrations have been mostly adopting rubber insulated cables, whereas in areas of Eastern and Southern Railways, paper-insulated cables prevail. The application of rubber insulated cables has not always been satisfactory because due to moisture and saline conditions, e. g. in Bombay area, a rapid deterioration of such cables was observed when cables were buried underground. For this reason, the Railway's practice is now to install such cables above ground. Paper-insulated cables again have the disadvantages of requiring good sealing of cable ends which turns out costly, because additional pot-heading being required.

The technological progress abroad in the use of thermoplastic compounds for purpose of cable insulations and sheaths lead to the consideration of Railway Authorities also in this field. Even though thermoplastic compounds, especially P. V. C., have been used for over 25 years successfully as cable insulation and sheaths on the Continent, it was not to be expected that the Indian Railways might be prepared for a rapid change-over and this especially before they had collected their own experiences.

*Signal Engineer with M/s Siemens Engg. & Mfg. Co. of India Ltd.

First P. V. C. Signalling Cables PROTODUR in India:

After preliminary tests of a P. V. C. cable sample by the National Physical Laboratory in New Delhi, the Railways decided to allow installation of P. V. C. type signalling cables PROTODUR in India, as an experimental measure on two power signalling installations which were under order by Messrs. Siemens Engineering & Manufacturing Co., of India Ltd., viz. Panel Interlocking at Subzimandi Station, Northern Railway and Route Relay Interlocking at Churchgate Station, Western Railway.

PROTODUR is a trade name for a P. V. C. mixture having excellent properties and being specially developed for insulation and sheathing of cables. The build-up of PROTODUR cables may vary according to its requirements, the principle feature being, however, PROTODUR insulations and sheath whereby a lead or tough rubber sheath is dispensed with and thus also pot-heading is not required. Such cables are completely moisture proof and more durable as regards ageing especially under aggressive climatic or soil conditions, compared to rubber-insulated signalling cables.

PROTODUR cables adopted for the above first two all-relay interlocking installations were of imported make and conforming in their specifications to the standards of the German Federal Railways.

Unarmoured cables, buried underground and covered with a layer of bricks after having been bedded in sand were adopted in the first instance. For the second installation, viz. Churchgate, a heavier type of cable—being double steel tape armoured underneath the outer P. V. C. jacket—was adopted, because here cables were laid above ground in concrete ducts, the reason for this still being the Railway's apprehension of burying cables under-ground because of their previous experience with rubber cables.

The PROTODUR cables adopted for the above two installations were of multi-core design, with plain

Fig. 1

Fig. 2

circular copper conductors of 1.4 mm. dia., i. e. size approx : 1/.055". This is a standard size adopted by the German Federal Railways and although being slightly smaller compared to the 1/.064" diameter normally adopted in India, no difficulties were experienced as in any case, signalling circuits normally carry currents in the range of milli-amperes only. Where currents are higher, that is especially for feeding of electric point machines, heavier conductor cross-sections have been used.

Photographs Fig. 1 and 2 shows the installation of P. V. C. PROTODUR cables at Churchgate Station, where they are laid in concrete ducts.

Also the indoor wiring of the above signalling installations has been carried out completely with P. V. C. insulated wires and indoor multi-core P. V. C. cables, as can be seen from photograph Fig. 3, showing part of the relay room at Churchgate.

PROTODUR cables in both the above installations have stood the tests satisfactorily as was to be expected.

TROPODUR Cables – same as PROTODUR – and their advantages

The excellent results and economy obtained by the use of PROTODUR cables not only for control and signalling purposes, but also mainly for power cables, encouraged the manufacture of such cables in India as a joint enterprise of Indian capital and two well-known German Cable manufacturers. The manufacture of the cables is now carried out by the Cable Corporation of India Ltd., Borivli under the new trade name TROPODUR and under the licence SIEMENS—GERMANY. Messrs. Cable Corporation of India

Fig. 3

Ltd., are equipped with most modern machinery for manufacture and testing which ensures that at every stage in the manufacture of TROPODUR cables, rigid quality control and modern production techniques are employed. TROPODUR cables, as manufactured now in India, can without doubt, be claimed to be equal in quality and standard to imported PROTODUR cables.

The following advantages claimed for PROTODUR cables, therefore, apply equally to TROPODUR cables :—

1. Most simple installation due to absence of lead sheath.
2. No sealing of cable ends required, instead direct connection to terminals of apparatus.
3. High mechanical strength and resistance to ageing, especially when exposed to humidity and chemical atmosphere, as well as sunrays.
4. Suitability for every current application, be it in air, water or underground.
5. Due to absence of impregnating compound, no restriction for laying of cables on steep gradients.
6. No fire hazards as TROPODUR compound is flame retarding and would not burn by itself.
7. A wide choice of metric conductor cross-sections and availability of TROPODUR wires, unarmoured and armoured cables make the same universally applicable for practically all uses in Railway Signalling installations.

Properties, Grade and Specifications of TROPODUR Cables

TROPODUR cables now manufactured in India are of 1.1 kV grade and conform to Indian Standard Specification 1554–1961 for P. V. C. insulated (Heavy Duty) Electric Cables. This specification specifically allows laying of such cables in the same manner as armoured paper insulated lead covered cables which are normally used underground. The use of such high voltage grade cable for Railway Signalling where usually voltages do not exceed 110V, has been justified purely from the view point of sufficient mechanical thickness of insulation to ensure durability even under conditions of rough handling and for purpose of absolute safety being required in Railway Signalling circuits. As such, even I. R. S. Specifications for Rubber and Paper-insulated signalling cables lay down voltage grades of 660 and 1100 Volts respectively.

For the purpose of this article, it would go too far to illuminate all technical details of the specification. One question, namely that of insulation resistance deserves, however, some explanation since it is used quite often wrongly to assess the suitability of P. V. C. cables in Railway Signalling. This again is somehow connected with the temperature range within which cables can be used safely, which is from −40°C to +70°C for TROPODUR.

Insulation Resistance

P. V. C. being a thermo-plastic compound has the natural property of softening at higher temperatures and also decreasing thereby its insulation resistance. A reverse process, however, takes place when P. V. C. temperature is again lowered and no after-effects remain within the prescribed temperature range. It is even observed that due to ageing, the insulation resistance of P. V. C. might slightly increase because of reduction of the content of plasticizer.

Contrary to this, insulation resistance of rubber insulated cables normally decreases with ageing and will not regenerate. For this reason, insulation resistance for rubber insulated cables will have to specified quite high (800–2400 M-Ohms × 1000 yards) at the stage of manufacture to allow for a slow, but continuous deterioration after installation and laying. Quite contrary, as P. V. C. cables are in-sensitive against moisture, the insulation resistance at the stage of manufacture for such cables, will practically remain the same after laying with a chance of slight increase due to ageing after long years, and must, therefore, not be so high from the beginning.

Although the values of insulation resistance laid down as per specification I. S. 1554–1961 works out to only 0.022 M-Ohm × 1000 m at 60°C for an insulated conductor of 2.5. sq. mm cross-section with insulation thickness of 0.9 mm, (corresponding to 2.321 M-Ohm ×1000 m at 20°C), practical insulation values obtained in the manufacture of TROPODUR cables (and as measured in the tests fields between cores on finished cables) range between 500 and 2300 M-Ohm × 1000 m at 20°C, or correspondingly 4.76 and 21.9 M-Ohm × 1000 m at 60°C.

The question arises what ohmic leakage current may occur between two adjoining conductors with maximum voltage encountered in railway signalling under temperature of 60°C for a circuit of 1000 m length. Even when taking into account the lowest practical insulation resistance of TROPODUR cables, such leakage current at 110V works out to

$$I = \frac{U}{R} = \frac{110}{4.76 \times 10^6} = 23.1 \times 10^{-6} \text{ A} = 0.0231 \text{ mA.}$$

From the above, it may be concluded that a leakage current of such small magnitude can be considered as harmless, since no relay or other device in signalling will operate on such current. It proves further that TROPODUR cables may safely be used even when exposed to high temperatures.

Types and sizes used in Railway Signalling:

As per established practice on the Indian Railways, armoured cables are usually adopted for outdoor circuits, the conductor size being 1/.064″ for practically all control circuits with the exception of bigger sizes for track leads and power supply circuits. On the Continent smaller sizes as low as 1/.035″ (=0.9 mm dia.) and in U. K. the size of 1/.044″ is now increasingly being used because signalling cables are seldom assessed as per current capacity and cross-sections are determined rather by mechanical strength and permissible voltage drop.

In line with the introduction of metric standards in India, TROPODUR cables are manufactured with rational metric sizes of conductor cross-sections being as under (in sq. mm).

1.5, 2.5, 4, 6, 10, 16, 25, 35

From the above, mostly 1.5 sq. mm (corresponding to 1/.055″) and 2.5 sq. mm (corresponding to 1/.071″) will be used in Railway Signalling. These two sizes are also available as multicore cables upto 19 cores.

As regards types, TROPODUR cable manufacture distinguishes 3 categories, all being 1.1 kV grade, viz.

1. Insulated wires (heavy duty), type NSYA.
2. Unarmoured cables with outer P. V. C. sheath and filling layer of buthyl-regenerate, type YY.
3. Round or flat steel wire armoured cables with outer P. V. C. jacket and also filling layers of buthyl-regenerate, types YRY or YFY.

All the above three categories are available in cross-sections as mentioned initially. For cables, conductor numbers, types of stranding etc. vary as per actual requirements.

Photograph Fig. 4, shows a sample of armoured TROPODUR cable type YRY from which the built-up may be easily discerned.

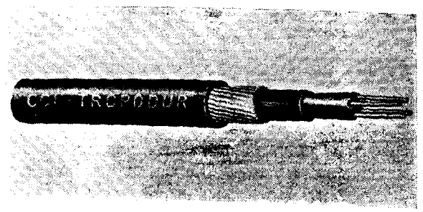


Fig. 4.

First major supply order from Railway Board:

Encouraged by the success of Imported PROTODUR cables in two power signalling installations in India and in line with the Government's policy to utilise a maximum of materials manufactured in the country, the Railway Board accepted for the first time a major quantity of TROPODUR cables as an alternative to rubber insulated signalling cables within their Global Procurement Programme of 1959–60.

The order placed in October, 1960 with Messrs. Siemens Engineering & Manufacturing Co. of India Ltd., for a total quantity of approx : 181 Km armoured TROPODUR cable with copper cross-section of 2.5 sq. mm, mostly multicore types, has in the meanwhile been fully executed and cables have been delivered to the various railways to be used in their current works programme.

Manufacturing and Testing of TROPODUR Cables:

Only through careful and proper processing good materials will yield good results. Therefore the Cable Corporation of India, one of the most modern factories in India, is equipped with the latest machinery with automatic and semi-automatic controls for temperature regulation and quality control during the insulation and sheathing processes. Fig. 5 shows parts of the modern plastic extruders for these processes controlled automatically and Fig. 6 shows the automatic diameter controller and the spark tester working with 8 kV A. C. Both the apparatus are working continuously, checking every core at every spot.

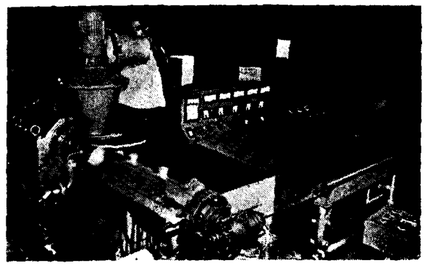


Fig. 5.

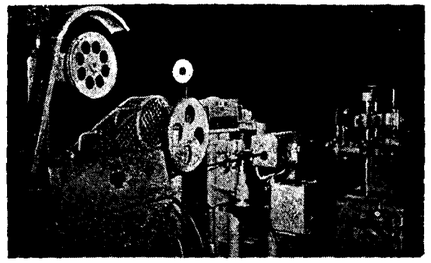


Fig. 6.

A high quality and uniformity in production can only be achieved by additional control at every place in the manufacture. Therefore the factory has established also manual control at every manufacturing stage. Qualified engineers are watching carefully that every product conforms strictly to the relevant specifications.

Independent from any other department and from the control engineers, the factory's well equipped Testfield and Laboratory is the vital centre for certifying the quality of every raw material and final product. Every cable length leaving the factory is passed through this testfield to ensure uniformity throughout the production programme.

Conclusion:

TROPODUR cables are now being manufactured indigenously and have a wide and recognised application in the field of Railway Signalling in India. Since introduction of P. V. C. cables in India is quite new and since as per Railway's practice mostly rubber and paper-insulated have been used in the past, the purpose of this article was to throw some light on an interesting development and at the same time, to prove the outstanding advantages obtained by application of such cables as well as to show the modern production techniques and rigid quality controls adopted for TROPODUR cables in India.

[Photographs by courtesy of Western Railway and Cable Corporation of India Ltd.]

SHOULDER BALLAST CLEANING MACHINE

A Yorkshire locomotive manufacturer recently demonstrated a shoulder ballast cleaning machine which is claimed to be an important advance in this aspect of permanent way maintenance. It is a self-propelled machine which ensures efficient drainage through the ballast with a minimum of line occupation. It travels from stabling point to work site under its own power and when in operation is capable of speeds up to 600 yards an hour, during which time it can handle 300 tons of stone ballast. The machine is powered by a Rolls Royce type C6TFL diesel engine developing 208 b.h.p. at 1,800 r.p.m., continuous rating, which drives four Deri-Sine duplex hydraulic pumps through a toothed belt and "Hunslet" gearbox.

Two digging heads are provided, one each side of the machine. Each one is individually controlled for speed of digging, depth of cut and so on, and by means of hydraulic rams is completely retractable within the body of the machine for travelling.

Double-deck dry type vibrating screens are provided, with a mesh suitable for 2 in. to ¾ in. ballast, and these are divided by a centre plate to provide independent screening for left and right hand digging heads. From the screens the cleaned ballast gravitates to chutes on either side of the machine and is returned to the track. The dirt is carried away by two dirt disposal conveyors.

Railway Signalling & Communications Relays

OVER many years the standard types of railway signalling apparatus have been developed along closely defined lines by a few companies who have specialised in this field, and many specifications have been written around the proprietary components. With the advent of modernisation and the use of localised AC power supplies, together with the general advance of electronics which of necessity demands the miniaturisation of components, more and more the general commercial manufacturers of relays are being asked to submit their products for inclusion in railway systems.

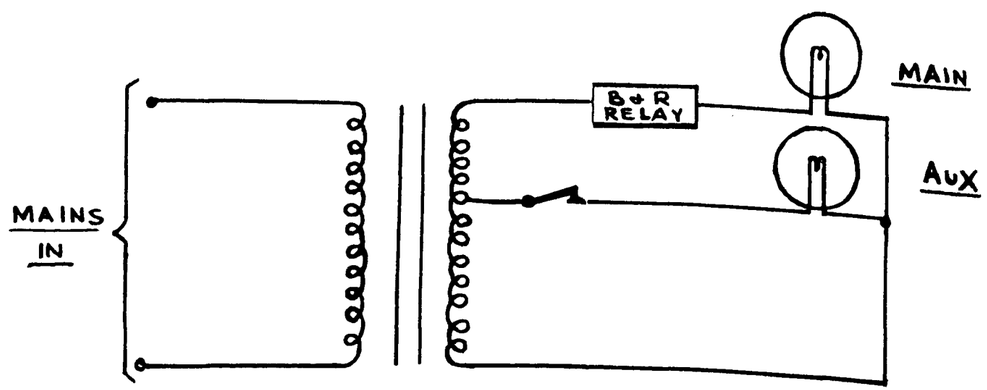
In 1957 the Council of the Institution of Railway Signal Engineers set up a committee to investigate the standardisation and miniaturisation of signal relays. As a result, a specification has been drawn up which will cover a large percentage, possibly as high as 90%, of the line relays (including special relays for interlocking circuits, which replace mechanical interlocking systems incorporating bolts and levers) used in modern signalling practice.

In submitting its proposals, the above mentioned committee has considered the basic need for component interchangeability together with the fact that the need for economy of power consumption is no longer such an important consideration as it was in the past. The basis of the new specification is to produce a standard socket into which can be plugged various relays to operate the functions required. This socket must accommodate two connections, as previously on the larger relays, but the cross section of the connecting wires has now been reduced to a conductor diameter of 0.044" having a maximum overall diameter of 0.110". With this accepted reduction on the diameter of the standard conductors, the physical size of the relay has been much reduced and will be approximately one quarter of the volume of its older counterparts.

With the advent of single and of multiple aspect signalling, together with general electrification of signal illumination, a commercial relay has been introduced with automatically brings a stand-by lamp into operation should the filament of the main lamp fail. At the same time, notification of the failure is given to the adjacent signal box.

This relay, manufactured by B. & R. Relays Limited, is basically a commercially manufactured unit, but certain safeguards have been built integrally into the relay to ensure that its function can be relied upon to a very high degree. The function of the relay can be seen in the diagram and operates as follows.

The coil of the relay is a series winding in circuit with the main filament and the relay operates together with the lamp. The lamp is a tungsten filament bulb with the inherent high surge currents which means that



the relay has to be made to withstand approximately 10 times the normal magnetising current. This high surge tends to give the moving armature a heavy hammer below on the yoke face, and steps have to be taken to ensure that the unit is mechanically strong enough to withstand these blows up to a million operations. Such blows cause a general bedding down between the armature and pole face, which while not materially harmful to the unit tends to work harden its structure and increase the remanence of the steel. Such inherent remanence must be counter-balanced by sufficient bias pressure of the contacts on the relay or it will be found that the relay will hold up after it has been switched off.

In order that this mal-function does not happen in service a very stringent specification for contact pressures and armature gaps has to be adhered to.

Owing to the tolerances of the various components comprising the signalling device the relay has to be calibrated within very close differential limits and it must always be borne in mind that the coil must run continuously at the lamp current and withstand the ten times switching loads. These parameters of adjustment can only be maintained with the specialised relays which are to be found on the commercial market.

With the ever widening field of electronics the railway engineer will insist on the maximum reliability of components, but at the same time he must ensure that the rare event of a component failure will not create a dangerous condition. To this end the field of Static Switching (also known as Logic Switching) is being investigated with ever growing impetus.

In a Static Switching system the conventional electro-mechanical device is replaced by a completely static unit using transistors and ferrite cores. Unlike the electro-mechanical relay, which generally has one input (coil voltage) and one or more outputs (contact loading), the logic 'relay' may have one or more input signals (often in the form of rectified A.C.) but has only one output signal. Its operation is based on the 4 basic logic functions:

AND OR NOT MEMORY

In the case of the logic AND unit, an output is obtained when, and only when, all its input signals are present. Using an OR unit, however, an output will be obtained when any one, or more, of its inputs is applied.

The input to a NOT unit 'blocks' the output, and an output is obtained when *no* input is present.

Certain logic units combine these functions, to give for instance, the AND—NOT and the NOR (equivalent to OR—NOT).

The MEMORY function has 2 possible forms—a 'limited' function and an 'unlimited' function. Following the application of an input to a limited MEMORY, the appearance of an output is delayed by a pre-set time interval. An unlimited MEMORY will provide an output following the application of an input pulse, and will maintain this output until the application of a 2nd input pulse.

Logic functions may, of course, be performed mechanically using the conventional relay. The AND function corresponds to normally—open relay contacts wired in series. Wiring these contacts in parallel would be equivalent to the OR, whilst the NOT corresponds to a normally—closed relay contact. The latching relay will perform an unlimited MEMORY logic function, whilst several types of delay-to-operate (or limited MEMORY) relays are marketed.

This article gives an indication of the diverse applications of modern switching techniques which will be used in the modernisation plans of railway signalling and B. & R. Relays Limited are keeping abreast of these developments.

METHODS OF SAMPLING IRON ORE

Reliable methods of sampling iron ore are of great importance in as much as besides direct monetary implications caused by a false valuation of the ore, many difficulties await the consumers for successful operation of the blast furnace if the results of sampling do not truly represent the actual average quality of the ore.

Keeping these in view, the Indian Standards Institution has published an Indian Standard Methods of Sampling Iron Ore (IS:1405–1960). Collection and preparation of samples from a lot for determining ore sizes, moisture content and chemical composition of the iron ore in the lot would be rendered easier by the publication of this standard, which deals separately with sampling of iron ore from stock piles, loaded rail wagons, ships' holds and from conveyor belts.

Standard RPg Batteries for our Railways

By An Engineering Correspondent

INCORPORATING TWO REVOLUTIONARY TECHNIQUES

INDIAN RAILWAYS, the country's largest transport undertaking, make prominent use of STANDARD RPg Batteries which incorporate two new techniques now recognised to be revolutionary advancements in battery manufacture.

One of them is the Pg Tubular Plate; the other, the MITEX Microporous Rubber Separator, with spun glasswool mat reinforcement. Both these are now made in India by M/s. Standard Batteries Ltd. by arrangement with the original overseas patentees who are their technical collaborators.

DEVELOPMENT IN THE LAST 100 YEARS

The role which these techniques have played in the advancement of the battery industry the world over can be gauged from the developments in battery-making in the last one-hundred years. Though battery types have remained more or less unchanged since the 19th century, great improvements have been made, especially in regard to capacity and quality.

The first-lead-acid batteries were simple devices, made just by immersing lead sheets in sulphuric acid and charging and discharging until the required capacity was obtained. Later, electro-chemical methods and mechanical designs were used to increase the active surface. Finally, the plates were pasted with the active material to get an even higher capacity.

TUBULAR PLATES

The very first good-quality lead-acid battery was made in the United States with tubular plates—i.e.,

A view of the Pg Section. Assembly of Pg positive plate group

A view of the Pg Section. Assembly of negative plate group.

with the active material packed in slotted hard rubber tubes. This greatly reduced shedding....increasing battery life by about 2—2½ times.

Improvements were constantly being made because of severe competition from the manufacturers of pasted plates who too were continually striving to improve their own product. In the early forties, a patent for tubular plates was obtained in the United States, using glasswool sleeving instead of slotted hard rubber tubes. This enabled the walls to be thinner, leaving more room for the active material, and prevented shedding.

This design, too, had to be abandoned within a few years, because the material in the wall was considered too weak.

About ten years ago, yet another design was developed. This used polythene instead of hard rubber; and the result was that the walls could stand the strain even by heavy or short discharges, and there was no question of having burst tubes under any circumstances. But the disadvantage of slitted tubes remained: the tubes continued to lose the active material.

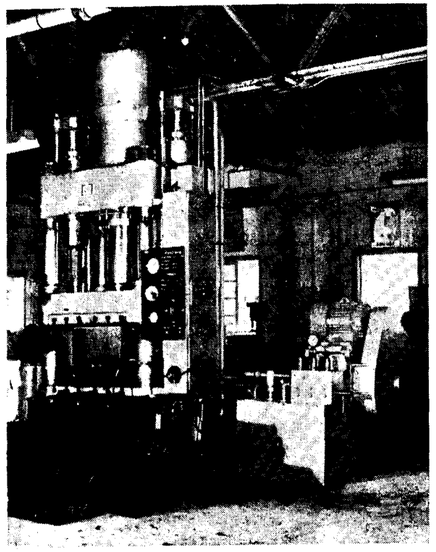
THE Pg TUBE

The latest advancement is the Pg Tubular Positive Plate. It's main component is the Pg tube made of p.v.c. which has a higher mechanical strength and rigidity than either the rubber or polythene tubes. The internal pressure that a Pg tube can stand is 50—60 atm (750—1000 psi), when new, and about 25 atm. (350psi) after 2000—2500 cycles.

The comparative figures for hard rubber tubes are 10—15 atm. (150—200 psi.) when new, and 1—2 atm. (15—30 psi) two years later. Because the brittle hard rubber wall must have a thickness of at least 10—12 mm, its internal dimension is no more than 7½ mm, whereas the inner dimension of the stronger Pg tubes is 8½ mm.

In practical terms, the difference is one of 25—30% more active material in each Pg tube.

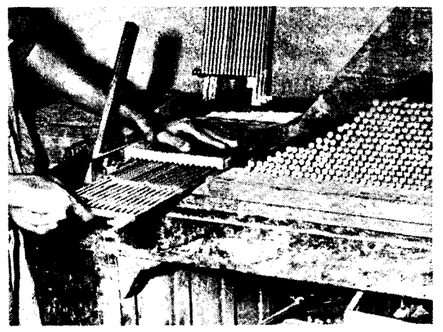
Moreover, the glasswool completely prevents any shedding, making it possible to further increase battery life, and have lower bottom supports rather than higher plates. This increases the capacity by another 10%. Indeed, it has been discovered that by a combination of these methods, the total capacity can be increased by as much as 60%.



A view of one of the 200-ton hydraulic presses for making RPg Railway battery containers at Standard Batteries factory.

MITEX MICROPOROUS RUBBER SEPARATORS

These are synthetic types of separators which are far superior to ordinary separators so far used as regards porosity, chemical inertness, electric insulating property and mechanical strength. They contribute to the battery's long life by eliminating one of the commonest causes of battery failures: failure of the separators due to corrosion by oxidation.



Pg tube being threaded on to pre-cast positive grids.

A recent survey on battery separators has shown that the failure of batteries due to failure of separators is as high as 30% in the case of wooden separators but only about 2% in the case of microporous separators.

MITEX Separators are tough....yet they are only a fraction of the weight and volume of ordinary separators. They are widely preferred in many countries as being ideal for submarine batteries and special batteries created for the defence services.

NEW PLANT BEING ERECTED IN INDIA

M/s. Standard Batteries Ltd. are the pioneers in India in the field of tubular batteries. They are also the first to mould the hard rubber containers as also to manufacture the synthetic type of separators in India.

Today, at the Standard Batteries factory, every component part of the battery is manufactured, with the exception of the Pg tube which is being imported. But the Plant to manufacture these tubes here is under erection, and will go into production soon. When this is done, the complete Pg battery may be said to be made in India, by India and for India.

GALVANIZED STEEL SHEETS (PLAIN AND CORRUGATED)

The Indian Standards Institution has prepared a draft revision of Indian Standard Specification for Galvanized Steel Sheets (Plain and Corrugated), IS: 277-1951, which covers the minimum requirements for four classes of plain and corrugated galvanized steel sheets produced by hot dip galvanizing.

This standard was first issued in 1951, and the main modifications made in this revision relate to the inclusion of another class of galvanized steel sheets having a light coating of zinc and inclusion of rationalized metric values in the standard.

Railcar, EMU Coach, Carriage & Wagon Supplement

Manufacture of Mylius Gears for Railcars

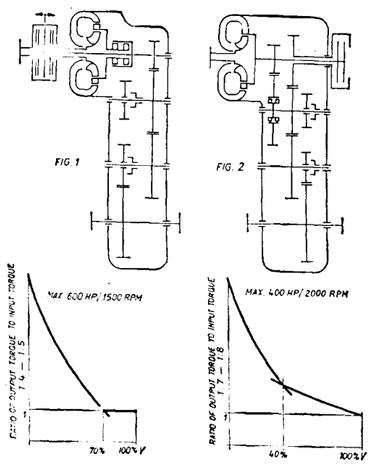
By An Engineering Correspondent

We have great pleasure in publishing below a short technical write-up concerning "Mylius Gears" which are extensively used in Railcars. It is needless for us to over-emphasize the tremendous part played by these Gears, so well designed on the unit construction principle, in transmissions for diesel-hydraulic locomotives. The technical chart published in this article explains salient features. The Manufacturer is none than the firm of Deutsche Getriebe of West Berlin which has thirty years of manufacturing experience.—Editor.

MYLIUS GEARS

THE Deutsche Getriebe GmbH has been well-known for more than 30 years as manufacturer of Mylius gears for railcars. In 1953 the firm also took up the manufacture of transmissions for diesel-hydraulic locomotives with coupling rod and Cardan shaft drives for up to 1,200 HP input power to the transmission. Since then, such has been the demand for simple transmissions for shunting locomotives, further gearing types have been designed on the unit construction principle to give a diversity of arrangements.

(Continued on page R.C.2)



The simplest type is shown in Fig. 1 in which a simple reversing gear with hollow-shaft torque converter and interposed twin coupling is so designed that starting is effected through the converter, and the direct gear is engaged upon the changeover speed being reached. In Fig. 2 a two-stage reversing gear is arranged below the torque converter. This is fitted with automatic changeover and permits a total torque multiplication of 7 to 8 times the torque at maximum useful revolutions.

A further arrangement is obtained by combining the twin coupling with a hollow-shaft converter and a two-stage reversing gear so as to give a three-stage tractive effort curve with one direct gear stage.

It need hardly be added that for locomotives with Cardan shaft drives the associated axle drive designs, whether simple, back gears or distributor type, are also manufactured.

The use of FORMICA decorative laminates in the Railway Industry

By An Engineering Correspondent

FORMICA decorative laminated plastic was first manufactured in America by the Formica Insulation Company in the year 1925 and introduced to Great Britain in the year 1936 in particular for the interior decoration of the steamship "Queen Mary", although it was also used for panelling, table tops and toilets in several hotels.

These initial installations are in an excellent condition today after exceptionally hard service of over twenty-four years. The appearance of the doors of the gentlemen's toilets and bathrooms at the railway station at Leeds, illustrated in Fig. 1, is exceptionally good despite the fact that the facilities are available for twenty-three hours everyday and were subjected to very severe treatment by the equipment of the troops during the Second World War.

In the year 1945 a laminated plastic factory, the second largest in the world, was established in England for the production of both FORMICA decorative and Industrial laminates. Subsequently, factories manufacturing FORMICA laminates to an identical specification were set up in France, Italy, Spain, Germany, Australia and New Zealand.

The basic constituent materials used in the production of FORMICA decorative laminates are papers and resins. Three grades of paper are used. Kraft paper to form the core in sheets varying in number to suit the thickness of the finished product; the decorative sheet of white, block or coloured paper, printed in repetitive designs, or to imitate realistically the grain of timbers; and a single sheet of white paper of special texture which forms the protective skin over the printed decorative sheet.

Prior to being cut to the requisite sheet sizes the core paper, the decorative paper and the protective overlay are impregnated with the appropriate resins by means of specially designed impregnation plant. One type of such a machine is shown in Fig. 2.

The rolls of paper are set up at one end of the machine and slowly unwound into the resin bath and then pass through a drying oven after which stage the paper is rewound into rolls or automatically cut to

Fig. 1.

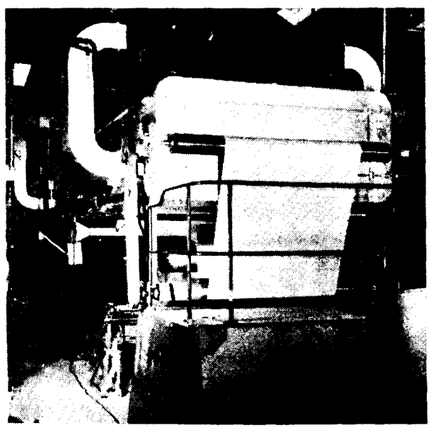


Fig. 2.

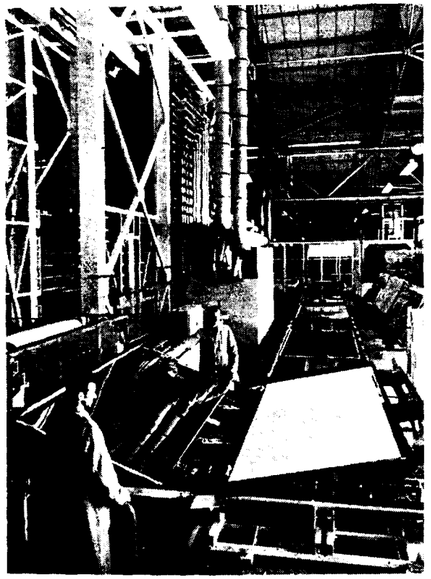


Fig. 3.

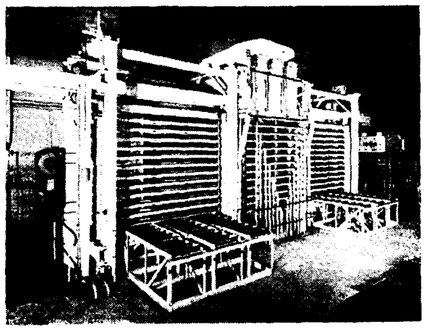


Fig. 4. 12 Daylight, H.P.H.W. heated, hydraulic press, 8′ × 4′, showing the preloader (left) in the act of charging the press.

predetermined lengths for immediate factory requirements.

In the operation of the impregnation machine the temperature of the oven in which the paper is dried must be carefully controlled. The 'degree of cure' of the resin on the paper must be precisely controlled and since this is dependent upon the time/temperature history of the material, the speed of the paper through the oven and its temperature are of great importance. Temperature control instruments are incorporated in the impregnation machine to perform this job.

The various papers are then assembled in packs to suit the production of 1/16″ and 1/8″ thickness laminates with the colour or design on one side only, or 1/8″ and 5/32″ laminates having a decorative surface on both sides.

In the case of Single-sided laminates a sheet of Glassine paper is arranged adjacent to the exterior layer of core paper to ensure the ready separation of the finished laminates following the polymerisation of the resins.

A stainless steel plate, highly polished on both sides, is placed next to the overlay and this produces the superlative glossy surface of the finished product. Fig. 3 gives an impression of the mirror-like surface of the plates which is faithfully transmitted to the melamine impregnated overlay.

Series of packs are loaded into a hydraulic press, one type of which is illustrated in Fig. 4, and the 'cure' of the material is completed under pressures up to one ton per square inch and controlled heat treatment. By this operation, separate entities of Kraft paper, decorative sheet and protective skin is transformed into a homogenous mass.

In the course of the 'curing' operation the protective skin which is impregnated with melamine resin becomes as transparent as plate glass.

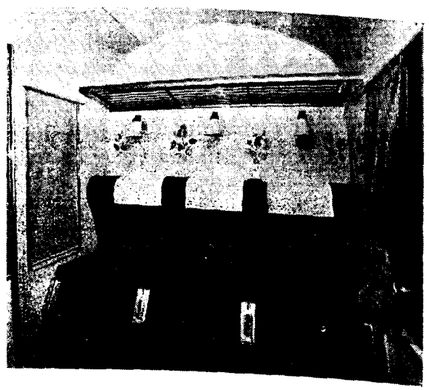


Fig. 5.

By virtue of the characteristics of melamine resin the surface of FORMICA decorative laminates is hard and resistant to abrasion and, in addition, is unaffected by the chemical action of the majority of fluids in normal domestic use.

The surface of the original FORMICA laminates made a quarter of a century ago was not treated with melamine and thus it is logical to assume that the durability of the present day product will excel the excellent results achieved by the initial formula.

All the raw materials and chemicals employed in the production of FORMICA laminates are subject initially to the most rigorous scientific examination to ensure compliance with acceptance specifications. The prepared resins and the impregnated papers are also subject to control inspection. The finished product, too, is critically examined immediately after leaving the press and again after the subsequent finishing operations.

Fig. 6.

FORMICA decorative laminates were first used for the interior decoration of British Railways passenger stock in the year 1946 at a time when materials with fire resisting properties were advocated following a series of fires on trains with fatal consequences.

At first the use of FORMICA laminates was confined to toilets and kitchens of main line stock and to the ceilings and partitions in suburban trains. The outstanding advantages of this new product soon became manifest, in particular, the durability of the attractive surface, the fastness of the colours and the tangible maintenance economies amounting at that time to twenty-five pounds sterling per annum, per vehicle. Since under normal conditions FORMICA decorative laminates would give satisfactory service during the life of the carriage, this economy alone is of paramount importance.

In consequence, the use of decorative laminates has extended to the interior surfaces of all types of railway carriages operating in the British Isles, including the London Underground stock, and to passenger rolling stock in all parts of the world.

Fig. 5, Fig. 6 and Fig. 7 show respectively a first class compartment, a second class compartment and the toilet of a modern British Railway carriage, the surfaces of which are lined with FORMICA laminates. The decorative motifs incorporated in the laminates illustrates the versatility of FORMICA Artwork productions. Fig. 8 shows the interior of a Restaurant car and Fig. 9 the corridor of a main line coach.

Fig. 7.

The interior of carriages recently built in England for the Toronto Underground Railway is shown in Fig. 10. Opaline Green, Arabesque and Ivory Softglow FORMICA patterns were specified for this contract.

Fig. 8.

Fig. 9.

In general, laminates 1/16″ in thickness are used for railway carriage applications and are affixed, for preference, with synthetic resin to a backing of either first grade resin bonded plywood or best quality Hardboard.

To ensure the most satisfactory results the exposed surfaces and edges of the backing should be effectively sealed with paint or a synthetic solution to counteract the effect of humidity.

Fig. 10.

In the case of ceilings, it is the practice to preform the laminate together with the backing in a simple wood mould. FORMICA laminates 1/16″ thick can be readily bent cold to a radius of 8″. For smaller radii, however, the special postforming grade must be used which, by means of infra-red heating within defined limits of temperature and the use of simple apparatus, the laminate can be easily formed to a radius of one inch. By the use, however of a specially designed machine the laminate can be bent over a heated mandrell to a radius of half an inch.

Laminates 1/16″ thick are used without backing for panels of small area and for curved surfaces that are not likely to be damaged by the impact of luggage.

Laminate 1/8″ thick, double-sided is used to economical advantage in applications such as door panels or partitions where both decorative surfaces are visible, and for panelling in the proximity of water tanks where condensation is likely to set up the deterioration of plywood or composite backing.

FORMICA decorative laminates are eminently suitable for lining stations in Underground Railways and the surfaces of escalators in view of its immunity from attack by insects, its fire-resistant properties and the fact that it does not support fungal growth. In the case of the former application, unsupported 1/16″ fire-resistant grade of laminate is used and the outer core is chemically treated to withstand the effect of saline solutions that are likely to infiltrate through the ground above the tunnelling. The panels are interlocked in extruded plastic mouldings designed to divert the percolation to a drainage system.

Fig. 11.

Fig. 11 shows a modern escalator, the horizontal and vertical surfaces of which are lined with FORMICA laminates bonded to metal faced plywood half an inch thick.

FORMICA laminates have been widely used for the decoration of Railway Restaurants, Hotels and Bars and, in many instances, for lining the walls and ceilings, in addition to counters and furniture. FORMICA Artwork murals are often incorporated in the decor featuring, in delightful colours, historical railway subjects and scenery of local interest. Fig. 12

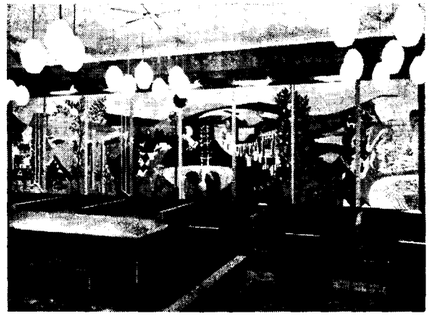


Fig. 12.

illustrates a rather small restaurant at one of the London stations which is panelled entirely in FORMICA laminated plastic. The primary concept of the mural, which depicts the countryside of the county of Kent through open windows, was to create a scene that would by illusion increase the width of the narrow room. The technique of postforming has been applied in this application to practical and aesthetical advantage.

Up to the present time FORMICA decorative laminate has been mainly used for interior application although it has been used experimentally with complete success for exterior decoration. A new grade of FORMICA has now been devised to withstand the effect of sunlight and extremes of climatic conditions which will result in the use of this new product for the exterior cladding of buildings in view of the important maintenance economies that will accrue apart from the importance of the continuity of the initial appearance.

SOVIET ASSISTANCE IN LAYING OUT IRAQ'S LONGEST RAILWAY

Soviet engineers are satisfied with the work done in preparing for the construction of Iraq's biggest railroad—the Baghdad-Basra trunk line. In an incredibly short period—less than eight months—Soviet specialists conducted surveying work, drew up the construction project and issued the first blue prints. The Iraqi organisations were able, with the help of Soviet advisers, to unfurl construction along the whole line.

The Soviet Union has already supplied Iraq with 20,000 rails, equipment for the building of a depot, apparatuses for signalisation and communications. Two powerful track layers, provided by the USSR, are working on the line.

The 550 kilometre long Baghdad-Basra trunk line will be the main railroad in Iraq. It is the biggest project that is constructed with the help of the Soviet Union. The USSR will also help in the construction of the 60 kilometre line from Basra to the new port on the shores of the Persian Gulf, and will also build enterprises for the repair of diesel locomotives, for the assembly and repair of railway cars, for the production of concrete sleepers. Soviet plants will supply diesel locomotives and railway cars.

Indigenous Railcoach Production
First All-Indian Integral Railcoach

By A Special Correspondent

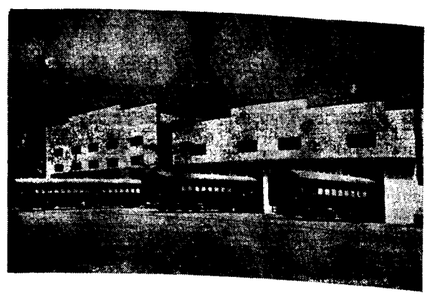
THE first All-Indian Broadgauge Integral III Class Railcoach—fully indigenous from raw materials to the finished product—has been delivered on 31—8—61 to the Indian Railways by the Railcoach Division of the Hindustan Aircraft Ltd., Bangalore. This marks the beginning of the final phase in the production of Integral Coaches at this factory. It was only a little over 3 years ago—on the 26th of May 1958, that the first Integral Coach built at HAL in collaboration with M/s. MACHINEN-FABRIK AUGSBURG—NURNBERG, (M. A. N.) of Germany was handed over to the Indian Railways. But within this short interval, the factory has been able to launch upon the manufacture of these coaches with bogies, shells and furnishings completely with indigenous materials.

An interior view of the HAL integral coach showing the seats, berths, luggage rack, lights, and fans.

This rapid progress has been due not a little to the skill and efficiency of the workers at the Railcoach Division who have with remarkable ability adapted themselves to the production of this new design of coaches and have proved themselves to be equal to the best one comes across in the far more advanced countries of the West.

The idea of building railcoaches at HAL on the same lines as the manufacture of Aircraft was conceived some time in 1946 and soon it took shape. After preliminary development work in the year 1947 a suitable design for an all metal broadgauge Class III Railcoach was evolved. This design was based very largely on the principles governing airframe design viz., the greatest strength with the lowest possible unit weight. In collaboration with the Railway Board, the HAL design was finalised and this led to the starting in 1947 of a production line in HAL for Railcoaches that revolutionised III Class travel in India.

To start with an all metal III Class 3 tier coach was developed to be built on standard IRS underframes. The first HAL designed Railcoach with an all metal body thus rolled off the production line on 27.9.1948. Hundred Coaches of this design known as model 404 were delivered to the Railways during 1948-50.



Integral Coaches coming out of the production lines at the Railcoach Division of HAL.

Railway Track & Permanent Way Engineering Supplement

Refixing Screws and Spikes in Wooden Sleepers

By K. McCabe
Member of the Permanent Way Institution

RAILWAY engineers are faced with many problems involving the fixing of one or more materials to others. One of these many problems, which can give rise to trouble, is that of sleeper fastenings. Even if a secure fixing is achieved when the track is first laid, maintenance is important, and with the increased speed and weight of modern trains the importance of the matter has become accentuated, and applies equally to both old and new sleepers.

When spikes or coach screws work loose the most common practice to correct the trouble is either to fill the hole with a wooden plug and rebore, or to move the sleeper a few inches, drill new holes, and make a new fastening. The former seldom lasts very long and the latter costs much in time and manpower.

In 1936, Philplug Limited, now a subsidiary of Expandite Limited, England, produced Philplug Sleeper Compound. This is a cementitious asbestos material, and since its inception it has been used in ever increasing quantities by railway engineers throughout the world.

It stands to reason that with any method of refixing the sleeper itself must be in reasonable condition. However, provided it is not rotten or badly split, successful can be achieved. If, for instance, the screw or spike hole is situated in a split, a clamp can be fitted to prevent the split opening further when the method of refixing is carried out.

In using Philplug Sleeper Compound only two additional tools are required over and above those normally used by maintenance gangs. One of these is to form a thread, commonly called a "former" and the second, a ramming and piercing tool. It is not possible to say before hand whether a former will be necessary, but this can be determined once the screws had been tested. Special formers can be supplied, if necessary, and to enable this to be done two screws should be available to enable tests to be carried out. As far as the piercing tools are concerned, since these must be capable for use with either screws or spikes they are available in various sizes.

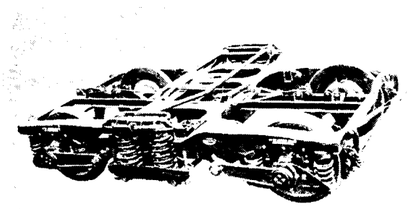
Philplug Sleeper Compound was initially only produced in a loose fibrous form, but as the result of development work it was later found possible to manufacture this in the form of a rope. Both types are still available and it is a matter of personal preference as to which is used, the rope form having the advantage of faster application. Apart from the secure fixing achieved with this material one of the main advantages is that it is not necessary to move the chair in order to refix the screws.

The manufacturers supply full information on the method of use of the material, but in order that readers can assess its relative merits with other methods it is proposed to set down the sequence of operations as concisely as possible as the technique may be completely unknown to many.

On removal of the screw it should be carefully examined and if found to be broken the part remaining embedded in the sleeper should be driven through into the ballast. Preparation of the sleeper compound for use is relatively simple. In the case of the rope form, a length of about 1 ft. would be broken off and dampened by placing it in the hand, which has previously been immersed in water. Pressing the material in the hand will then cause the former to absorb the water in sufficient quantity for hydration of the cement content. In the case of the loose type of material, it is thought that the best method to employ is to empty the contents of a tin into a bucket and add only sufficient water to make a semi-dry mix. Since opinions will vary on the question of whether sufficient water has been added, it is probably useful to have a simple test available. If, therefore, some of the damp material is squeezed hard in the hand, no

Subsequently an improved design known as Model 407 was evolved incorporating more passenger amenities and safety measures. Over 1,500 Coaches of this model were delivered to the Railways between the years 1950 and 1960.

HAL also designed and built 60 Military coaches known as Model 408, during the years 1958—59 for the transportation of military personnel.



The Design of the bogie fitted to the HAL integral coach is unique—most advanced even according to the latest western standards.

It was in the year 1956 that it was decided to build, in line with the latest technique of construction of Railway coaches in Western Countries, all metal light weight integral type Class III Coaches of welded construction complete with wheels and bogies. Unlike the coaches of previous models built on standard IRS underframes supplied by the Railways, the underframe in the Integral Coach forms an Integral part of the body which bears stresses proportionately and thus permits light weight design—7 to 8 tons lighter than the coaches of previous models. These coaches also incorporate more passenger amenities such as wider seats, well ventilated compartments with pleasing interior colour scheme, larger number of lights and fans, spacious lavatories etc. So far more than 400 coaches of this type known as 411 have been built and handed over to the Railways.

The design of the bogie fitted to the HAL Integral Coach developed in collaboration with Messrs. MACHINENFABRIK AUGSBURG—NURNBERG, (M. A. N.) is unique inasmuch as it differs widely from the existing I. R. S. type and other bogies in India—a new type which has not been used in India before and which is in fact the most modern type even in the West. This type of bogie that is fitted with Hydraulic Shock absorbers, Helical Springs, Roller bearings, metal bonded rubber fittings and many other innovations is known to give the best riding quality and consequently ensures more comfortable travel than ever obtained before.

With a view to utilising the superior riding quality of these bogies in other directions too the Railcoach Division of HAL is also at present building day-cum-sleeper coaches for the III Class Passengers.

Not only has the production of Integral Coaches got into full stride at a rapid pace but there has also been a striking spurt in production, the target peak of 1 coach a day having been reached well ahead of schedule.

With the introduction of the latest innovations and corresponding modernisation in the manufacturing facilities, HAL has started developing other designs viz., Postal Vans, Motor and Parcel Vans, Brake and

Exterior view of HAL integral coach.

Air Vice Marshal Ranjan Dutt, Managing Director, HAL, signing the document handing over the first fully indigenous integral coach manufactured by HAL to the Indian Railways. To his right looking on is Mr. K. P. V. Menon, Deputy General Manager, Railcoach Division, HAL. In the background can be seen the Coach specially decorated for the occasion.

Luggage Vans etc, to meet the requirements of the Indian Railways.

Currently HAL is also developing a Meter gauge bogie using the principles of modern design to give maximum riding comfort to the travelling public on the Meter gauge lines of the country.

As a result of the speeding up of production in the Railcoach Factory there has been considerable savings in foreign exchange made possible by the utilisation of indigenous materials and the development of indigenous manufacture even for new items which have not so far been manufactured in India.

AUTOMATIC TRAFFIC CONTROL ON RAILWAYS

A complex of cybernetic devices by means of which it will be possible to automatic traffic control on certain sections of railways has been developed by the staff of the Leningrad Railroad Signalling and Communications Designing Institute. On the basis of data recorded on a punch tape, the automatic devices automatically choose a free track, switch the points, light up the proper signals. The automatic dispatcher selects the best train crossings and controls their movement. The first cybernetic installation already went into operation at the Leningrad-Finlyandsky station, one of the biggest passenger terminals of the Soviet Union. Similar devices are being installed on a 80-kilometre section of the Yelgava-Riga-Kemeri Railway.

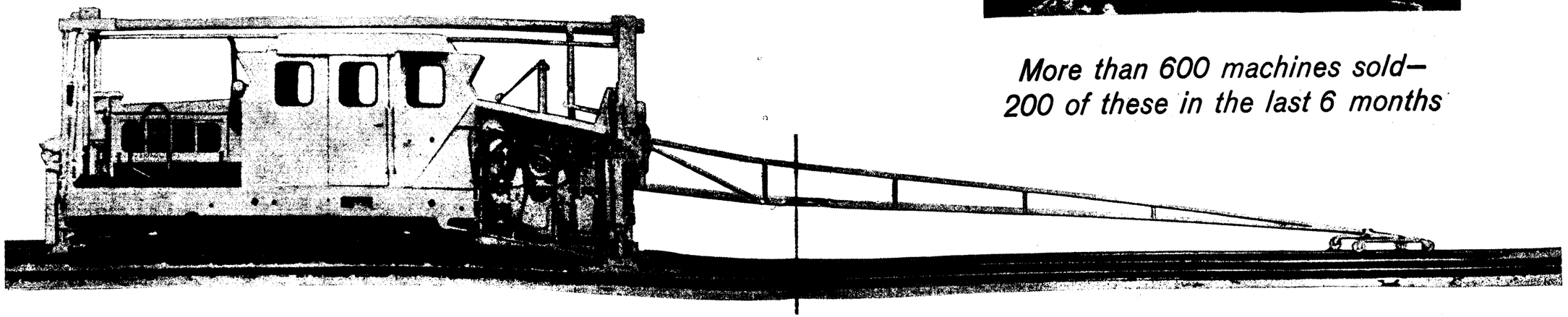
Automatic traffic control opens up the possibility of further increasing the carrying capacity of railways, said engineer Konstantin Krivitsky who headed the group of designers. In any case the computer will choose the most time-saving variant of train running and will do that better and quicker than the best despatcher.

B.60 LEVEL-TAMPER

PERFECT LEVELLING
BY ONE MAN
AT NORMAL RATE OF TAMPING

PRECISION	*± 1 mm. in both longitudinal and transverse profiles*
SPEED	*Simultaneous levelling and tamping*
ECONOMY	*One man replaces the normal levelling and jacking gang*

65 Matisa B.60 Level-Tampers sold in less than a year



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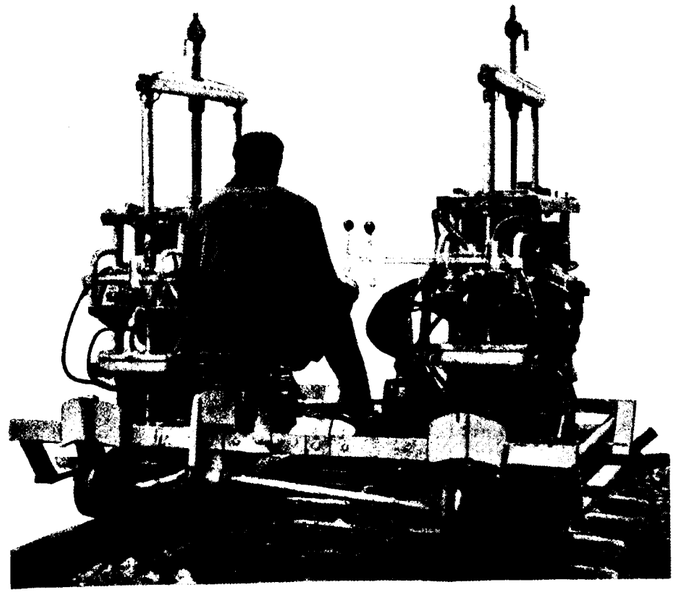


More than 600 machines sold—
200 of these in the last 6 months

Associated Companies and Agents throughout the world.

water should emerge. If it does the material is too wet, and conversely if the material does not pack together, it is too dry.

The next operation is to take sufficient damp material to fill the hole, and having fed this in, it is rammed to the bottom with the appropriate tool. It is, perhaps, worth mentioning that when the loose type of material is used a "plug" smaller than the hole should be formed in the hands, in the first instance, so that this can be fitted in on the same lines as the length of rope. It is not necessary to exert undue force during the ramming operation as the weight of the tool itself should be sufficient. If, however, the hole has become enlarged or elongated, extra ramming will be necessary to achieve proper compaction.

Having previously stated that it is unnecessary move the chair it is obviously desirable that the refixing screw should not wander from its desired position, and in order to prevent this the compacted sleeper compound should be pierced with the piercing tool, keeping the latter in the centre of the ferrule or hole in the chair. After removal of the piercing tool it may then be seen that the use of a former is necessary, in which case it should be inserted in the hole and tightened down on the chair. The use of the former will cause the thread to be cut into the contours of that previously in the timber and when it is withdrawn the screw can be inserted and tightened down.

It goes without saying that the operation described above should be carefully and conscientiously carried out. If, for instance, a hammer were to be used to drive either the former or the screw into the hole instead of allowing these to cut their path, there would be a danger of the walls of the hole being destroyed, ultimately leading to a poor fixing being made.

When refixing spikes the process is somewhat simpler, in that it is merely necessary to use the piercing tool, and after this has been withdrawn the spike is inserted and driven home with a sledge hammer.

It was suggested earlier that one of the main advantages of the material is that it is unnecessary to move the chair. Possibly, however, an even greater advantage, particularly from the operating point of view, is that no delay whatsoever is necessary after the fixing of screws or spikes before traffic may be run over the track. This is due to the fact that when the spike or former was used it compressed the compound hard against the sides of the original hole, and the fixing becomes effective immediately.

With curved tracks it is sometimes found that due to the sideways force exerted by trains the rails are pushed "wide to gauge." When this occurs it is, of course, merely necessary to ensure that the rail is repositioned before the piercing tool is inserted into the sleeper compound. In instances where the rail has been pushed excessively wide, perhaps $\frac{1}{2}$" or more, it is probably advantageous to fix a tie bar in position and to leave this for about 24 hours.

Finally, it is perhaps worthy of note that the sleeper compound becomes part of the timber, and since the screw or spike is completely sealed off it is protected from corrosion. This is doubly important as not only is the life of the screw or spike considerably lengthened, but it may be withdrawn and reinserted at any time. Philplug Sleeper Compound remains unaffected by exposure to continual changes in temperature and even under extreme tropical conditions will provide a firm and secure fixing, which can add years to the useful life of a sleeper.

Indian Technicians at New U.K. Airport Engineering Centre

Three radio technicians from India are among those working at a new U. K. Ministry of Aviation telecommunications engineering establishment just opened at Gatwick airport. The new establishment will deal mainly with field engineering of air safety devices. It has cost about £ 350,000, and 270 people will eventually work there.

The centre will provide an immediate major repair service and be responsible for installation programmes and major overhaul of equipment in Ministry of Aviation airports and radio stations throughout Britain. Small, specialized quantities of equipment, models, and prototypes will also be produced there.

Several separate units are brought together in the new centre. Before the war there was a civil signals organization in the Air Ministry, and in 1946 a small installation test and repair unit was formed. A Ground Control Approach maintenance and inspection unit was formed in 1947, and from it came proposals resulting in the precision-approach radar system now being constructed at the Gatwick establishment. These units will work in future from Gatwick.

Geometric Track Maintenance with the Matisa B-60 Level-Tamper

By An Engineering Correspondent

IT is now more than twenty years ago since the first use of Matisa tampers revolutionised the methods of ballast tamping associated with laying and maintenance of track. These forerunners of the present machines which were then known by the expressive but not very elegant name of "production tampers" enabled manual tamping to become a thing of the past whilst at the same time ensuring a finer quality of work and higher output at much less cost.

For all that, the mechanisation of tamping only produced a partial solution to the problems of track maintenance because, although the production tamper ensured perfect compaction of the ballast under the sleepers, it could not itself lift the track to the precise level required. It was therefore necessary to carry out separate levelling operations before tamping.

In the past, therefore, the track was raised on jacks and every fifth or sixth sleeper was packed by means of beaters. As time went on, this method of lifting the track and holding it to level on jacks was perfected, to be followed in its turn by the use of lifting and packing machines.

But all such operations carried out before tamping have their disadvantages. To mention only two, there is :

— the difficulty of obtaining a sufficiently accurate longitudinal and cross level, due to variation in the stability of the temporary support of the track provided either by jacks or by hand packed sleepers,

— the high cost of lifting and packing by such methods, on account of the large amount of manpower required.

In order to do away with these disadvantages, Matisa has developed automatic levelling equipment. With this equipment, mounted on tampers which are the most up-to-date and efficient available, the lifting of the track to the required level and its effective tamping are carried out simultaneously and continuously. Longitudinal and cross levels of exceptional accuracy and permanence are obtained with a speed of working hitherto unattained. After experience gained over a long period of comprehensive trials, Matisa chose to develop this precision levelling equipment which is entirely independent of the handling of the tamper and the reactions of the track rather than produce something simple in appearance but which would have several limitations in use and could not guarantee a sufficiently accurate result. This equipment comprises a means of lifting the track, controlled by a measuring device.

The lifting device, mounted on the front of the tamper, includes an independent, transversal frame, to which rail clamps are attached, and which is carried on two hydraulically operated lifting jacks, the feet of which bear down on the ballast shoulders. Two other hydraulic jacks exercise a counter-pressure on each rail in the area of the rail clamps, thereby preventing the rail being raised above the pre-set level. In addition they damp out any undesirable vibrations of the rail.

This independently mounted articulated equipment assures absolute accuracy of lift and notably eliminates the accidental slew of the track towards the centre of a curve.

The measuring device is composed of reference planes, automatic in operation, and the related controls.

The lifting movement of the jacks is automatically controlled by the relative angular positions of the two articulated reference planes which comprise the equipment and which are positively related to the rail positions. These reference planes are formed by a forward mounted articulated arm, a rigid framework spanning the machine and the arms at the rear of the framework which are in contact with the heads of the rails. The controls for the hydraulic jacks for raising the track are grouped at the front of the machine.

The longitudinal level is set by the reference plane. It is controlled by sighting a target board carried on the jacking assembly at a fixed height above rail level through a special high-precision telescope mounted on a stand which can be placed on the track at a distance from the forward reference plane. By sighting from high or fixed points onto the target board of the control rail, the lift given may be periodically checked.

Cross level is controlled automatically by a special pendulum unit which determines the transverse inclination of the reference base. Superelevation can thus be varied and controlled at will in transitions and curves to within 0.5 mm. The value of applied superelevation is indicated positively on a scale.

Experience with the Matisa Level-tamper under very varied conditions has confirmed that the accuracy under normal working is within ± 1 mm.

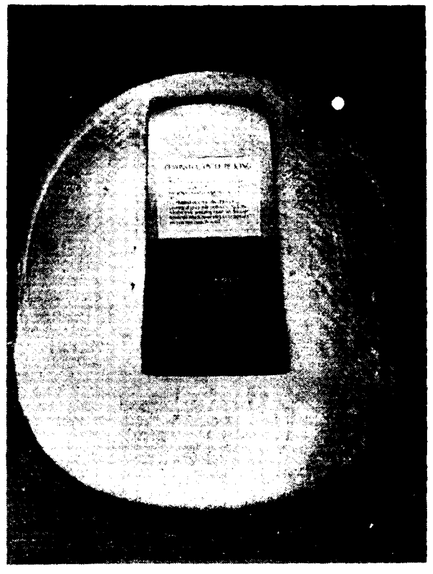
The hourly output far exceeds that hitherto obtainable, since a single machine can now level and tamp simultaneously almost 300 metres per hour.

GOLDEN OUTLOOK FOR DIESEL DRIVERS

Triplex gold-film glass, for de-icing and demisting, has been fitted to driving cabs of 75 Brush 1,365 H. P. diesel-electric locomotives ordered by British Railways.

Gold-film glass panels are the latest Triplex development for de-icing and demisting. A gold film is deposited on the inner surface of laminated glass. The film is so thin (two ten-millionths of an inch) that is absolutely transparent. It does not glitter, and is capable of carrying power inputs of the order of at least 600 watts per square foot.

This method of de-icing is being adopted on Britain's latest types of aircraft.



This photograph of the windscreen of a jet fighter placed in a refrigerated chamber, where temperature is minus 30°C, shows how effectively Triplex gold-film glass prevents icing and misting. The windscreen remains clear, but side windows which have now protection remain thickly iced. Similar screens are manufactured for diesel-electric locomotives.

A Triplex gold-film glass panel is placed into position at the front of the driving cab of a new Brush diesel-electric locomotive.

Flexmaster Rail Maintenance Equipment

By An Engineering Correspondent

INTRODUCTION

THE Flexmaster rail maintenance equipment has been specially designed to meet the requirements of track maintenance engineers who are interested in obtaining a set of equipment that is light, easily portable, inexpensive, and can be used by unskilled labour.

All these requirements have been met by the manufacturers in using a power unit that is not a component part of any one attachment, (i. e. saw, drill, etc.), but is a separate unit, the accessory being driven by a detachable flexible drive working between it and the motor.

A set of Flexmaster rail maintenance equipment comprises the following units which can, of course, be purchased individually :—

POWER UNIT AND FLEXIBLE DRIVE— CODE FX. 322

The power unit normally used is a 220 c. c. four-stroke petrol engine complete with a centrifugal clutch, adaptors to accept the flexible drive, and all mounted on a rubber-tyred trolley. (If required, electric or air motors can be used.) (The trolley can also be omitted if the engine is required for mounting on flats or railway bogies.) The flexible drive is normally 10 ft. long with a 15 mm. inner core and 30 mm. metallic or rubber outer casing: this drive is very strong and specially designed to withstand rough handling, and its end fittings will suit any of the accessories.

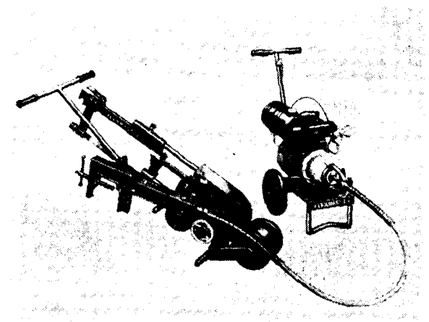
RAIL DRILLING UNIT—CODE FX. 904

A heavy duty driller that is suitable for drilling holes up to $1\frac{3}{8}$" dia. This unit is very light (weight approx. 70 lbs.) and one of its main advantages is that it engages beneath the rail, therefore offering no obstruction to traffic when in position: the only part that has to be removed is the handle which slides on and off. The time taken to drill a $1\frac{1}{4}$" dia. hole through a rail is $1\frac{1}{2}$ – 2 minutes, depending on rail specification and hardness.

All units are tailored to suit a size or range of sizes of rail and full specifications are always required before manufacture.

The drilling height can be finely adjusted by means of a slide, and drilling positions for different standard rails are marked on this, if required.

The correct lateral spacing for the holes is obtained by means of a gauge bar and stop made to suit any given rail specification. No measurement or marking out of the rails is necessary.



RAIL SAWING UNIT—CODE FX. 902

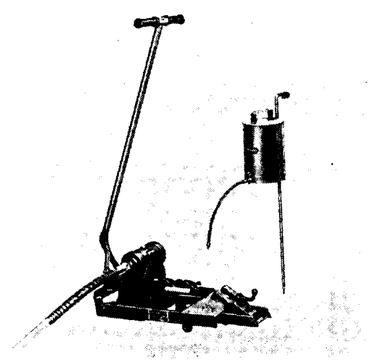
This machine is designed to cut up rails or other steelwork accurately, quickly and at a low cost under field conditions. It is not always possible to produce ready cut rails and other steel sections on the site of the work, which means that time and labour are wasted on hand sawing to required lengths. Other methods such as torch cutting and the "nick and break" method have the disadvantage of causing shattered or burnt rail ends or fissures.

SPEED OF CUTTING

This can, of course, be controlled by the adjustment of the throttle of the power unit. An indication of the cutting speed, however, is that the attachment will cut through 109 lb. flat bottomed rail in six minutes.

ACCURACY

It is possible to remove as little as 1/16" from a steel joist or rail, leaving a smooth accurate facing.



ECONOMY

Special high speed saw blades are supplied, which are capable of cutting fifty to sixty 95 lb. B. S. carbon rails before requiring replacement at a cost in fuel of less than six shillings. The blade is lowered on to the rail section by cam mechanism, which eliminates the risk of blade breakage when starting the cut.

FINE ADJUSTMENT

The Saw is supplied with a device for fine lateral adjustment of the saw blade after the unit has been clamped to the rail, and also a barrow mounting to enable the saw to be wheeled along the track or on a level surface by one man.

RAIL PLANING UNIT—CODE FX. 900

This unit is used to grind down the weld after a joint has been made between two lines. It ensures a precise alignment on top of line from rail to rail, and a later model that has just been introduced will also grind the side of the rail.

Stock removal is very fast due to the easy handling of this unit, and centres have been so designed so that there is no need to remove chair blocks. A special high speed grinding wheel is used working at 6,000 r. p. m. off a 2:1 increase head, which ensures an exceptionally fine finish. Combined grinding time—In top and side of rail—*8 mins.*

RAIL GRINDING ATTACHMENTS

This equipment, which includes a 6"×1"×1" grinding wheel and 5" cup wheel, is mounted on the end of the flexible drive by means of various handpieces and can be used for removing weld from under the lip of the rail or about the points, etc., where it is not possible to use the Planing Unit. Wire brushes can also be used for the removal of rust, and even sanding heads can be fitted for sanding, polishing, buffing, etc.

SLEEPER BORER AND COACH SCREW RUNNING ATTACHMENT— CODE FX. 903

This attachment will bore holes through sleepers in four to ten seconds, depending on their thickness. It will also screw the coach screws right home in the same time. The operators are perfectly safe because there are no exposed moving parts, and Bowden cables provide finger-tip control for the engine. Tension in the slipping clutch can be adjusted to individual requirement for screwing down coach screws. For its purpose, the attachment is exceptionally light. Normally, when using equipment of this type, it is necessary for the operators to support the weight of the engine as it is directly coupled to the gearbox. Flexible shaft drive eliminates this disadvantage. The weight of the unit is 66 lbs.

FISH BOLT RUNNER—CODE FX. 906.

The Fish Bolt Runner consists of a reduction gearbox with double-ended spindle for connection to a slipping clutch and socket to fit any given size of fish bolt or nut. The slipping clutch and socket can be fixed to either end of the projecting spindle, enabling bolts to be tightened up or loosened at will.

CONCLUSIONS

As we have stated, all the attachments outlined are interchangeable on a single power unit and flexible drive, and it is only necessary to purchase one power unit for a complete set. Following this it can be seen that the operator does not have to lift the weight of the power unit every time he applies the working piece to the permanent way.

Another most important factor is that of safety and the personal comfort of the operator. Due to the fact that the power unit is working anything up to 10 ft. away from him he is not subjected to fumes and noise, and can also hear clearly any warning signals that may be given.

The sole manufacturers of the Flexmaster Permanent Way maintenance equipment are Flexible drives (Gilmans) Limited of "Skatoskalo Works", Millers Road, Warwick, England, and they will gladly forward catalogues and prices on request.

Technical Conditions for Sleeper Tamping with the aid of Tamping Machines

By An Engineering Correspondent

THERE are two types of tamping machine(s) which have been constructed and tested by us.

In the case of the first type, the inserted tamping tools or tines are hydraulically compressed (vibrations being simultaneously produced), until a certain pressure, selected beforehand on the machine is developed. Due to the fact that the pairs of tamping tools work independently of one another during this type of operation, this type of tamping is generally described as *asynchronous* or non-synchronous. The distance travelled by each pair of tools can vary, although they develop an equal pressure parallel to the rails. Accordingly, the pressure of the ballast against the lower side of the sleepers and the amount of compression imparted to the ballast will always be constant. In view of the fact that the oscillations or vibrations spread at a different rate in ballast of varying density (in loose ballast at a reduced rate, in compact ballast much more quickly), the influence of vibrations remains constant where tamping is done with asynchronous equipment.

In the case of the second type of tamping machine(s), the inserted tamping tools are mechanically brought closer to one another over a certain distance which is determined by the operator, oscillations or vibrations being simultaneously produced in the same way. It is hard enough on the operator to expect him to have the proper feeling for two levers—working one with each hand—but he can certainly not be expected to successfully operate four varying levers. Since in the case of such tamping units, the tamping tools must travel an equal distance underneath each rail, this manner of tamping is described as *synchronous* tamping. The distance travelled made by all tamping tools operating underneath one half of the sleeper is constant which means that the volume of ballast moved is equally large, no matter whether the sleeper is lifted up to a larger or smaller extent and irrespective of whether the tools strike lumps of ballast or not. Accordingly, the pressure exercised parallel to the rail and, subsequently, the pressure exerted on the bottom of the sleeper can not be constant. The pressure from one pair of tools to the other must therefore fluctuate. Really expert operators will be able to produce an approximately equal average pressure underneath both the left and the right rail which will differ however, according to whether it is exerted inside or outside the rail. Accordingly, the oscillations or vibrations respectively will have a different influence on the compression of the ballast.

With a view to comparing the two types of machine(s), a study must be made of how to satisfy the demands made by the Railway Administration, while testing the machines under the most unfavourable working conditions, and when deficiencies become most conspicuous. The most important thing is that these requirements should be fulfilled, rather than a machine produced because of conventional tradition. Below we are listing the demands stipulated by the railways and the extent to which these types of machines are able to satisfying them.

1. The cross level of the rail determined before tamping must not be altered.

SYNCHRONOUS MACHINES

Where coarse-grained ballast has to be dealt with, the tamping tools seize the large pieces individually, press them underneath the sleepers just as far as push the small pieces, irrespective of pressure, thus driving the sleepers upwards.

The requirement is not met

ASYNCHRONOUS MACHINES

Once the degree of compression of the tamping tools has been properly adjusted for the size of ballast used, it will be impossible to tamp the rails (sleepers) upwards. Where forward projecting tools are used, a damping device is used which holds the rails at a predetermined height and prevents the tracks from being pressed upwards or lowered.

The requirement is met

2. The sleepers must be equally tamped in spite of varying small and large lifts.

SYNCHRONOUS MACHINES

Theoretically, this cannot be done, since the volume of ballast displaced by the tamping tools is only governed by the operator. Precision tamping is therefore left to coincidence, especially in the case of ever varying small and large lifts. Real quality work can therefore *never be attained.*

The requirement is not met

ASYNCHRONOUS MACHINES

In view of the fact that the ballast is pressed under the sleeper until the desired pressure is reached, the influence of varying lifts at the points where rails are low is of no importance whatever, both from the theoretical and the practical point of view.

The requirement is met

3. Even when the machine does not stop over the centre axis of the sleeper, or in the case of sleepers laying askew the quality of the tamping should be just as flawless as in the case of the neighbouring sleepers.

SYNCHRONOUS MACHINES

If one or more tamping tools strike against a sleeper, the sleeper will be moved, or tamping will be prematurely interrupted. The operator's instinct will tell him *to stop tamping before he should*!

This demand cannot be met!

ASYNCHRONOUS MACHINES

If one or more tamping tools strike against a sleeper, the rest of the stroke which has to be covered to achieve compression, is covered by the opposite tamping tool, so that the adjusted pressure is reached underneath the sleeper.

This demand is met

4. The machines should be able to precision-tamp tracks with poor ballast.

Where beds of ballast have formed into large concrete-like lumps, precision tamping can no longer be expected of any tamping unit. These lumps should be broken up between the sleepers and not be pushed underneath the sleepers.

SYNCHRONOUS MACHINES

In the case of this type of unit, the distance covered by the tamping tool ascends from zero to a maximum. Therefore, no impact can be exercised on the bed of ballast. If the incrustation is too hard at one pair of tools, the tool will often break, since the incrustation cannot be broken up in one pressure action. However, if the ballast is crusted over the full length of the sleeper, it will be found that it cannot be broken up at all with the aid of the machine. Generally the ballast is solid all over.

Mechanical units have a limited reversing capacity as there is the risk of the friction coupling seizing. Therefore, it will not be possible to break up a crusted bed by the simple device of opening and closing the tools.

This demand cannot be met !

ASYNCHRONOUS MACHINES

In view of the fact that, in the case of this type of unit, the pressure increases from zero to a maximum, no impact can be exercised on the bed, apart from the vibrating power. By quickly opening and closing the tamping tool (in the case of hydraulic units there is no such thing as a limited reversing facility) the lump in the space between two sleepers can be broken up, so that subsequent precision tamping is rendered possible Experience shows that 35 pressure units above atmospheric pressure are sufficient to deal with any crusted ballast.

With the aid of hydraulics, more power can be made effective than would be possible with mechanical equipment. The aforementioned 35 pressure units above atmospheric pressure are 50% of the degree of compression actually available. The compressive pressure of the tools can be increased by a turn of the hand.

This demand can be met !

5. *Good tamping results should also be achieved where coarse ballast is used.*

This point has already been treated under Condition 1

SYNCHRONOUS MACHINES

This demand cannot be met !

ASYNCHRONOUS MACHINES

This demand can be met !

6. *Cross level of track should not suffer any changes under load.*

SYNCHRONOUS MACHINES

In view of the fact that the applied pressure is dependent on the quantity and granulation of the ballast gripped by each individual pair of tools, it differs from pair to pair. If an impact load hits the sleeper following tamping (axle loads moving quickly over the sleepers will have the effect of an impact load), such sections as have been tamped down harder will take a bigger load than those where tamping has been rather poor. The sleeper will continue to settle until the resistant pressure equals that of the load. Settling of the sleeper changes the cross level of the track.

The demand cannot be met !

ASYNCHRONOUS MACHINES

Since the pressure exerted by the ballast against the sleeper support area is constant, there are neither theoretical nor practical possibilities for irregular settling.

The demand is met !

7. *The cross level following tamping should be maintained over a long period.*

The cross level varies according to the existing tamping errors following tamping, to the irregularities in the consolidation of the ballast bed and the formation (this is not dealt with here). Irregularities in the consolidation of the gravel or ballast bed will be reduced, the more regular the compression.

SYNCHRONOUS MACHINES

As the existing condition simply cannot be free of low spots requiring rectification, operational dynamic loads arise which have a bad effect on the cross level. Since the degree of compression and the vibrations vary underneath one and the same sleeper, they naturally vary from one sleeper to another. Accordingly, the degree of compression must vary from sleeper to sleeper. The maximum extent of compression can neither be determined by means of tests nor established by adjustment. It can only be attained by chance.

Since the degree of compression is left to the operator's judgment and dexterity, the durability of the track level thus produced becomes likewise a function of these uncertain factors.

Irregularities in consolidation may be expected !

ASYNCHRONOUS MACHINES

In accordance with point 1, the shortcomings still present after tamping are really negligible. The consolidation of the bed is regular since the degree of compression exerted on the bed of ballast and the vibrations transmitted are equally large underneath each sleeper. The largest extent of compression is reached if the ballast pressed underneath the sleeper continues to move slightly in the direction of the longitudinal axis of the sleeper. Since the compression force may be selected, the most favourable condition can be determined by experimenting. If one succeeds in preventing the tools from getting too close to the sleeper, then each and every sleeper will have an equally large support.

There is no need to fear irregularities in consolidation !

8. *The machines are required to tamp joint sleepers harder than standard sleepers.*

SYNCHRONOUS MACHINES

An automatically adjusting pressure change is not available. To achieve this the mechanical machine must several times re-insert the tines, causing a considerable loss of time.

ASYNCHRONOUS MACHINES

Machines automatically adjust to a greater pressure.

9. *The machines are required to give greater speed of work.*

SYNCHRONOUS MACHINES

The mechanically driven synchronous machines are both limited in output peak and efficiency.

ASYNCHRONOUS MACHINES

Peak performance is achieved by the fully hydraulic machine with uniform quality, uninfluenced by human error.

SUMMARY

From the above it appears that synchronous machines can never meet the demands made by Railway Administrations. Exactness and quality of the tamping job are dependent on the operator's judgement and dexterity. This has long been a cause for much debate.

The asynchronous unit is the only machine which fills in an individual quantity of ballast underneath each sleeper compressing it with equal pressure (just as is done in hand measured shovel packing).

Asynchronous machines are merely dependent on the machine adjustments to be effected by the operator. They meet all demands made by the Railway Administrations. Such machines are not a subject of debate—*they are bought.*

PROOF showing that the demands made on the operator of a synchronous mechanical machine are so heavy and numerous that they simply cannot be coped with.

Operating a mechanical synchronous machine :	*Tamping operation with hydraulic unit (the operator can walk at the side of the unit, or optionally work it from the seat)* :
1. The machine must first be in motion.	1. The machine advances automatically.
2. The machine must be stopped exactly over the centre of the sleeper.	2. By working a push button, the brakes start to work and the clutch is released. Though it is desirable that the machine stops over the centre of the sleeper, it is not of excessive importance in the case of the asynchronous tamping machine, since the shorter movement of one pair of tools is compensated by the longer movement of the other pair.
3. Lowering of tamping units.	3. Is effected automatically.
4. Starting of closing cycle.	4. Is effected automatically.
5. The closing cycle must either be stopped or continued by touch in the case of the left hand unit.	5. Is effected automatically.

6. The closing cycle must either be stopped or continued by touch in the case of the right hand unit, too.	6. This too, is effected automatically.
7. Change over to opening cycle.	7. Following the action of the relief valve (about 3 seconds), the opening cycle must be started.
8. Raising of tamping units.	8. This is effected automatically.
9. Control of left aperture limitation and right aperture width.	9. and 10. This is effected automatically since the tool arms come to rest on stops.
10. Forward travel to next sleeper constitutes a separate operation.	
11. Joints with short fishplates and close sleepering need special attention.	11. Reversing is effected with the aid of two push buttons.
12. To loosen crusted ballast between sleepers, the tools should be repeatedly opened and closed. In view of the fact that reversing facilities are limited, the operator is confronted with a difficult task.	12. To loosen crusted ballast, the tools are quickly opened and shut several times. Only two buttons must be actuated.

SUMMARY

13. The operator must uninterruptedly work with both hands and feet. After 6–8 hours the operator will become exhausted. His hands will shake and his back will ache. The vibration which is transmitted to the entire body, as well as the noise of the chain drives, soon reduce him to the status of an unskilled driver, unable to heed efficiency of quality.	13. The operator takes care of all operations with two fingers which enables him to dedicate his entire attention to the tamping job. No physical or mental stress!

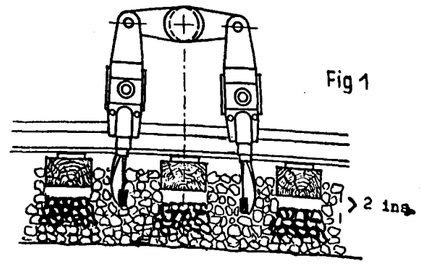
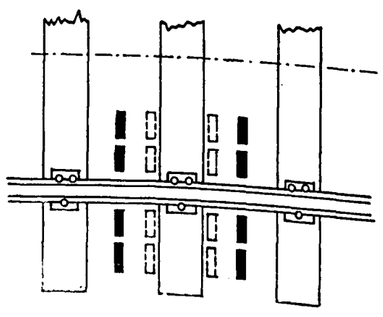


Fig 1

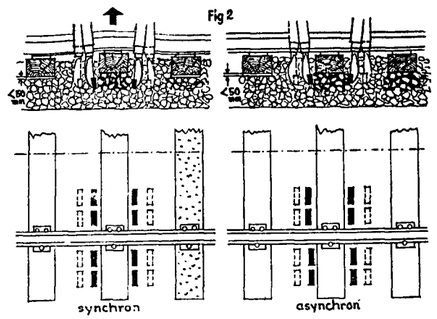


Illustrated comparison between Synchronous and Asynchronous Tamping.

Example 1: Tracks being raised more than 2 ins., with tamping tools coming to rest over the sleeper axis. Clean ballast.

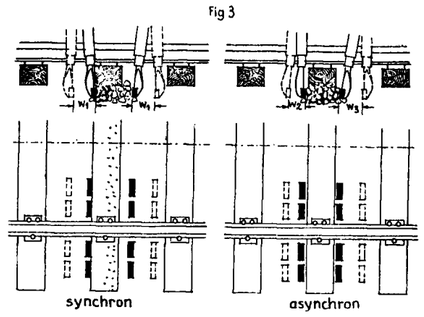
Where first-rate operators are available, it will be possible to achieve good results with both methods of tamping, conditions being ideal as outlined above.

Example 2: Track lifts of less than 2 ins.



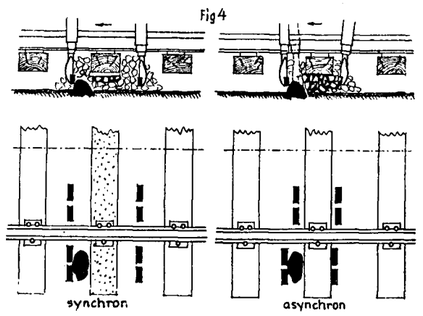
(a) A great source of error arises when the tools squeeze too much ballast.	(a) All tools terminate their compression once the selected pressure has been reached.
(b) The sleeper is forcibly raised whenever even one piece too much of ballast is gripped.	(b) No raising of sleepers since the quantity of ballast pressed has no influence on tamping.
(c) The next sleeper works loose.	(c) The next sleeper does not work loose.
(d) Uneven cross level and tamping.	(d) Equal cross level and tamping.

Example 3: Tamping tools do not come to rest over the centre axis of the sleeper.



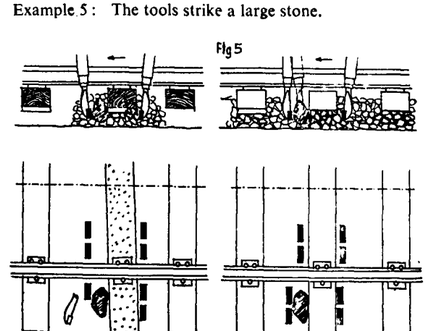
(e) Irregular compression.	(e) Regular compression.
(f) Sleeper gets either displaced or damaged.	(f) No sleepers get displaced.
(g) Machine excessively strained.	(g) No excessive stress placed on machine.
(h) Time lost in adjusting axial position.	(h) No loss of time.

Example 4: A pair of tools strikes against an obstacle.



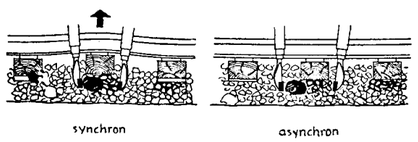
(i) All tamping tools stop.	(i) Only the one pair of tamping tools hitting the obstacle stops, while the other pairs continue to work.
(j) No compression underneath the sleeper.	(j) The ballast gets uniformly compressed.
(k) Machine excessively stressed.	(k) No excessive stress placed on the machine.

Example 5: The tools strike a large stone.



(l) The sleeper gets displaced.	(l) No sleepers displaced.
(m) The tamping operation is only partially carried through.	(m) Equal tamping.
(n) Tool breaks	(n) No tool breakage.

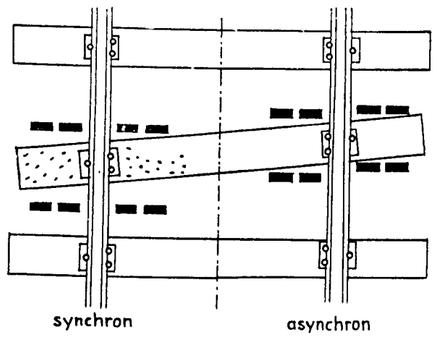
Fig. 6



Example 6: The tools squeeze a large stone underneath the sleeper.

(o) The sleeper is tamped upwards.	(o) The sleeper is not tamped upwards.
(p) The next sleeper works loose.	(p) The next sleeper does not work loose.

Fig. 7

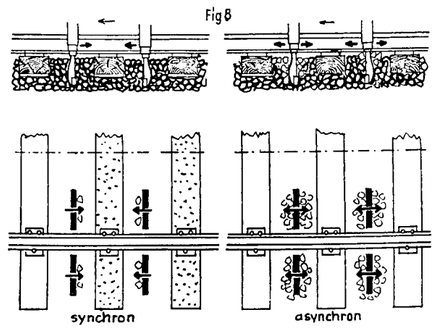


Example 7: When a sleeper lies askew.

(q) Tamping tools stop as soon as the first tool hits the sleeper.	(q) Even sleepers lying slightly out of square are tamped at constant pressure.
(r) Further tamping operation rendered impossible.	(r) Sleepers lying out of square do not matter at all and tamping operations may be continued even into a set of switches.

Example 8: Ballast badly crusted.

Fig 8



Example 8: Ballast badly crusted.

(s) If tools quickly opened and closed, the clutch will suffer damage.	(s) Encrusted deposits are broken up by the quick opening and closing operation.
(t) Increase of compression is impossible.	(t) Compression can, if necessary, be increased.
(u) Tamping impossible.	(u) Tamping subsequently possible.

BARODA RAYON

Baroda Rayon Corporation is understood to have two schemes on hand, both of which are under the active consideration of the Government of India. One of the two schemes pertains to the manufacture of tyre cord. Application has already been made for the necessary industrial licence for the purpose.

The other scheme is in connection with the production of caustic soda. This is estimated to cost Rs. 1.5 crores.

Meanwhile, the company is understood to have received the last consignment of the imported machinery and equipment. The installation work is expected to start in August. The plant is expected to go into production before the end of March 1962.

SOUTH AFRICAN RAILWAYS — WATER TREATMENT CHEMICALS

The Natal Tanning Extract Company Limited of Pietermaritzburg, which is an associate company of John Pittam & Co. Ltd., London, has just been given the annual contract for supplying the South African Railways with the bulk of their needs for Water Treatment Chemicals.

Last year, their share of the business was about 15% of the total. This year, they have been awarded contracts for the supply of the total needs of compounds in briquette form together with a proportion of the powders. The annual value of these contracts is approximately £90,000.

The associate company has been included in the agreement completed by its parent company with the Dearborn Chemical Company at the beginning of this year. This is of significance when unusual problems arise, since Dearborn are undoubtedly the most experienced specialists in supplying water treatment materials for railway applications.

* * *

FURNACE OIL FOR LOCOMOTIVES

The suggestion that furnace oil could be used in the steam locomotives by the railways in place of coal, particularly in areas which are far more remote from coal-producing belts like Kerala, has been accepted in principle by the Union Railway Ministry. But the details of cost have to be worked out before the Railways are willing to implement it.

It is learnt that the idea of substituting furnace oil for coal was put forward at an inter-ministerial meeting of officials by the representatives of the Oil Ministry. While accepting it in principle, the Railway officials seem to have suggested that unless the economics of using furnace oil was fully known the idea could not be implemented. It is learnt that the details of it are being worked out jointly by both the officials of the Railway Ministry and the Oil Ministry.

* * *

UNIQUE EARTH-DIGGING MACHINE

An earth-digging machine with rotating milling shaft substituted for buckets, with two big spades loading conveyers with the excavated earth is being tested in Stalingrad. During the work the machine moves uninterruptedly forward on broad caterpillar track, excavating earth 2 metres deep. This machine has an hourly output of upto three thousand cubic metres of earth, thus dispensing with the labour of 15-20 thousand people. It was stated that two more such machines are being manufactured at the Voronezh Excavator Plant.

Carrying Capacity of Sleepers on Ballast

*By Åke Holmberg**

A SLEEPER consists of one or two rigid bodies. I the first case the sleeper is monolithic and almost equally stiff throughout its length while, in the other case, the centre part between the two bodies possesses a stiffness which is negligible compared to that of the blocks. The carrying capacity of the two sleepers—assessed by an analyst—is basically different. That of the monolithic sleeper depends largely on the strength of the sleeper while that of the two-block sleeper depends at least as much on the way the blocks are actually supported by the ballast. This article deals with the last mentioned phenomenon. Usually the ballast is composed of crushed stone (macadam) or a pit-run, rather fine gravel. The traditional approach to the determination of the carrying capacity of a sleeper would, therefore, be through the theory concerning the capacity of rigid foundations on cohesionless material.

But two difficulties crop up at once. Firstly, this theory is as yet in the state of infancy. Secondly, it is highly questionable if in this case the ballast may be regarded as a "cohesionless material" in the sense it usually figures in these theories. At least in the case of a typical macadam, the individual grains attain dimensions comparable to those of the sleeper and, hence, the assumed continuity of the rupture zones or slip surfaces, which appear in most theories, is quite unrealistic. Therefore, it is comforting to notice that some scientists have developed usable formulae without utilizing such slip-surfaces.

Thus in 1931 Kogler observed that for a centrally loaded foundation, the mean intensity of reaction at failure increased proportionally with the ratio of area to circumference of the contact surface.

In 1934 professor Carl Forssell, Stockholm, correlating this, the results from his own very extensive tests and whatever else was known on the subject up to that time and presented his conclusions in a surprisingly simple form.

Primarily his theory was applicable to foundations with a contact area point-symmetrical about the acting load. The intensity of reaction was assumed to increase recti-lineally from Zero at the edge (for reasons of equilibrium) to a max. value at the axis. The rate of increase found at failure was thus introduced as a characteristic for the soil in question. Hence, according to this theory the criteria for failure is *either* that the critical rate of stress increase is reached *or* that soil is crushed at the centre.

Professor Forssell found that the critical rate of stress increase for foundations on dry granite sand amounted to 4, 5 kg/cm³/cm and on granite sand under water to 2, 4 kg/cm³/cm. The ratio 4, 5/2, 4 = 1, 9 was approximately equal to the ratio between the unit weights of dry and submerged sand. At a max. intensity of about 70 kg/cm² crushing of the sand was observed.

In additional test series, professor Forssell found that for an eccentrical load the bearing capacity could be determined with good accuracy by the same conceptions as above *provided* that the area contributing to the reaction was assumed to be point symmetrical about the vertical component of the reaction and tangential to the actual contour of the foundation.

Most of the purely theoretical approaches to the problem operate, as mentioned with certain slip surfaces or rupture zones and may usually be traced back to Prandtl's pioneering work of 1920.

It is mentioned above that the actual conditions in case of a sleeper on ballast may deviate considerably from the assumptions made for the various theoretical developments. It is of interest, to apply one of the latest and in Scandinavia most frequently used theories on this particular problem.

In 1961 professor J Brinch Hansen expresses the average contact pressure at failure as

$$\sigma_{av} = \tfrac{1}{2}\,\gamma\, B N_\gamma \cdot i_\gamma \cdot s_\gamma + \gamma\, D \cdot N_q \cdot i_q \cdot s_q \cdot d_q, \text{ where}$$

*Dr. Eng., Cons., Partner of Centerlöf and Holmberg AB, Lund, Sweden, Leader of the Research Work at Swedish Rail System AB.

γ = the unit weight of the soil

B = the width of the foundation

N_y = a factor incorporating the influence of the internal friction, φ, assuming the foundation depth being zero. (For $\varphi = 40°$ $N_y = 430$ and $\varphi = 42°$ $N_y = 1000$)

i_y = a factor incorporating the influence of the inclination of the load resultant, V/H, assuming the foundation depth being zero, $i_y \approx (1 - H/V)^4$

$s_y = \left[1 - \frac{1}{2}\,(0,2 + \tan^6 \varphi)\,\frac{B}{L}\right]$ incorporating the influence of the geometrical shape of the foundation for various φ — values.

D = the foundation depth.

$N_q \approx N_y$ = a factor incorporating the influence of the depth D as well as of the internal friction φ.

i_q = a factor incorporating the influence of depth D as well as of the inclination of the load resultant, V = H,

$$i_q = \left[1 - \frac{H}{V}\right]^2$$

$s_q = \left[1 + (0,2 + \tan^6 \varphi)\,\frac{B}{L}\right]$ incorporating the influence of the depth D as well as of the varying φ — values.

$$d_q = \left[1 + \frac{0,35}{\frac{B}{D}\,\frac{0,6}{1 + 7\tan^4 \varphi}}\right]$$

incorporates the influence of the depth D for varying φ — values.

B and L is the width respectively length of the reaction area. However, B should always be taken as the side of the area parallel to the horizontal load component.

In case of a sleeper block, one may assume that the governing load acts at the outer edge of the rail base at an inclination of H/V = 0,5. For Swedish conditions the vertical component is approximately equal to 1, 2 times the statical wheel load (max. V = 1,2 . 10 = 12 metric tons). Applied to the 101-sleeper the system of

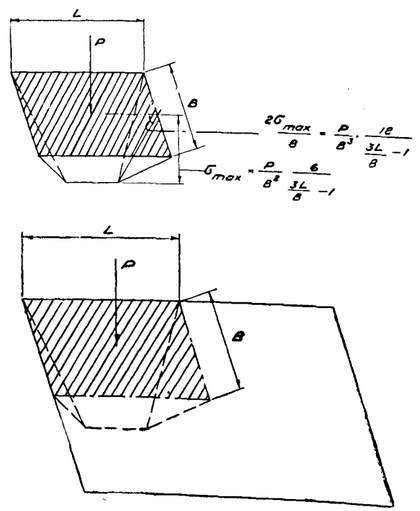


Fig. 1

load and corresponding reaction area is as shown on fig. 2. Shown is also the distribution of the reaction pressure according to professor Forssell. In the latter case, the possible effect of the foundation depth has been neglected.

For a unit weight of ballast = 1,6 t/m³ (metric tons) and D = 0,15 m. the formular of professor Brinch Hansen gives in the state of failure for $\varphi = 40°$.

$\sigma_{mean} = \frac{1}{2} \cdot 1,6 \cdot 0,452 \cdot 430 \cdot \frac{1}{1,6} \cdot 0,60$

$+ 1,6 \cdot 0,15 \cdot 430 \cdot \frac{1}{4} \cdot 1,80 \cdot 1,17 = 6 + 54 =$

60 t/m²

For $\varphi = 42°$

$\sigma_{mean} = \frac{1}{2} \cdot 1,6 \cdot 0,452 \cdot 1000 \cdot \frac{1}{1,6} \cdot 0,48$

$+ 1,6 \cdot 0,15 \cdot 1000 \cdot \frac{1}{4} \cdot 2,04 \cdot 1,17 = 11 + 144 =$

155 t/m²

The actual value is $\sigma_{mean} = \frac{12}{0,452 \cdot 0,315} = 84$ **t/m²**

The result is shown here not out of malice but to warn against an unreflecting use of the geotechnical principles which are most frequently used nowadays.

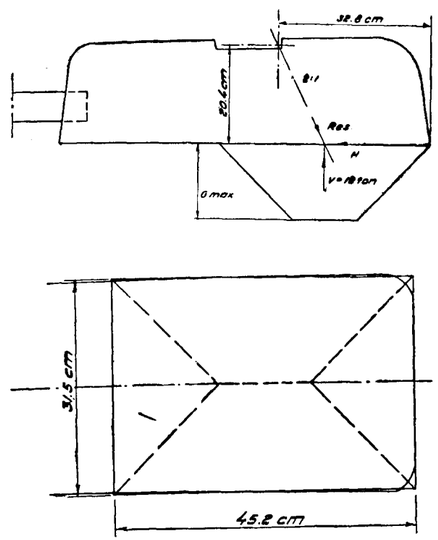


Fig. 2

Although the result for $\varphi = 42°$ was quite acceptable, the computations show, obviously, that the method exaggerate the effect of as well the internal friction as of the depth of the foundation.

Under these circumstances there is, consequently, no reason to discard the original and apparently elementary calculation of professor Forssell. According to this, the rate of increase of load intensity under a 101-sleeper block with 12 tons vertical load amounts to 1,4 kg/cm²/cm. The assumed angle of friction in the contact area between concrete and ballast is satisfactorily far below a probable max value at failure.

These figures describe an actual and working system. Based thereon, minor modifications may be introduced as changing conditions may warrant.

Yet a warning should be added. Quite regardless of formal calculations it is most likely that the internal friction of the ballast influences the carrying capacity even if it may not be to such a degree as indicated by professor Brinch Hansen. It would, therefore, without control tests be imprudent to apply experiences from sleepers on macadam ballast to sleepers on ballast composed of fine gravel.

Whether the problem "Carrying Capacity of Sleepers on Ballast" should be entrusted the science of soil mechanics or the science of rail road construction for a proper answer may be discussed. But with the present summing-up as background it may be said that the problem has not yet been treated to a conclusive and final solution.

It is hoped that the discussion about the proper classification of the problem within one scientific branch or another shall not result in it being left without anybody taking care of it at all.

The construction of the rail road bed and track, which in the coming years will absorb a considerable part of the capital investments of the young countries, is today performed in a way that would hardly have astonished George Stephenson. And that in spite of the fact that the rolling stock and the signal systems have developed beyond recognition.

For anybody who has any possibility to step in and do something this condition in itself should be a strong exhortation to act.

British Firm Builds Jet Riverboat

A 19½ ft. cabin launch, powered by a jet engine and intended for use in shallow creeks and rivers, has been built by the British firm of Graham Bunn Ltd. The launch is for an oil company working in Nigeria, where it has been found impracticable to use propeller craft. It will replace the helicopters which are being used to serve oil-prospecting installations on rivers.

The launch is powered by a Dowty-Hamilton marine jet unit with a top speed of 24 mph. It is steered by altering the direction of the jet.

The managing director of the boatbuilding company said one of the characteristics of the jet unit was that it maintained full power on tight turns when the propeller—because of the angle of the boat when turning fast—lost some of its thrust.

An Important Announcement

WE have great pleasure in announcing to all our readers and advertisers that we are incorporating a special supplement entitled INDIAN RAILWAYS CHITTARANJAN LOCOMOTIVE WORKS SUPPLEMENT along with our January-March 1962 edition. We need not very much stress the international importance of this gigantic locomotive 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 engineering works 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 locomotive engineering to our above Supplement.

The last date for receiving technical contributions is 5th January 1962. Advertisers desirous of buying advertising space in the above Supplement should intimate the fact to the Technical Editor on or before 5th January 1962 as there is very limited advertising space available.

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WHEELS, TYRES, AXLE-BOXES, BALL-BEARINGS & SPRINGS SUPPLEMENT

Reinforced Plastics Bearings in Railway Operation

By R. G. Walmsley
(Director & General Manager, Railko Limited)

IT may not be generally appreciated that most of the pioneering work on the use of Unlubricated Plastics bearings, which are to-day used by Railways throughout the world, was undertaken in India during the 1930's.

At this time considerable investigation into the effect of various materials on the hunting characteristics of locomotives, particularly the XB Class 4—6—2's, was undertaken. At this time the main requirement was increased friction and most of the materials used at that time as bogie centre and side bearer liners were derived from existing motor vehicle brake and clutch linings.

It could well be that the decision to convert these locomotives from lubricated metal to unlubricated plastics liners on the load carrying bearings, influenced the decision to fit similar plastics liners on the Stanier tank engines of the then London Midland & Scottish Railway.

During the war, manufacturers of plastics bearings were engaged on other things, but the post war building programme of the Indian Railways stimulated the development of a range of bearing materials which formed the basis of the wide range of materials available to Railway Engineers to-day. For the first time there was full and complete co-operation between the Railway and the manufacturer to develop materials with technical characteristics to suit the locomotive design. The writer looks back with pleasure to the full and frank discussions of those days with the Indian Railways Standardisation Board, and particularly with Mr. Da Costa, in London and also in Delhi and Chittaranjan.

The world-wide scale upon which these locomotives were built caused the first introduction of these materials to locomotive builders in many countries, particularly the U. S. A. and Canada, and undoubtedly did a great deal to bring the advantages of the controlled plastics bearings to the notice of engineers all over the world.

Thus, starting from a derailment in India nearly 30 years ago, has grown an industry and a science which in some measure has affected railway design. From the original bogie centre liners, applications have grown to include side bearings, horn cheek liners, draw bar measuring liners, vestibule end liners, brake-gear bushes, bearings in point and signalling systems, chair or tie pads, and a host of other applications. Outside the railway field these material find applications in many industries from steel mills to food production but it is undoubtedly the interest of the Indian Railways that kept them alive in the early days.

Even to-day, there are many who do not fully realise the very wide range of materials which are available with widely differing characteristics of friction, both static and dynamic, and new materials are constantly under development. In fact the range available to-day is so great, that for an engineer to reject the use of fabric bearings because one particular grade has not given good service, is no more logical than for him to reject all metals because a piece of brass did not work. Unfortunately, this is an attitude which exists in certain quarters. Plastics bearings have found their place alongside conventional metal bearings and their use is growing daily. The man who asserts, from little experience, that they will never be widely accepted is obviously the great-grandson of the man who said that an iron ship would never float.

One of the main considerations in the development of an unlubricated bearing material is the relationship

between static and dynamic friction. If the co-efficient of static friction is too high, the bogie or pony-truck will tend to lock, causing a build-up of high flange forces before crackoff, with consequent flange and rail wear and rough riding.

Ideally, the coefficients of static and dynamic friction should be the same, but this is rarely, if ever, attainable in practice, but the difference can be reduced to very small margins.

Loading over the bearing surface is also very important, generally speaking a material with a high static friction will also exhibit high friction tendencies under very low speed movements through a range of loading conditions. This gives rise to the phenomenon of stick-slip or stick-on in which the surfaces will move relative to each other in a series of isolated jerks rather than true slipping. This is important during the slow speed passage of points or sharp curves and is often accompanied by undesirable noise conditions.

Bearing materials, specially designed for railway operation, are widely available but it is always very advisable to know the full operating conditions when making a selection. The bare specification of a coefficient of friction is meaningless because all materials will vary widely in this respect dependent upon the loading, speed of sliding and other operating conditions, but experience has proved that materials specially chose for the job have a considerable influence upon the riding characteristics of rolling stock. On the other hand, to be asked, as plastics bearing manufacturers sometimes are, to supply a fabric in order to turn an inherently bad design into a sweet riding vehicle is stretching things a bit too far. What we can offer is unlubricated bearing materials with closely controlled friction and wear characteristics designed to suit a specific application, which characteristics will not change throughout the life of the material.

RAILWAY FREIGHT VEHICLES WITH DISC BRAKES

The first vehicles to go into regular services on any railway using disc brakes—with the wheel itself as the disc—are now running in express freight services in the U. K. The British Transport Commission says that British Railways are the first in the world with this new development in railway power brakes, and the system is to undergo large-scale trials on 212 coal wagons of three types under service conditions.

The first batch of vehicles equipped with disc brakes are 62 21-ton hopper-type coal wagons, which discharge their load through doors in the bottom of the vehicle. These wagons regularly form three express freight trains a week which run at almost passenger-train speed with bulk loads of coal from Mansfield (Nottingham) to a depot in London. Another 150 wagons, 50 16-ton mineral type, and 100 24½-ton hopper type, are also to be fitted with disc brakes.

"In addition to the principal advantage of far longer periods between brake-pad renewals, disc brakes can also achieve a more consistent braking performance, and much better heat dissipation, without the disadvantages of other thermal effects, including brake fade. All these attributes of the disc brake are of particular importance in vehicles which are operated at high speeds, but there are a number of operational problems to be overcome as well as a complete appraisal of all the costs involved before disc brakes could be considered for general use.

*** *** ***

INTEGRAL COACH FACTORY TO MAKE ELECTRIC MULTIPLE UNIT COACHES

The Integral Coach Factory, Perambur, has undertaken a new line of production—electric multiple unit coaches for the Calcutta Railway Electrification Project authorities.

The Railway Board have placed orders for the supply of 64 E. M. U. four-unit trains at a cost of about Rs. 15 crores and the first unit is expected to be delivered by the last quarter of 1962 or the beginning of 1963.

Shri K. Swarup, Chief Administrative Officer, Integral Coach Factory, said that production of electric multiple unit coaches was an entirely new line of production. With the help of the French collaborators of the Calcutta Electrification Project as well as the Factory's own Swiss collaborators, they hoped to meet this urgent request on an emergency basis.

SKF Bearing Arrangements on Locomotives and Rolling Stock

THE development during recent years of the application of roller bearings to coupling rods and axle journals on locomotives and rolling stock is described below, together with details of some bearing applications designed by SKF in co-operation with railway companies and rolling stock manufacturers.

The primary requirement of a modern bearing application is that the bearing itself should be as compact as possible, but nevertheless sufficiently robust to ensure a satisfactory life. This not only reduces the weight of the bearing assembly, but also makes it possible to fit roller bearings to older types of locomotives and rolling stock previously fitted with plain bearings, in spite of the restricted space available.

The SKF Spherical Roller Bearing was redesigned some years ago, and the new type—the C-design of spherical roller bearing—whilst having the same boundary dimensions, had considerably greater capacity than that of the previous design. A smaller bearing can thus be used for a given load without reducing the life of the assembly, and smaller axleboxes in narrower horn guides are now possible. C-design bearings may also be mounted in locomotive coupling rods, where the earlier design was precluded, because of its weight, and the limited space available.

The first C-design bearings were manufactured ten years ago, and about 100 were fitted into axleboxes of passenger coaches and goods wagons, for trial purposes. Axlebox bearings are subjected to heavy loads under unfavourable conditions, and it was therefore considered that a test of this kind would quickly provide useful information. Amongst the vehicles so fitted were sleeping cars on the Stockholm—Narvik line, and these have to date covered 2 000 000 Km. (1 200 000 miles) free from defect, and are still in service.

Cylindrical roller bearings have also been used in axleboxes to an increasing extent. These bearings are wider than spherical roller bearings for a given application, and are used where axial float is required. The axleboxes in such cases often incorporate a ball bearing to take the axial thrust loads, sometimes damped by rubber buffers, helical springs or belleville washers.

Although the day of the steam locomotive with its coupling and connecting rods may soon be over, and other types of locomotive are being constructed in increasing numbers, some steam locomotives are still being built. Certain types of diesel and electric locomotives are fitted with coupling rods, and, in the case of diesel locomotives, these offer a distinct advantage since they are easier to dismount than the final drive gearbox used with cardan shaft drive. Roller bearing assemblies have been used in coupling rods since 1930, and are now used extensively in steam, diesel and electric locomotives.

The first application incorporating C-design bearings was in May 1953, on a D-306 type locomotive of the

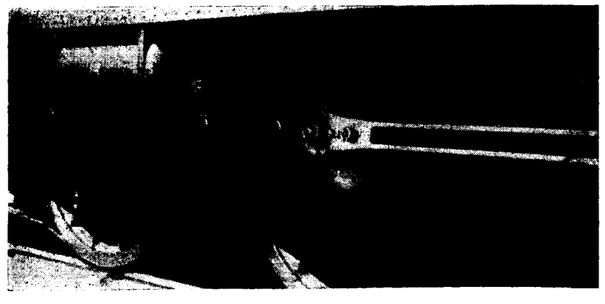


Fig. 1.

Swedish State Railways, see Fig. 1. The bearings were fitted in the normal plain bearing rod, but the crankpins were of smaller diameter than those for plain bearings; this was possible because of the reduced stresses in the journal, since the narrower bearing gave a lower bending moment on the pin. The roller bearings are still in service on this locomotive, and the bearing scheme is shown in Fig. 8. At about the same time the coupling rods and driving crank pins of another D-class locomotive were fitted with roller bearings, see Fig. 3. The driving pin bearing arrangement incorporated a guide ring to prevent the coupling rod from tilting. This locomotive is still in operation with the original bearings.

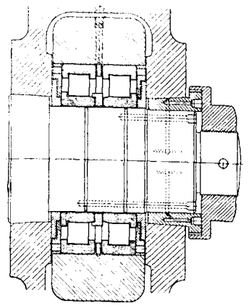


Fig. 2.

Fig. 3.

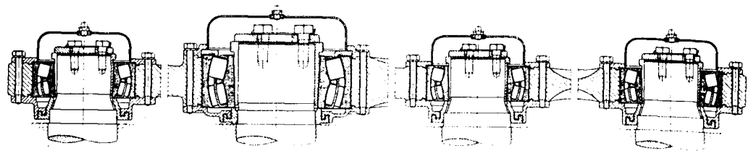


Fig. 4.

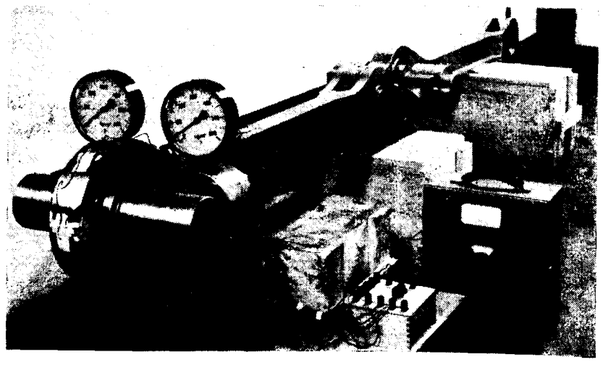


Fig. 5.

As a result of these successful tests, all the Da type and Ud type locomotive subsequently ordered by the Swedish State Railways—a total of 109 new locomotives—had their coupling rods fitted with roller bearings, the basic scheme being shown in Fig. 4. In addition to this, all Da type locomotives previously built, were converted to roller bearings. Before the details of the application were finalised, coupling rods, with the bearings fitted, were subjected to laboratory tests to ascertain the load distribution within the bearings, and to obtain data covering the design of the coupling rod ends. Rods were subjected to loads which varied from zero up to 40 tons for the larger rod, shown in Fig. 5, and up to 20 tons for the smaller rod.

Similar bearing scheme have also been produced for steam locomotives in Finland, and Fig. 6 shows a locomotive fitted with roller bearings on all crank pins. The assemblies

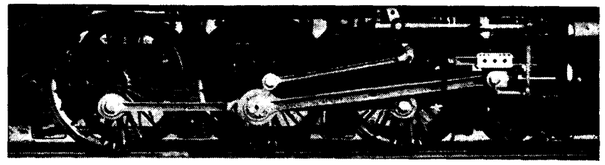


Fig. 6.

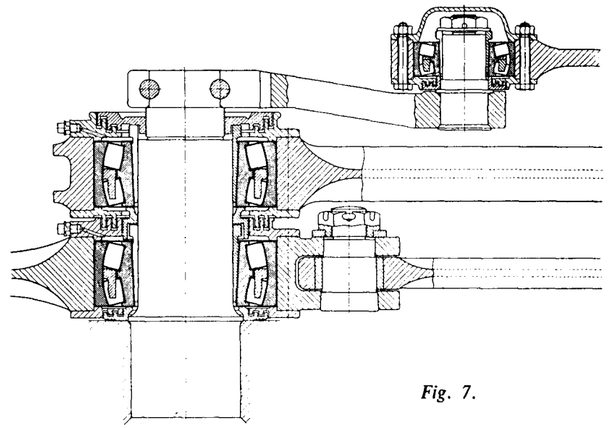


Fig. 7.

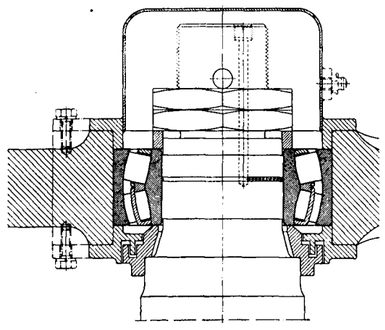


Fig. 8.

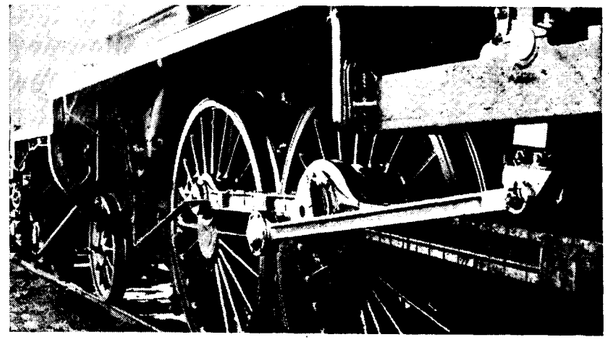


Fig. 9.

used on the main crank pin and on the return crank are shown in Fig. 7. A section of the crosshead is shown in Fig. 2, and it will be seen that the gudgeon pin is fitted with cylindrical roller bearings.

In previous tests on rods only static measurements had been taken, but when the opportunity presented itself, measurements were taken by means of strain gauges on the connecting and coupling rods of a locomotive in service. Figs. 9 and 10 show how the leads were secured in position; a junction box, from which the cables were led to the car containing the recording equipment, can be seen adjacent to the trailing wheel.

These rod bearing arrangements are only a few examples out of many applications featuring the

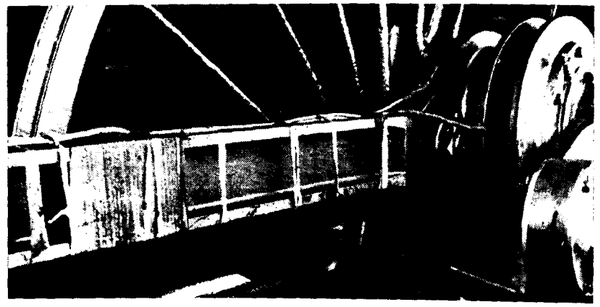


Fig. 10.

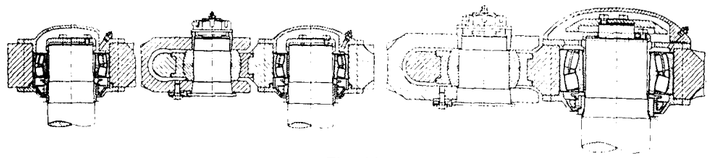


Fig. 11.

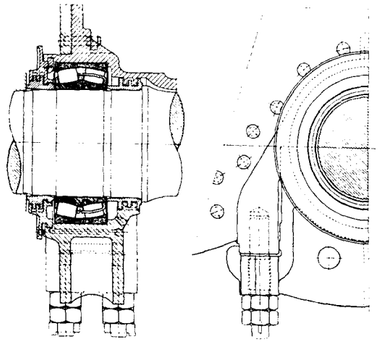


Fig. 12.

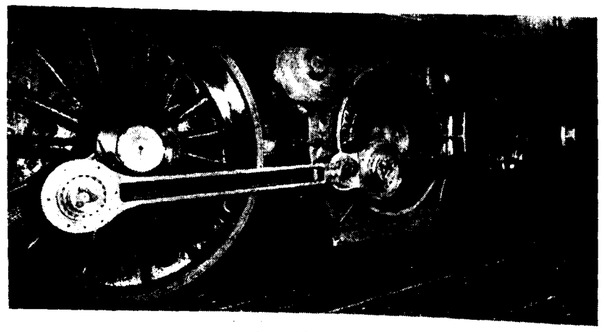
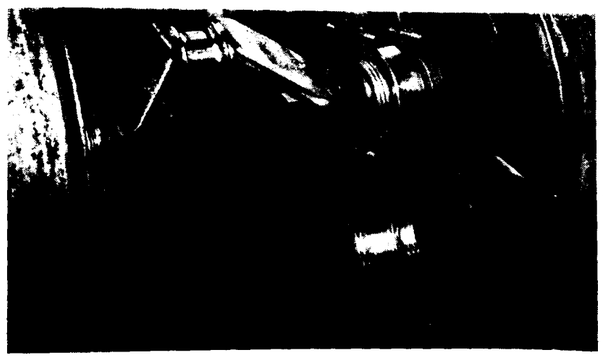


Fig. 13.



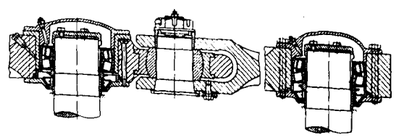


Fig. 14.

C-design spherical roller bearing, and it is interesting to note that these applications have proved satisfactory even in cases where the application of bearings of other types supplied by other manufacturers has been unsuccessful.

Another interesting bearing assembly has been applied to a series of locomotives, the axles of which have lateral movement controlled by Beugniot levers. These locomotives have all their crank pins fitted with roller bearings, as shown in Fig. 11, and

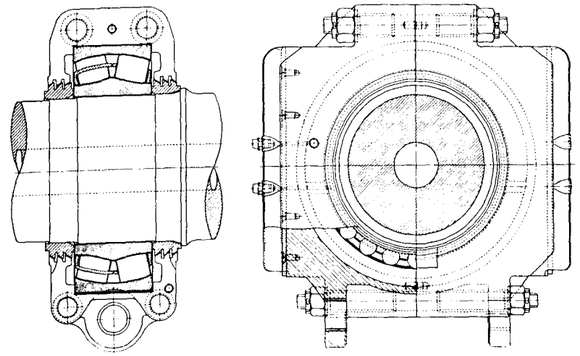


Fig. 15.

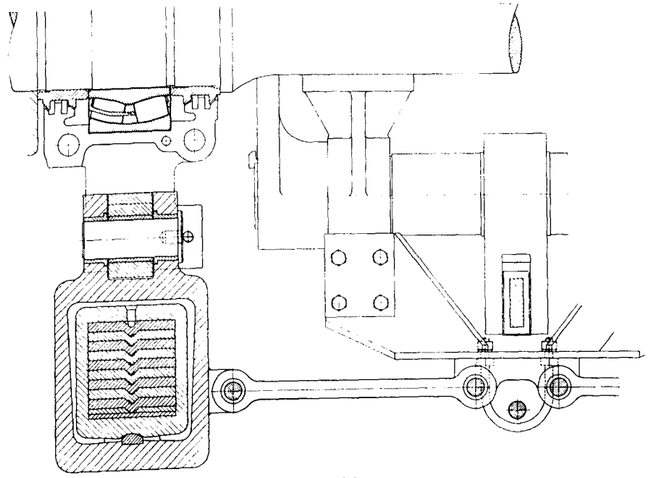
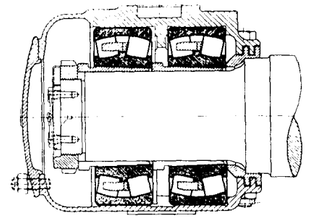


Fig. 16.

Fig. 17.



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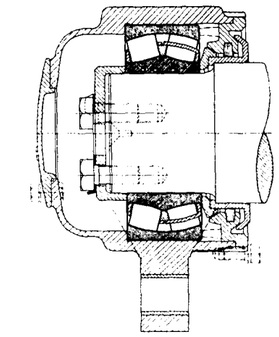

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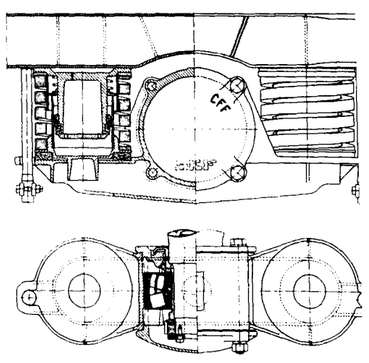

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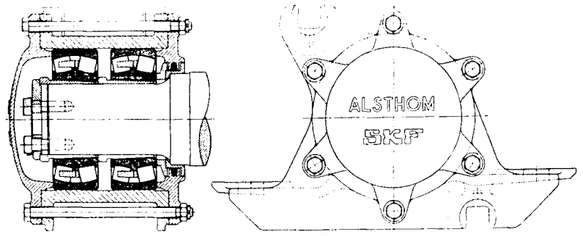


Fig. 21.

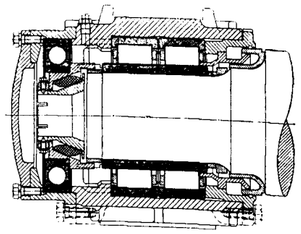
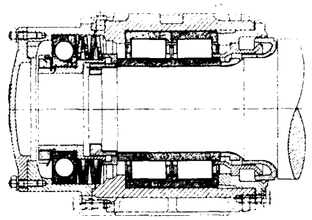


Fig. 22.



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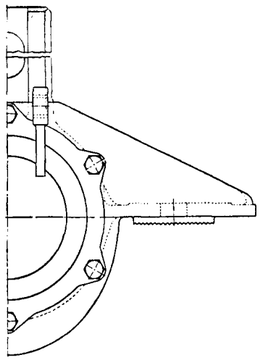

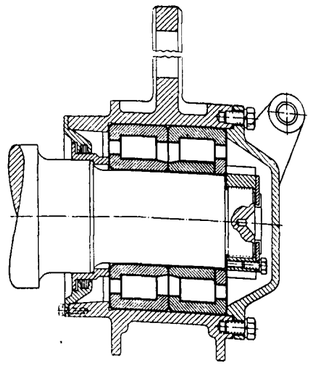

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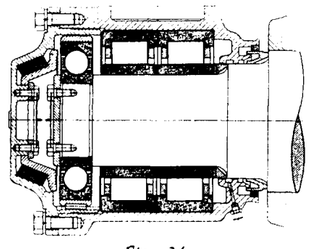


Fig. 24.

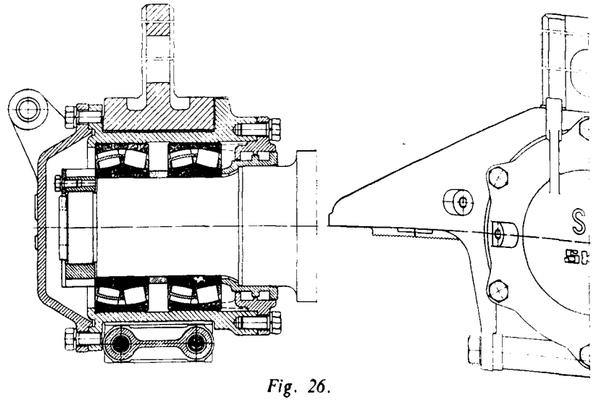


Fig. 26.

the design allows an axial displacement of the axles of ±22 mm. (0.86 inches). The coupling rods are driven by the jackshaft flycranks.

In designing the bearing assemblies for a jackshaft, the designer is frequently restricted in the space available, but this problem has been successfully overcome by using C-design spherical roller bearings. Dm and Da type electric locomotives have been so fitted and all locomotives of these types ordered recently will have their jackshafts carried in roller bearings : in addition, all existing locomotives fitted with plain bearings, will be converted to roller bearings. The jackshaft bearing assembly used on the Da type electric locomotives

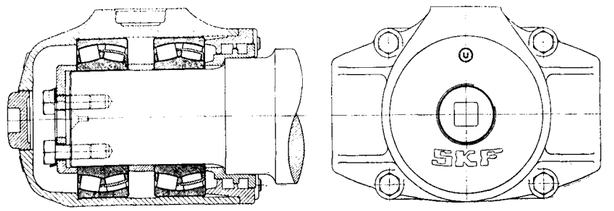


Fig. 27.

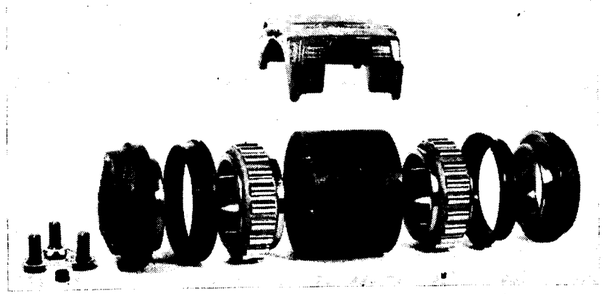


Fig. 28.

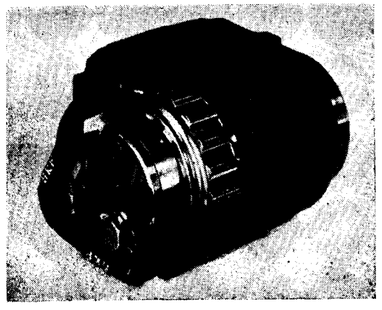


Fig. 29.

is shown in Fig. 12, and the bearing assemblies for the wheel and flycranks pins are illustrated in Fig. 13.

Because of restrictions on space, the axleboxes used on rigid-frame locomotives, are usually split vertically and Figs. 14 and 15 show a typical example of this design.

In cases where it is necessary to provide for axial displacement of a locomotive axle, the arrangement used in Fig. 16 may be used. The design incorporates spherical roller bearings, and an axial displacement of ±20 mm. (0.79 inches) is permitted by allowing the axlebox and its stirrup to swing about the spring buckle. Where greater axial displacement is required the arrangement shown in Fig. 17 may be used, this example being taken from the new Dm type electric locomotive, where the displacement is ±30 mm. (1.18 inches). It will be seen that the swing link pins are carried in rubber bushings, and it is worthy of note that the axlebox body is made of spheroidal graphite cast iron (S. G. iron), which is being used increasingly in such applications.

Typical axleboxes of conventional design, incorporating spherical roller bearings, and suitable for bogie locomotives, are shown in Figs. 18, 19, 20 and 21. Where axial freedom is required, cylindrical roller bearings are normally used, Fig. 22 illustrating a design in which a rubber buffer is fitted to absorb the axial shock loads. This buffer is replaced in some cases by Belleville washers as shown in Fig. 23, or by helical springs. The axlebox illustrated in Fig. 24 is suitable for a 170 mm. (6.7 inch) journal, and since the thrust loads in this case may amount to 30 tons, a heavier rubber buffer is incorporated.

Axleboxes using cylindrical roller bearings, as described above, have been used on passenger coaches, and Fig. 25 shows a design used on the Minden-Deutz bogie in Germany. Should it be necessary to change a wheel and axle set equipped with these axleboxes, however, the alignment of the axles must be readjusted, and, to obviate this, the alternative design shown in Fig. 26 has been developed. This has been tested in Sweden and will be used on a large quantity of coaching stock. The axlebox has a body casting of cylindrical form and uses twin spherical roller bearings. The cylindrical body is carried in a housing secured to the bogie suspension system, and is retained by a tie bar across the opening at the bottom of the housing. A rubber pad and clearance between axlebox and housing permit a displacement of ±1.5 mm. (0.059 inches). When the tie bars have been removed, wheel and axle sets complete with axleboxes may be changed without interfering with the alignment of the axlebox housings, and no adjustment is therefore necessary.

So far as the European market is concerned, axleboxes for goods wagons have been largely standardised and the Union Internationale des Chemins de Fer, (U. I. C.) axlebox shown in Fig. 27 is in general use. This axlebox is suitable for a journal diameter of 130 mm. (5 inches) and for an axle load of 20 tons. Some 270 000 of these axleboxes have been supplied to date.

A new design of bearing unit for goods wagons is now being used, however, and although chiefly applicable to the American market, it is also being tested under European conditions. These bearing units, one of which is illustrated in Figs. 28 and 29, consist of an outer ring, two inner rings with rollers and cages, two rubber seals, an inside collar, an outside cover, securing bolts and a saddle. They are supplied in sizes suitable for journal diameters of 4½ to 6½ inches, and for axle loads of 11 000 to 27 000 Kg. (10½ to 26 tons). External dimensions of the units, and the dimensions of the seatings in the bogie side frames have been standardised, to permit interchangeability between units supplied by different manufacturers. Figs. 30 and 31 illustrate bogie equipped with these bearing units.

Primary suspension by means of rubber in shear and compression has been adopted for both locomotives and rolling stock. The axleboxes used are equipped with either single or twin roller bearings, and Fig. 32 shows a typical example, the rubber units being mounted obliquely between the axlebox and the vehicle frame.

Axleboxes similar to those described in this article have been designed for locomotives with axleloads of up to 30 tons, and for rolling stock with axleloads of 27 tons.

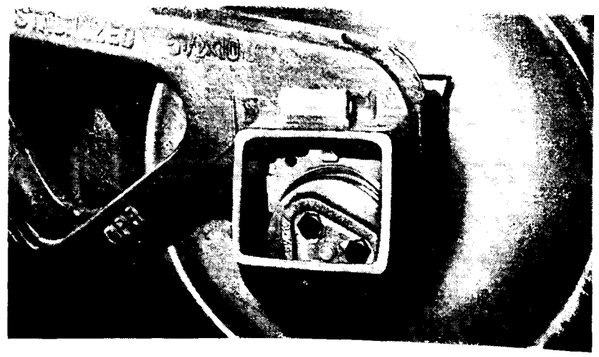


Fig. 30.

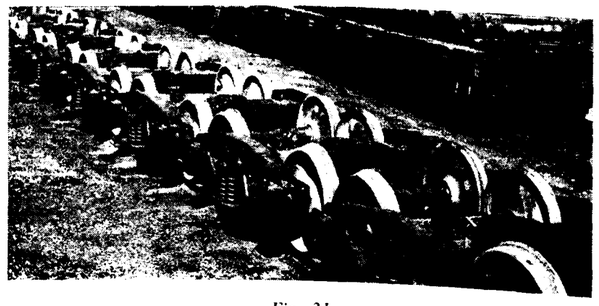


Fig. 31.

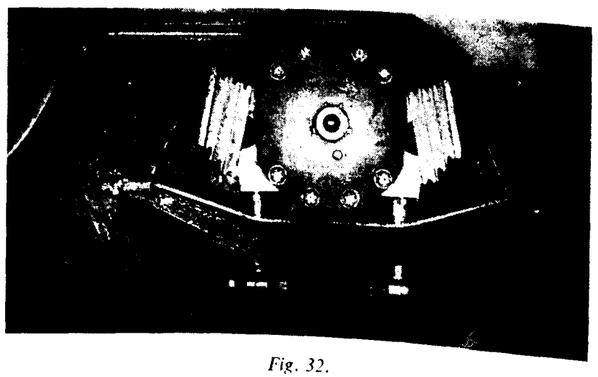


Fig. 32.

The number of SKF axleboxes supplied up to and including 1960 is as follows :

Axleboxes for steam locomotives	Approx.	100 000
,, ,, electric locomotives	,,	25 000
,, ,, diesel locomotives	,,	15 000
,, ,, motor coaches	,,	150 000
,, ,, passenger coaches	,,	400 000
,, ,, goods wagons	,,	960 000
,, ,, tramcars	Approx.	1 650 000
	Total approx.	100 000
		1 750 000

Another 75 000 axleboxes were on order as per Dec. 31st, 1960.

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.

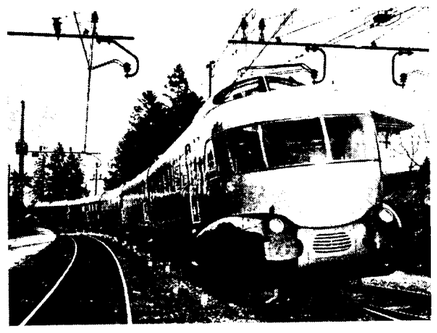
— Safer operation.

— 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 anti-friction bearings.

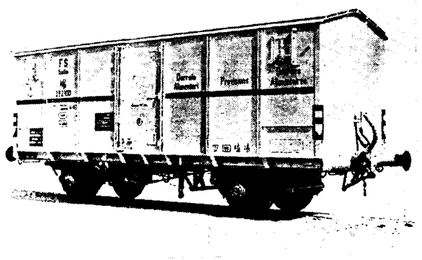
And the payloads to which, under particular emergency conditions, we have seen many cars subjected, point up the fact that the second problem, too, has been successfully solved.

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

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

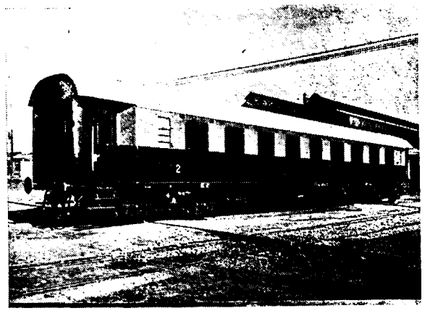
As to the remaining counts, railway statistics speak for themselves, particularly so on the score of maintenance, because with modern equipment overhauls have been spaced very much apart, without any maintenance operation, even of a checking nature, being required over the long intervening period.

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

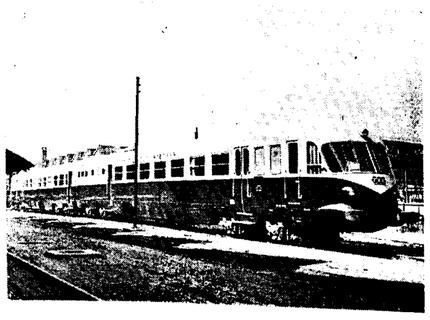


British-form refrigerator car type "Hgb" series 390,000 of the Italian State Railways, with RIV Tr. 191 taper roller bearing axle-boxes.

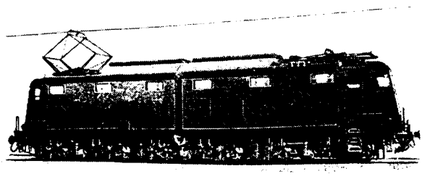
FIAT railcar set for the Indian Railways with axle-boxes, traction motors and transmission gear equipped with RIV antifriction bearings.



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



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



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

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

ROLLER BEARING AXLE-BOXES

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

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

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

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

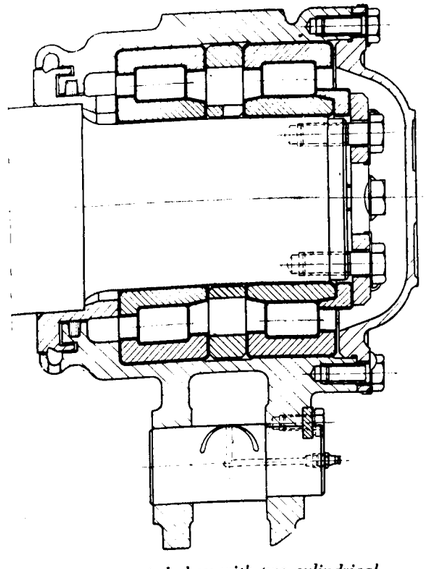


Fig. 1. Axle-box with two cylindrical roller bearings.

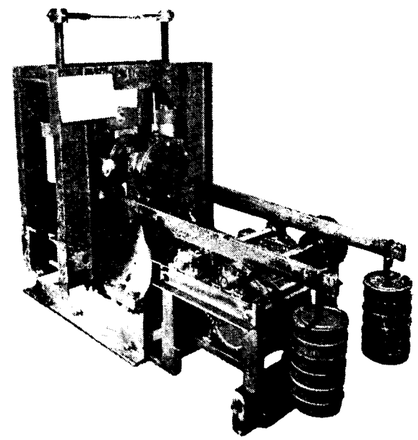


Fig. 2. Machine for testing railway axle-boxes under load.

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

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

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

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

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

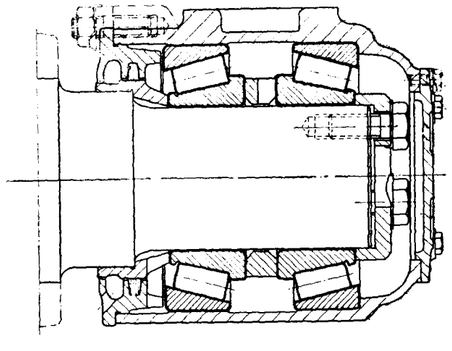


Fig. 3. Axle-box with two taper roller bearings.

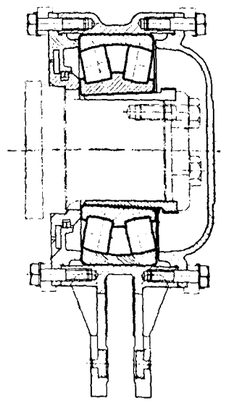


Fig. 4. Axle-box with one self-aligning bearing.

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.

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

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

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

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

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

VARIOUS ANTIFRICTION BEARING APPLICATIONS

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

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

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

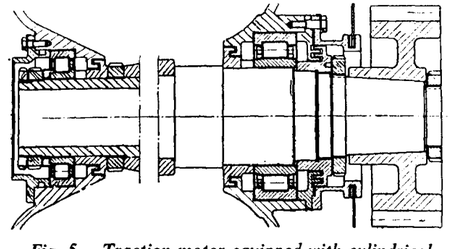


Fig. 5. Traction motor equipped with cylindrical roller bearings.

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

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

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

In reduction gears—which have now gained favour with most designers because they permit of locating the motor axles far away from the drive axles as desired and of obtaining certain rather high transmission ratios in a simpler way—the high speeds and

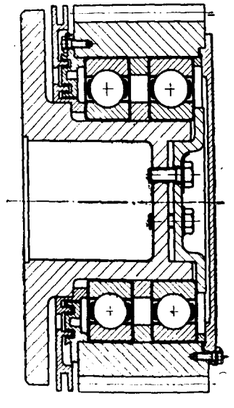


Fig. 6. Reduction gear for locomotive.

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 existing coils, has now solved the problem in all respects ; ball bearing equipped reduction gears require no maintenance between overhauls.

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

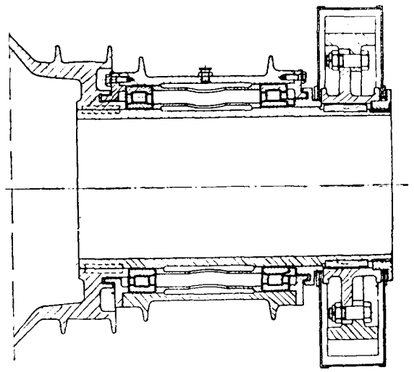


Fig. 7. Roller Bearings fitted on hollow axle of electric rail car.

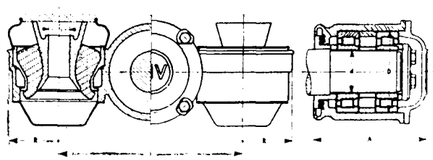


Fig. 8. Rubber springs fitted to a railway axle-box.

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

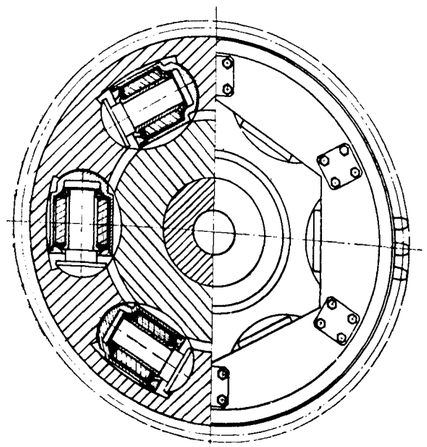


Fig. 9. Silentbloc flexible transmission.

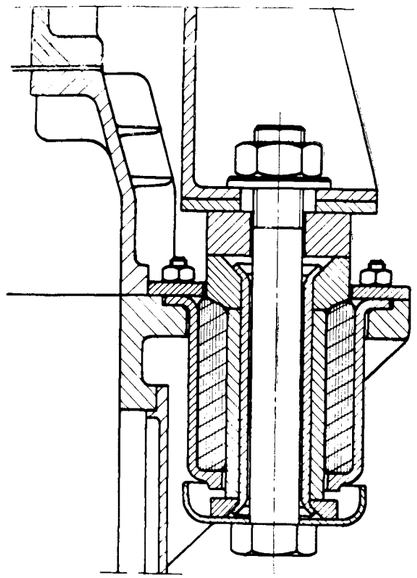


Fig. 10. Motor suspension equipped with antivibration mountings.

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.

A typical application is that in *Fig. 11*, which refers

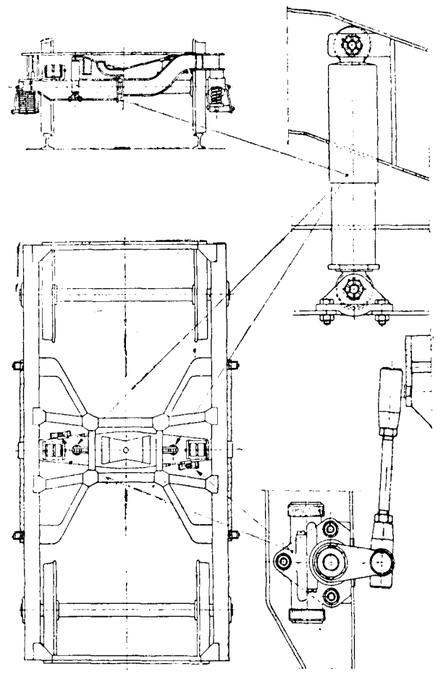


Fig. 11. Shock absorber arrangement on rail car bogie.

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.

PNEUMATIC TYRES FOR RAILWAYS

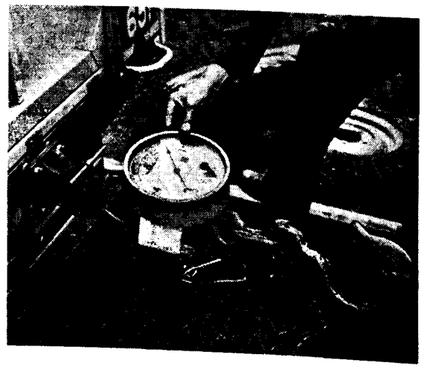
By An Engineering Correspondent

FOR more than 30 years, railway engineers and designers have been considering the application of the pneumatic tyre principle to rail transport. There are two obvious reasons for this; possible reduction in noise, and increase in comfort. However, there are a number of interrelated advantages and difficulties which made the project particularly interesting.

The increase in comfort is probably the least important factor, as the degree of comfort obtained in modern trains is already quite high, but the reduction in noise is much more important, not so much from the point of view of aural comfort, but because noise is the result of vibration. Vibration is one of the biggest problems in the design and manufacture of rolling stock, locomotives and track, and the high speeds possible today aggravate this to a great extent. In addition, the new use of long continuous lengths of welded rail increases this vibration problem to an even greater degree. The regular rail joints in the old type of track, serve to break up high frequency vibrations set up by steel wheels running at speed. Without these joints, the vibrations may build up and lead to hidden and premature failures. Consequently the majority of railway rolling stock has to be built to "Battle ship" specifications and weights are usually considerable.

If it were possible to tame this vibration problem it would also be possible to build rolling stock to a much lighter specification, making more use of modern light alloys and new construction methods. This reduction in weight would, for any given available tractive effort, either increase the effective payload, or the possible maximum speed. Pneumatic tyres would provide an attractive and ready made solution to these problems, could they be easily applied to railway vehicles.

There are however, a number of difficulties in their application. The effective contact area of a wheel running on a standard rail is much smaller than that of a tyre running on an ordinary road, so that the load per square inch of contact area for any given weight of vehicle is much higher. Normally a tyre relies on being able to spread its load and the direct use of pneumatic tyres on rails would necessitate a reduction in the load carried by each wheel. To some extent this could be overcome by the reduced weight of the rolling stock permitted by the elimination of vibration. One of the big disadvantages lies in the amount of necessary maintenance and the provision of adequate safety precautions. A steel wheel requires no maintenance other than periodic checking for flaws, but a



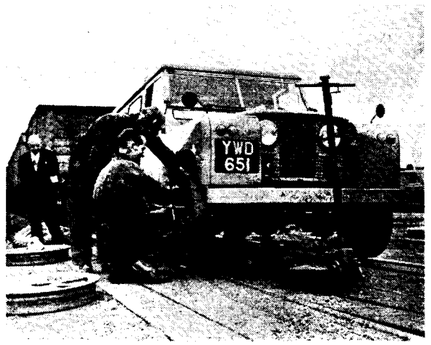
Testing drawbar pull on the Land Rover conversion.

pneumatic tyre must have its pressure regularly and accurately maintained. In addition there is the danger of punctures, for which allowance must be made, although they are, perhaps, unlikely in railway use. The rubber tyre, being a natural insulator, would obviously not operate track circuits in the normal manner, but this can be easily overcome by providing suitable contact brushes.

The first experiments, by Andre Michelin, using rail-cars, took place as early as 1929 and three different systems have been evolved and operated in France. The first system was applied to express trains running between Paris and Strasbourg. Here pneumatic tyres, of the type constructed with steel cord plies, were backed by steel flanges to give a suitable railwheel. The load capacity problem was overcome by fitting more than double the usual number of wheels per bogie, and in addition four small, flanged, safety wheels were provided as a safety precaution in the event of the failure of a number of the tyres.

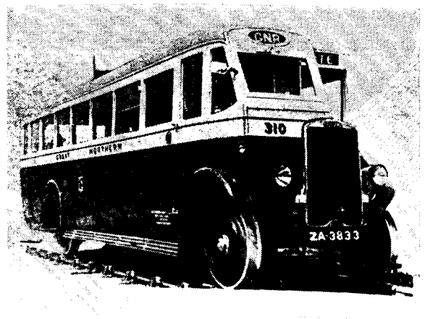
The other two French systems have both been applied to the Paris Metro and are rather similar in principal. Both require a special track, one running on ordinary commercial vehicle wheels and tyres on a concrete track, guidance being provided by horizontal wheels running either side a single central rail. The other Metro system again uses horizontal guide wheels, but this time running on two special rails immediately outside the conventional track. Flanged steel wheels are retained as a safety feature in the event of deflation and for use in the negotiation of all junctions and crossovers.

These three systems, through the reduction in weight which they permitted, and, the increased traction "grip" due to the rubber tyres, gave considerable increases in average operating speeds, or economics in motive power; but while suitable for restricted use on special routes, their constructional complications probably preclude their general adoption.



Duthane rail tyres being fitted to a Land Rover for testing.

Obviously, a preferable system would be one utilising existing track and not having undue constructional complications. A step in this direction was taken by the Dunlop Rubber Company working in conjunction with the Great Northern Railway in Ireland. The system was originally developed for the adaptation of normal road buses into rail cars. In this case the tyre does not itself run on the rail. A flanged steel rim with deep internal circular grooves is placed around a pneumatic tyre in the circumference of which are moulded corresponding circumferential ribs. Inflation of the rubber tyre forces these ribs into the grooves inside the flanged steel tyre, locking the two securely together. Thus we have, in effect, a steel wheel with a cushion of air between itself and the axle. It was found in operation that the service life of this method of construction approached that of the solid steel tyre.



One of the original G.N.R. – Dunlop rail coaches.

However, an interesting new development now taking place is the experimental use of Dunlop Duthane solid tyres on a road-rail conversion of the well-known Land Rover. These polyurethane solid tyres are fitted to a Land Rover, specially converted by Associated Locomotive Equipment Ltd., to enable it to run either on road or rail. The material sufficiently damps out the vibration which, in railway use, would render the direct conversion of a road vehicle difficult, if not impossible. The load potential is three or four times that of natural rubber and the resistance to abrasion up to five times greater. Some of the biggest problems associated with the railway use of conventional pneumatic tyres would thus appear to have been overcome to a large extent and, in addition, Duthane solid tyres have a wheel-to-rail adhesion factor more than three times better than ordinary steel wheels. Tracking is improved too, that is, the vehicle's ability to follow the track contours without "fighting" them and yawing from side to side within the wheel flange limits, is better and a smoother ride results.

Prototype vehicles are already in existence and the results obtained seem to promise a considerable future for these solid, resilient rail tyres.

Once the problems, which though difficult, are certainly not insurmountable, have been solved some form of resilient tyre is almost certain to be widely adopted for rail use. With the large variety of new materials available today it would seem to be only a question of time.

CRANES, TRAVERSERS, HOISTS, CONVEYORS AND MECHANICAL HANDLING EQUIPMENTS SUPPLEMENT

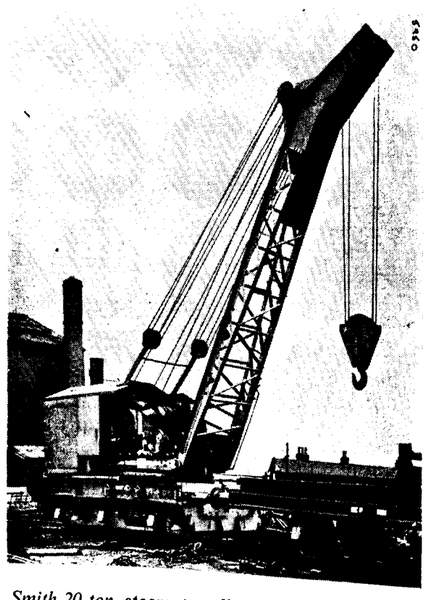
SMITHS—SERVANTS OF THE RAILWAYS

By An Engineering Correspondent

FAMILIAR sights on Indian Railways are the rail cranes manufactured by the British Firm of Thomas Smith & Sons (Rodley) Ltd., which is known, throughout the world, by the simple title of "Smiths of Rodley". More than 150 Smiths rail cranes have been supplied for service in India. What many Indian railwaymen may not know, however, is the very close link which this famous old firm has with the earliest railways of all, nor will many of them realise that the firm of Smiths was in existence even before 1825, when the first public railways system in the world was inaugurated.

Students of railway history will know, without any reminder, of the Stockton—Darlington railway and will know, too, that these towns are located in the North East of England. Only about fifty miles from Darlington lies the village of Rodley. When Stephenson was building his "Rocket", a man named David Smith was building at Rodley, with the help of two partners, machinery for cutting and shifting rock in the local quarries. A few years later, Thomas, the son of David Smith built the first Smith crane and from that point onwards Smiths became very closely associated with the development of railways in Britain. Cranes were needed not only for the construction of railway lines but also in the locomotive building sheds and in the actual operation of the railway systems themselves. Thus it is that this famous old firm has always identified itself with railway construction and operation and it is not surprising that this association should have been continued in many other parts of the world, of which India is but one. Because of this close link, Smiths have always been, and are still, completely familiar with requirements and able to design and supply machines which are ideally suited to the work they are called upon to carry out.

As every engineer knows, standard machines are not always suitable for special jobs and Smiths have always been able to say, with justifiable pride, that if there was no machine in their current range of productions which would cope with some special job, then they would set to and build one! An example of this occurred during the construction of Bombay Harbour. Cranes were required to lift 25-ton concrete blocks at 55-ft. radius on railway lines with a gauge of no less than 11-ft. Smiths quickly produced machines to tackle this job—no mean feat—for the cranes themselves weighed 175-tons!



Smith 20 ton steam travelling crane and match truck photographed after testing at our Rodley works prior to being delivered to the Indian State Railways.

A much more recent example of special construction work lay in the demand, by a British chemical firm, for a special crane to unload chemicals from ships' holds into railways wagons. The wharf at which this operation takes place is of timber construction and it was therefore essential to spread the great weight of the diesel-electric rail crane over as long a rail length as possible. Smiths designed and produced a machine having four bogies, each of two axles, which dealt with the work admirably.

It is not only in connection with railways that Smiths have produced cranes with historical associations. In 1898, for example, they supplied large numbers of steam travelling cranes, to lift four tons, for the construction of the Great Assouan Dam, across the Nile, 600 miles south of Cairo. This great barrage, when completed, used masonry to a total weight exceeding one million tons. The production of these steam cranes kept Smiths busy for several years!

Earlier than this, in 1887, Smiths contracted for the important task of supplying the steam travelling cranes necessary for the construction of the Ship Canal, between Liverpool and Manchester, which was to open up Manchester to the sea, 35 miles away, and to make it Britain's largest inland port, capable of dealing with great ocean-going vessels, as it is to this day. To produce these cranes, Smiths actually opened a special factory. More than 70 years ago such enterprise was rare indeed, but to Smiths it was merely a part of their already established tradition that the needs of the customer were of paramount importance.

In 1929, Smiths were called upon to produce a special crane for use in the widening of the single-span railway bridge across the Zambesi River in the heart of Africa. One of the stipulations laid down by the contractors was that the crane should be *guaranteed* not to break down. Needless to say, the machine, a steam locomotive crane lifting 7-tons at 20-ft. radius, never gave its operators a moments anxiety; yet there can be few firms who have been called upon to face so exacting a requirement in what was, after all, a commercial machine.

One could go on, almost indefinitely, instancing historical or other interesting examples of the way in which Smiths machines have been associated with various great enterprises, but considerations of space forbid. It is sufficient to say that today one finds Smith machines employed on the construction of nuclear power stations, or of the vast, new motorways now taking shape in Britain. In other parts of the world too, they are playing their vital part in enterprises of great note. And yet, in spite of all the demands which the modern world has brought for machines to "lift and shift", Smiths have remained always in the closest touch with railway development in all parts of the world and have continued to produce machines specifically designed for service on the world's railways. Today, diesel and diesel-electric power have largely replaced steam but, in addition to making the fullest use of these newer forms of motive power, Smiths still produce steam cranes and will continue to do so as long as any demand exists for them.

A fairly recent development is that of the truck-mounted crane, which has opened up a vast, new field of employment for lifting machinery. This consists of a crane, mounted upon a truck chassis, which may be taken anywhere by road at considerable speed and without inconvenience to other road users. Smiths produce two of these machines. The M.E.I. has a capacity of 22½-tons when employing a 30-ft. boom at reasonably short radius but also employs booms up to 100-ft. in length, with the option of using a fly jib of a further 30 ft. thus giving it the ability not only to reach out over a great distance but also to lift to a great height. The value of such a machine on all types of constructional work will be self-evident. The M.E.I. is a smaller machine, with a maximum lifting capacity of 10-tons. Both these machines are becoming extremely popular and already a number of them have been exported to some of the sixty-nine countries in which Smiths are represented.

Dockside cranes too have long been a special feature of Smith production and a great many types are produced at the Rodley factory but, since the nineteen-twenties, there has been another development which has assumed a steadily-increasing importance. This is the production of excavators of various types and, since many of these are employed for such work as the digging of railway cuttings and in the loading of rail freight, mention of them will not be out of place. Machines of up to ¾ cu. yd. capacity are produced and they are so designed that they may be utilised for a great many purposes connected with the digging, lifting or shifting of bulk material such as earth, sand, coal, gravel, limestone etc. etc. Mounted on crawler tracks of the caterpillar type, the machines are both mobile and versatile in the variety of duties which they can be called upon to perform. A variety of attachments is available, so that the machines may be converted for use not only on a number of different types of digging operations but also for pile-driving and for crane work.

With such a variety of productions and with such a vast exporting programme (total exports amount to almost 50% of total production), one of the problems facing such a firm as Smiths is that of servicing this equipment. They are now, as has been mentioned, represented in nearly seventy countries, chiefly by agents who have made a close study of the requirements in this particular field and who are able to help users and potential users to the fullest possible extent, not only in obtaining suitable equipment but in servicing and maintaining it thereafter. In India, Smiths are represented by Marshall, Sons & Co. (India) Ltd., of 33/1, Netaji Subhas Road, P.O. Box 22, Calcutta 1. This firm also has branches in New Delhi, Bombay Madras and in Colombo, Ceylon. In addition it has Associates in the United Kingdom and, through this widespread organisation, it is admirably placed not only to maintain close contact with Smiths but to provide excellent service and advisory facilities throughout India.

BOMBAY RAILWAY SIGNAL & TELECOMMUNICATION SOCIETY CONVENTION

The annual convention of the Bombay Railway Signal & Telecommunication Society was held on 20th and 21st February, 1961, at the Headquarter Office, Western Railway, Churchgate. The convention which was presided over by Shri S. S. Ramasubban, General Manager, Western Railway, was attended by members and officers of the operating and engineering departments of the Central and Western Railways.

Shri K. C. Pathak, Government Inspector of Railways, Bombay, who was the principal speaker on the first day, commenced the proceedings with his subject "Various Types of Signalling on the Indian Railways and their compatibility with the General Rules". He dealt with the evolution of Multiple Aspect Upper Quadrant Signalling on the Indian Railways and traced its growth from the early days. when this was installed on the Metre Gauge sections of the Assam Railway, to the present day extensive adoption on the Broad Gauge of the Central and Western Railways. He pointed out that normally the rules for Multiple Aspect Upper Quadrant Signalling should have been included in a self-contained chapter instead of being sand-wiched in the existing General and Subsidiary Rules which were primarily meant for Lower Quadrant Signalling. During the course of his lecture he also dwelt on the basic requirements of Colour Light Signals employed with Automatic Signalling and pointed out a few cases where the improper location of signals had resulted in accidents. Shri S. S. Ramasubban dealt with the merits of Two Aspect Lower Quadrant Signalling and Multiple Aspect Upper Quadrant Signalling and called upon the Signal Engineers to judiciously employ them taking all factors into consideration.

The meeting concluded with a vote of thanks by Shri G. R. Pathak, Chairman of the Society and Chief Signal & Telecommunications Engineer, Western Railway.

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HINDUSTAN AIRCRAFT TO BUILD BOGIES

The Hindustan Aircraft Factory, Bangalore, will manufacture its completely Indian-made integral railway coaches from May, 1961. Announcing this, Air Vice-Marshal Rajan Dutt, told pressmen that at present the Factory manufactured all the parts except bogies which were still imported. After May 1961, it would stop importing bogies also and manufacture them in the country.

The rail coach manufacture was nine months ahead of schedule and nearly 25 coaches a month were now being rolled out of the Factory, he said.

The manufacture undertaken with the technical collaboration of the German firm "MAN", was first started with assembly from imported parts and gradually indigenous components were increased.

In the last one and a half years since the scheme was undertaken, 330 coaches had been delivered to the Railway Board. He claimed that the design of the bogies of the "MAN" coaches was the best in the world.

The factory, before undertaking this project, was also manufacturing coaches of a different type (Model 407) and had delivered 1,565 of such coaches to the Railways.

Modern Crane Installations for Power Stations

By An Engineering Correspondent

OWING to the ever-increasing power requirements noticeable all over the world, closest attention is nowadays given to the problem of enlarging the capacity of power plants. There is no mistaking the trend towards the installation of ever bigger generating sets with their high efficiency ratings. In keeping with this development the designed hoisting capacity of the cranes must be raised continuously, as the weight and size of the various plant elements is also steadily being increased. Power station cranes with a lifting capacity of 120 tons, 150 tons or even in excess of these values are no longer considered a rarity.

The cranes used in power stations may be divided in accordance with their intended function into two major groups. One of these groups, known as power station cranes, is used for the assembly, disassembly and maintenance of the mechanical and electrical equipment of the power stations. The other group of cranes is used to bring up fuel and other materials required in order to operate the plant, for their transport within the plant, and for the disposal of residual products and waste materials. To this group belong the grab cranes used for charging the bunkers in steam power stations, the gantries for the fuel storage yards, the manipulators for the transport, temporary storage and the insertion of fuel rods and moderators in atomic power plants and many others. The development of power station cranes is characterized by the striving for an optimum adaptation of working speeds to operational requirements, by providing for variability of hoisting speeds and for the incorporation of sensitive controls in order to assure the secure installation and shock-free lowering in the mechanical and electrical components which in most cases are rather expensive. One may further notice the tendency to produce cranes of low dead weight, since this enables a reduction of the cost for the crane tracks which very often are of considerable length. In addition there is an increasing demand for the design of such cranes in a pleasing way that conforms to the overall architectural design of the station. Fig. 1 shows a powerhouse crane of 100 ton capacity, delivered to an Australian power station. This crane was designed as an all-welded solid-wall construction, which has a lower dead weight than comparable riveted crane girder constructions. In many cases the auxiliary supports may also be designed as solid-wall carriers of low girder height, thus giving the crane bridges an even more unobtrusive appearance.

Fig. 1. Powerhouse crane in powerstation Imst (Austria) carrying capacity 100 tons

Depending on the type involved, cranes in hydro-electric power stations may very frequently have very diverse tasks and functions. The powerhouse cranes for high-pressure and medium-pressure stations, and in part also those for low-pressure stations with power-houses of rather high construction, do not differ from the powerhouse cranes of heat-engine generating stations. Here, too, the merely serve for the assembly and operational maintenance of the generating plant as well as for the pumps, regulators, etc., which are part of the powerhouse equipment. In the case of low-pressure power stations, on the other hand, the principle that is being more and more favoured is to design the heavy assembly cranes for the power station generating plant as travelling portal cranes. Cranes of this type are as a general rule equipped with jibs, which also make them particularly suited for the installation of the turbine emergency sluice gates, weir gates and weir emergency sluice gates. Moreover, by designing these portal cranes in a suitable manner it also becomes possible to use them for the installation of the intake trash racks. Fig. 2 shows two types of twin weir cranes of this kind, with the crab travelling on the inside and with the control panel located in the

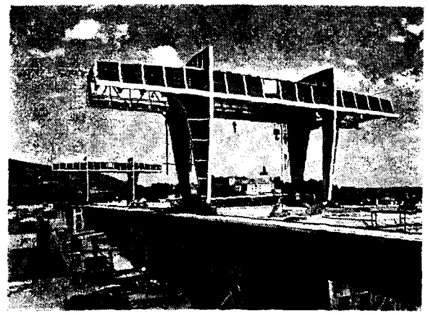

Fig. 2. 130 t – Weir cranes Ybbs-Persenbeug

mobile driver's cab. The incorporation of grab hoist gearing equipped with spider grabs enables these cranes to help in a very efficient manner in the task of cleaning the trash racks. With the aid of these grabs the dense matting of floatage can be torn open, which, particularly in spring, frequently accumulates within a very short time. In this way great masses of accumulated floatage can be scooped out, thus very quickly removing the danger to the trash racks. Because of their versatility and universal applicability, cranes of this kind are also known as universal weir cranes.

Cranes represent only a small part of the cost of the mechanical equipment of a hydro-electric power station which in turn amounts to only a fraction of the entire construction cost. In a medium-sized hydro-electric power station, for example, the expenditure for the acquisition of twin weir cranes, ready for operation, with a capacity of 50 ton each, amounts to only 0.5% of the total construction cost of the power plant. It is also generally recognized that at their present stage of development the power station cranes represent reliable and thoroughly developed installations, which are today—as they will be in the future—, indispensable prerequisites for the efficient operation of power plants.

INDIAN FOREMAN COMPLETES LOCO MAINTENANCE COURSE IN U.K.

Mr. R. S. Kalawar, a Diesel foreman in the Bombay division of Central Railways, leaves London after spending six months in Britain. He has been studying the establishment of maintenance facilities and methods of training maintenance staff.

After a course with the English Electric factory at Preston, Lancashire, he was attached to the Diesel motive power depot of the Western Region of British Railways at Plymouth, Devon; the locomotive works in Derby; the Devons Road motive power depot in London; and the Camden motive power depot.

Talking to a correspondent, Mr. Kalawar said: "One of my major tasks when I return to Bombay will be to assist with the establishment of new maintenance facilities, and also to organize training for maintenance staff. This course, which gave me the opportunity to do practical work in some of the most modern maintenance depots in Britain and to make a first-hand study of the manufacture of the latest locomotives, will be of tremendous assistance to me. It will help me greatly in training younger men in the maintenance and repair of British locomotives, of which we have a large number in our division." Mr. Kalawar will spend a few days in Germany on his way home to study German locomotives and maintenance methods.

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AVOIDING LOCOMOTIVE WHEEL SLIPS ON RAILS

An engineer of the General Electric (U. S. A.) Locomotive and Car Equipment Department has been awarded US $ 1,000 for suggesting a more economical method of operating railroad locomotives.

The engineer, John C. Aydelott, was awarded the prize for a paper he prepared for the Tenth Pan American Railway Congress in Rio de Janeiro last summer.

Aydelott's paper, the result of ten years of research, suggested that locomotive wheel-slip on rails could be controlled by correction only when the wheels were actually passing over a slippery section of rail. Former theory held that the weight of the train be limited to the amount that could be handled on the worst sections of trackage.

In practice, the older theory meant that total train weight was being needlessly restricted and that less goods and passengers were being moved. Aydelott contends that train weight should be limited by average conditions, thus increasing the amount of tonnage a locomotive can haul and reducing the cost of operation.

HEAVY MACHINERIES, AND RAILWAY WORKSHOP MACHINE TOOLS SUPPLEMENT

WRIGHTS RANGE OF MANUFACTURE

By An Engineering Correspondent

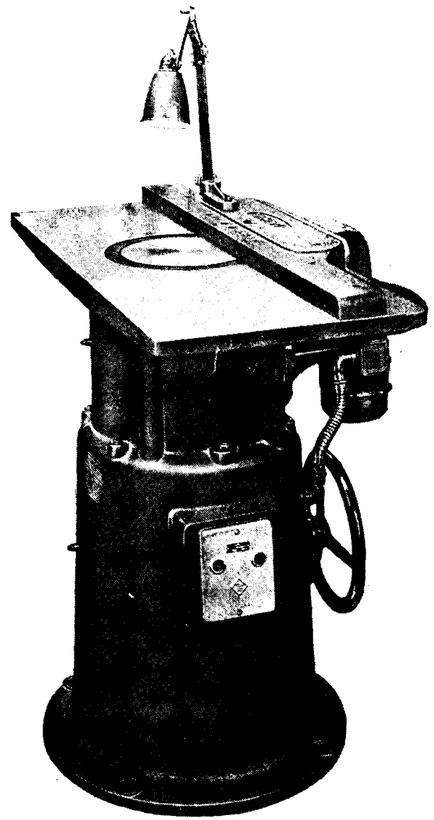
We have great pleasure in publishing below a short illustrated technical write-up dealing with Vertical Spindle Horizontal Table Grinders and Grinding Attachments for Machine Tools. The manufacturer is none other than the reputed firm of Electrical and Mechanical Engineers, Messrs. Wright Electric Motors (Halifax) Ltd., who have specialised in designing and developing of Surface Grinding Machines and Grinding Attachments for Machine Tools, for the past twenty years. These Machines are already employed in various Railway Workshops all over the world. In view of several expansion programmes envisaged for Indian Railways during the Third Five-Year Plan period, and development of heavy engineering industries both in private and public sectors, we are sure this write-up dealing with technical features of the machines would be of great interest to our engineers and industrialists.

WRIGHT Electric Motors (Halifax) Limited—a firm of Manufacturing, Electrical and Mechanical Engineers, established in 1900, have for the past 20 years specialized in the designing and developing of Surface Grinding Machines and Grinding Attachments for Machine Tools.

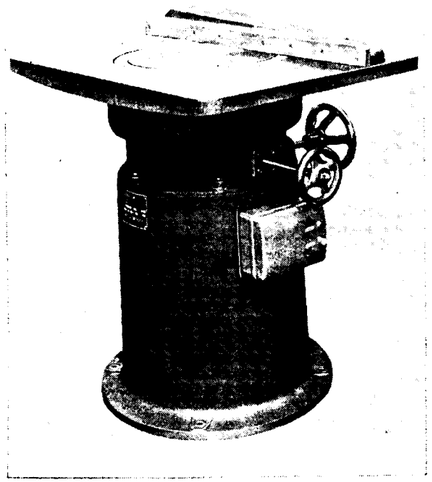
Their Vertical Spindle Horizontal Table Surface Grinders, for which Patents have been granted in most principal countries, and the range of Self-contained Motorised Grinding Heads are covered in India by Patents No. 54,338 and 55,705.

The 'Wright' Vertical Spindle Horizontal Table Surface Grinders are ideal machines for roughing and finishing operations in all Engineering Works, Foundries, Rolling Stock and Engine Maintenance Workshops, Dockyards, Garages etc. They are suitable for metals, alloys, plastics etc., and are precision built and simple to operate.

These machines are now being made in six different sizes, having grinding wheels of 8", 10", 12", 14", 16" and 20" diameter. All models are available in pillar construction, whilst the 8" and 10" sizes are also available as Bench types. These machines have a cast iron rib-reinforced rectangular working table, provided with an insert plate and a wheel centre disc made of high tensile, wear resisting, hardened steel. The whole surface of the table is accurately machined and



This photograph shows a "WRIGHT" Model 54/P14 Vertical Spindle Horizontal Table Surface Grinder fitted with motorised Dust Extractor Fan and low voltage lighting equipment.



This photograph shows a "WRIGHT" Model 55/20 Vertical Spindle Horizontal Table Surface Grinder.

This photograph shows a "WRIGHT" Model 57/ Mic. Ex 12 Vertical Spindle Surface Grinder, provided with a grooved worktable and adjustable and removable guide fence. In this case a distorted and corroded cylinder head is being re-surfaced.

ground over. A swivelling truing block, to take a diamond tipped wheel dresser is fitted. A guide fence is faced with a hardened steel strip, the body of the fence being of cast iron and arranged so that it acts as an exhaust hood, having cast-in ducts for carrying the dust to an outlet to which a dust extracting system can be connected. The grinder body is of heavy cast iron construction, giving extreme rigidity. A cup type grinding wheel is carried on a cast iron wheel hub, clamped with a steel plate screwed to hub. The wheel hub is keyed on to the tapered shaft extension of the driving motor and secured through a lock nut. Compensation for wheel wear and/or adjustment of depth of cut is obtained on the 8", 10", 12", or 14" models by vertical adjustment of the motor rotor by means of a handwheel through a pair of bevel gears. The rotor always remaining within the magnetic field of the stator.

On the 16" and 20" models the cup wheel is carried on a cast iron wheel hub, which is spigotted on to the upper end of the rotating member of the vertically adjustable piston, the latter being of high tensile steel and carried in a double row angular contact bearing. Compensation for wheel wear and/or adjustment of depth of cut is controlled by operating a hand wheel, which engages through gearing the vertically adjustable piston. Setting of depth of cut is maintained by means of a handwheel-operated locking device. The whole rotating mechanism is dynamically balanced ensuring smooth and vibrationless operation. The driving motor, mounted vertically in the grinder casting, is of the Totally Enclosed, dust proof type, of special design having high torque and low starting current features. The rotor shaft, made of high tensile steel, is fitted with deep groove single row ball-bearing at the top, and double purpose ball-bearing at the bottom end, both being stauffer lubricated.

The principal dimensions, supply arrangements, horsepower of the Motors, speeds etc., are as follows :—

Model	TABLE Height Ins.	TABLE Length Ins.	TABLE Width Ins.	CUP WHEEL Outside dia. Ins.	CUP WHEEL Inside dia. Ins.	CUP WHEEL Depth Ins.	MOTOR H. P.	MOTOR Full load speeds	MOTOR Surface speed of Wheel. FT. Per minute
"WRIGHT" TABLE SURFACE GRINDERS—INDIAN PATENT NUMBER 54,338									
Standard Supply Arrangements : A. C. 50 cycles. 2 or 3 phase									
54/B8	17¾	18	14	8	6½	2	1	2880	6030
54/P8	34½	18	14	8	6½	2	1	2880	6030
54/B10	17¾	24	14	10	8½	2	1.5	2880	7545
54/P10	34½	24	14	10	8½	2	1.5	2880	7545
54/ST.12	36	28	19	12	10	3¼	3	1440	4530
54/EX.12	36	42½	19	12	10	3¼	3	1440	4530
54/P14	36	42½	19	14	12	3¼	4	1440	5300
"WRIGHT" TABLE SURFACE GRINDERS—INDIAN PATENT NUMBER 55,705									
Standard Supply Arrangements : A.C. 50 cycles. 2 or 3 phase.									
55/16	36	38	23	16	13½	5	5	1440	6030
55/20	36	40	30	20	17	6	7.5	960	5025

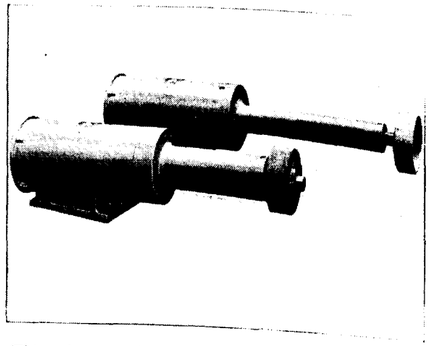
The 12" sizes are fitted as a standard with dust extractor fan units—the fan motor (developing 0.25 B.H.P. at 3000 r.p.m.) is wired to start up simultaneously with the main driving motor.

For the 14" models this accessory is optional.

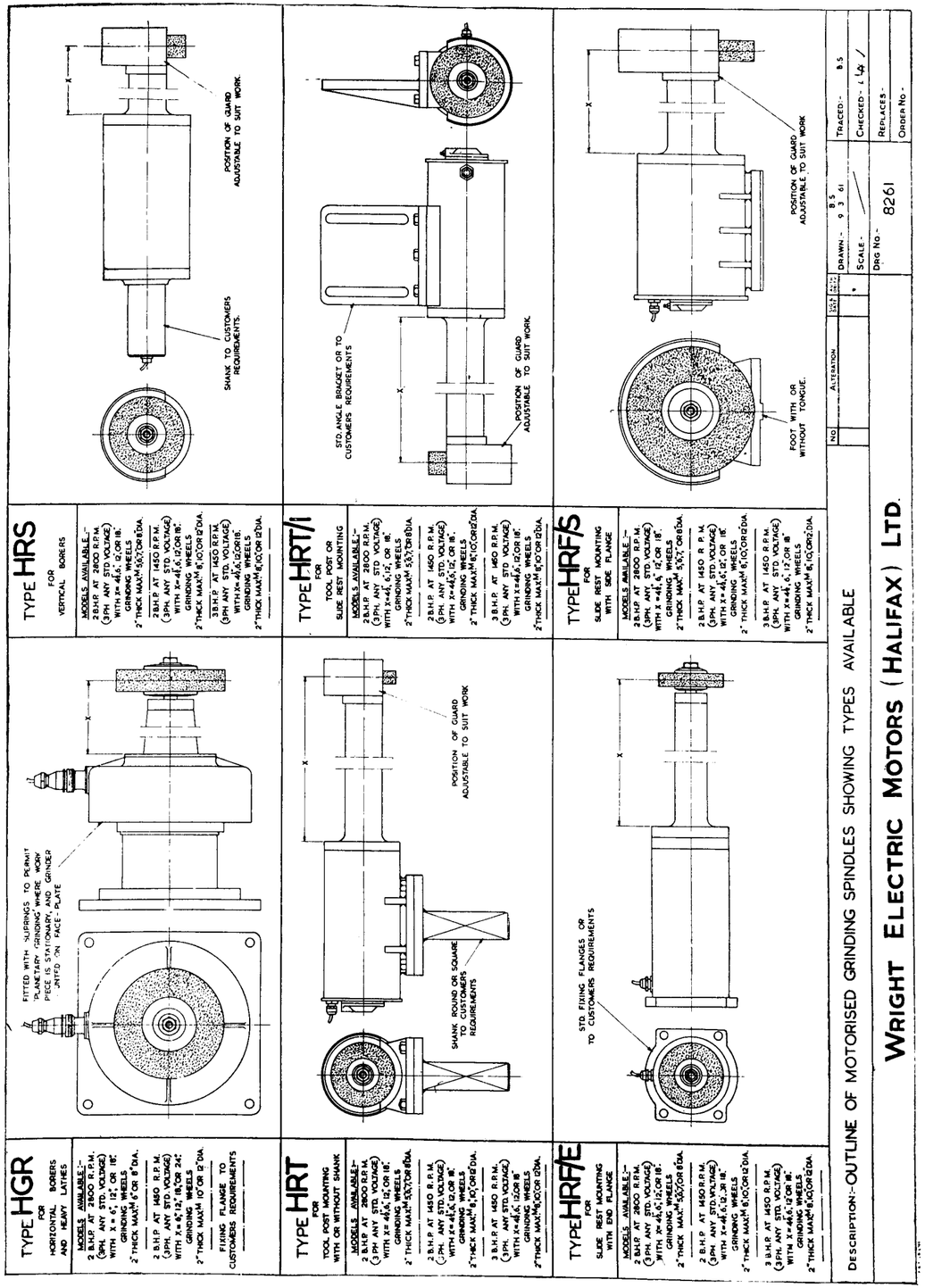
For use with the 16" and 20" machines, we recommend the adoption of a separate self-contained, motorised Dust Collector Unit, which we can supply in two different sizes, namely: No. 2—the extractor fan being driven by a 0.5 B.H.P., 2800 r.p.m. motor:

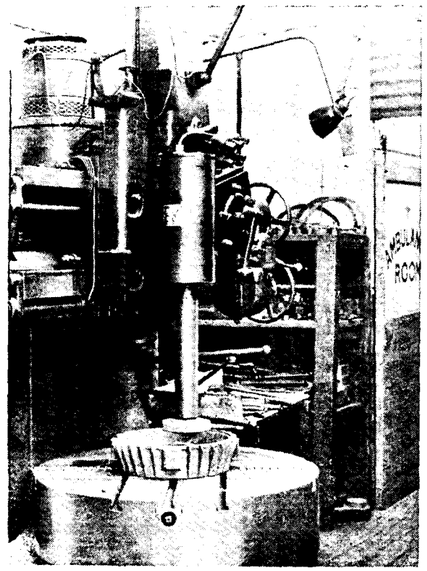
Size No. 3—the extractor fan being driven by a 0.75 B.H.P., 2800 r.p.m. motor: in these units, the fan is on the clean side of the filter; the process dust is induced through a low velocity, primary separator, which effectively traps all heavy particles: the fine dust is filtered by fabric sleeves before the air is finally passed through the fan, exceptionally high separating efficiency so being obtained.

The Table Surface Grinder patent features have also been adopted in the construction of our Motorised, Self-contained Grinding Heads; these units have proved their value as versatile attachments to Planing, Milling, Boring and Turning Machines and Heavy Lathes, and are now available up to and including 4 B.H.P. For surfacing foundation steel work on

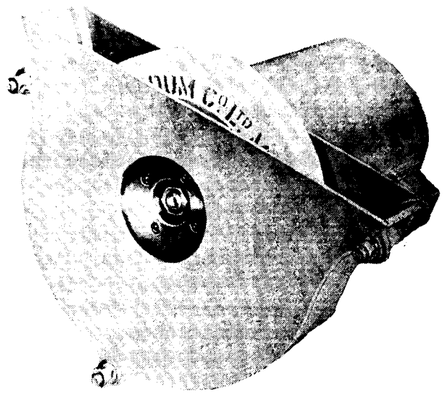


This photograph shows two "WRIGHT" Type HRF/S motorised heavy duty Grinding Spindles, fitted with side flanges for slide rest mounting, one having a 12" and the other an 18" snout extension. These units develop 2 B.H.P. at 2800 R.P.M. operational speed.

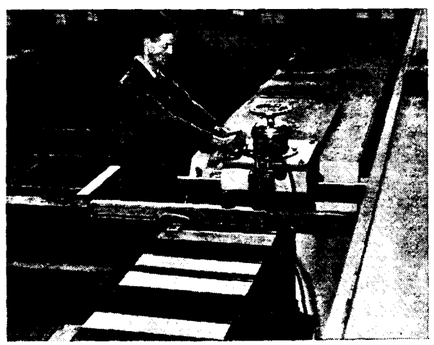


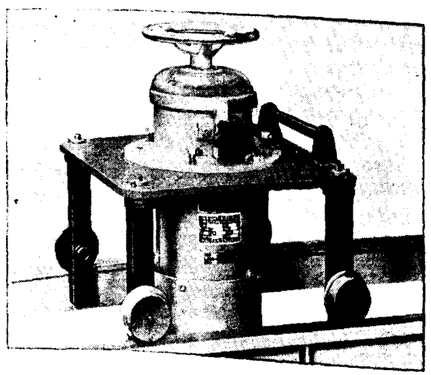


This photograph shows a "WRIGHT" Type HRT/1 motorised heavy duty Grinding Spindle, with 18" snout extension, developing 2 B.H.P. at 2800 R.P.M., used on a Webster-Bennett Boring Mill as attachment for internal grinding.



"WRIGHT" Grinder Motor Unit A3/8 fitted with special dove-tail type fixing feet, 14" diameter plain wheel and wheel guard. These types of Grinder Motor units are available in sizes up to 25 H.P.

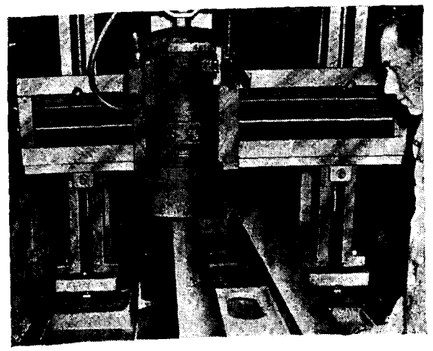




The illustration shows a Model 1.5/2P self-contained Motorised Grinding Head mounted on a four-wheeled Trolley.

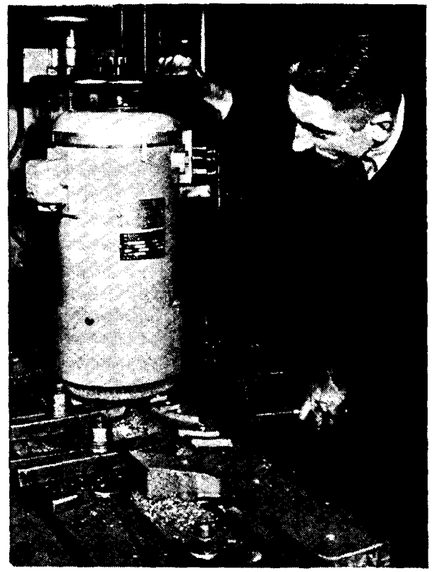
Eight of these units are being used by C.A.Parsons & Co. Ltd. for surfacing foundation steel work and turbine bedplate facings on board ships.

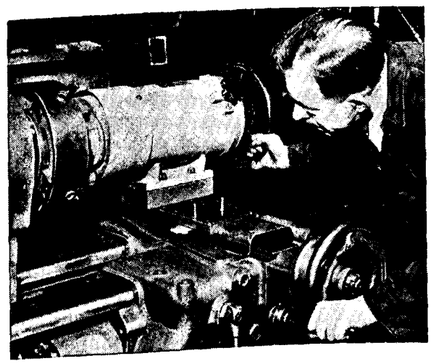
Several units are being used for a similar purpose by Davy Shipbuilding Ltd., Montreal, and Dominion Bridge Company, Edmonton, Canada.



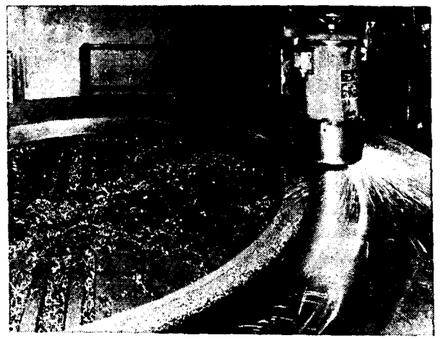
This photograph shows a "WRIGHT" Model 1.5/2P self-contained motorised Grinding Head attached to a Fritz Werner Hydraulic Slideway Grinding Machine. A lathe bed is being ground in this case.

The illustration shows a "WRIGHT" Model 2/2P self-contained motorised Grinding Head, developing 2 B.H.P. at 2880 R.P.M., mounted on the cross slide of a Planning Machine.





The illustration shows a "WRIGHT" Model 2/2P self-contained Motorised Grinding Head, fitted to a Ward No. 7 Lathe, and used for the grinding of hardened steel distance pieces.



This photograph shows a "WRIGHT" Model 4/2P self-contained motorised Grinding Head mounted on a 12 ft. Vertical Boring Mill. The component being ground in an eleven feet 6" diameter 2" thick steel plate.

Building Sites of Power Stations etc., for the surfacing of turbine bedplate facing on board ship, etc., these units can be supplied mounted on four wheeled trolleys.

"Wrights" have recently designed and developed a range of Motorised Heavy Duty Grinding Spindles, which are finding great favour as Attachments for internal as well as external grinding on boring Mills,

Planing machines and Heavy Lathes. The motors used in the construction of these Grinding Spindle Units are of the Heavy Duty Squirrel Cage, Totally Enclosed Dust Proof Type and are available in ratings of 2 B.H.P. at 2800 r.p.m. and 2 and 3 B.H.P. at 1450 r.p.m. A.C. 3 Phase, any one standard voltage. Designed with oversize nickel chrome spindles, carried in precision ball thrust and roller bearings; the complete rotors are dynamically balanced. The rigid steel stator can be fabricated with any shape of fixing foot (drilled or undrilled; with or without tongue), shank, bracket, end flange, etc. for slide rest mounting, tool post mounting etc, to suit customers special requirements. Snout extensions can be fitted from $4\frac{1}{2}$" up to 18". The type HGR units are fitted with sliprings to permit 'Planetary Grinding' where the work is stationary and the Grinding Spindle is mounted on the face-plate of the Machine Tool. The types HGR are available with standard snout extensions of 6", 12", 18" or 24".

Full particulars about the "Wright" machines and equipment mentioned in this article as well as other "Wright" products such as Grinder Motor Units (made in sizes up to 25 h.p.), 'Wright' Coated Abrasive Disc Type Surface Finishers, Cross-Swing Grinders and Bar Centring machines can be obtained from the sole distributors—Messrs. Alfred Herbert (India) Private Ltd., Post Box 681, 13/3 Strand Road, Calcutta-1.

Specification for Stationary Cells and Batteries, Lead-Acid Type (with Tubular positive plates)

The Indian Standards Institution has just published IS : 1651—1960 Specification for Stationary Cells and Batteries, Lead-Acid Type (With Tubular Positive Plates), which supersedes the previous standard on the subject No IS : 541—1954.

This standard prescribes the overall dimensions, capacities and performance requirements of stationary cells and batteries using tubular positive plates. The tests for performance specified in this standard are to be carried out in prevalent ambient conditions.

This standard belongs to a series of Indian Standards on secondary cells and batteries, five standards having already been published in the series covering lead-Acid storage batteries for different class of vehicles.

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INSULATOR HARDWARE

The Indian Standards Institution has prepared a draft Indian Standard Specification for Insulator Hardware for Overhead Lines with a Nominal Voltage of 3.3 kV and Above. This draft standard covers the characteristics, methods of tests and acceptance criteria for the insulator hardware. The dimensions of Insulator pins suitable for different working loads have been given completely in metric system for the ball and socket coupling for disc. insulators, this Standard follows the recommendations of the International Electrotechnical Commission.

This draft standard has been circulated to interested parties for eliciting technical comments. The comments will be taken into consideration before the draft is finalized as an Indian Standard.

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SPECIFICATION FOR FIXED CAPACITORS FOR FANS

The Indian Standards Institutions has just published IS : 1709—1960 Specification for Fixed Capacitors for Fans, which covers the basic mechanical and electrical requirements and methods of tests for fixed capacitors for use in various types of fans. It also gives the preferred capacities and dimensions of the capacitors as used at present.

In the past, a large number of AC fans used in this country was of the non-capacitor type, but the present trend is towards the use of capacitor type fans, which is largely influenced by the increased manufacture of paper capacitors in the country to cater to the needs of fan industry. This standard has been prepared with a view to bringing about uniformity in the characteristics of fan capacitors in order to assist the fan industry.

SCHAERER—LATHES

By An Engineering Correspondent

SCHAERER-Lathes are built since about 60 years. Today the programme includes Universal Lathes, Production Lathes with automatic working process, Semi-Automatic Copying Lathes, and special attachments for non-circular copying, particularly glass-molds and cam-shafts of Diesel-Engines and similar machines.

The special feature of the SCHAERER-Lathe are the underslang saddle guideways, arranged in such a

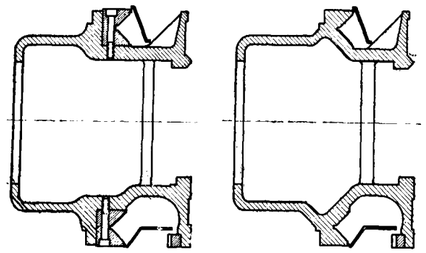
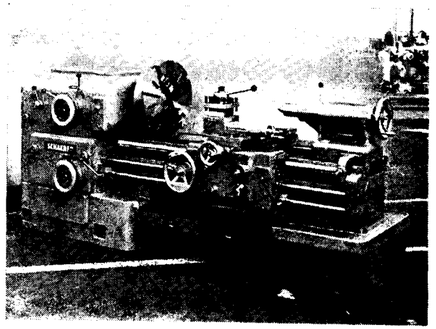


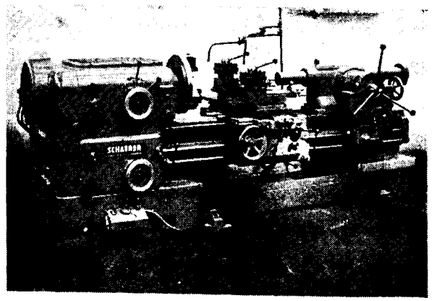
Illustration of SCHAERER-Guideways. At the top normal execution, at the bottom hard-chrome gibs.

way that they are well protected against damage by swarf. Their Vee shape guarantees that a permanent oil film is maintained. This ensures a long life for guideways and extra-ordinary resistance against warping. If high pretensions are made, these guideways even may be supplied as hard-chrome steel gibs.

Furthermore the SCHAERER-Lathes are characterised by their large drive capacity in comparison to the height of centres, by their important speed range (universal lathe = 1 : 200), and by their various special equipments. Regarding the SCHAERER Lathe Programme, it's easily possible to choose production lathes being particularly economic and suitable for special operations. As to the universal cutting, the SCHAERER Universal Lathe is fitted with all equipments, capable to execute a great range of work. As shown on the photos, the machines possess but some control elements in order to facilitate their operation. The quick change control lever is used for the rapid setting of all standard metric, inch and module threads as well as for the feeds. Settings can be read instantaneously from the control drum. Neither tables nor calculations for machine regulation are necessary.



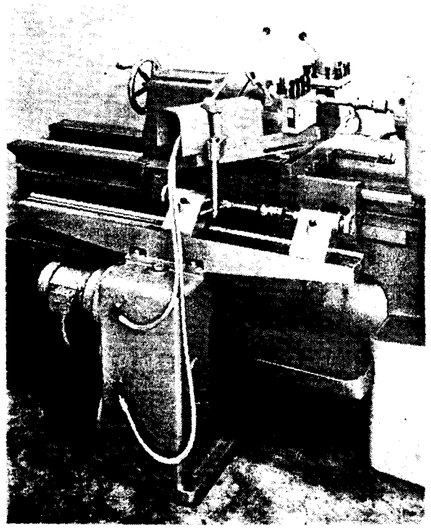
SCHAERER-Lathe in standard execution, centre height 320 mm. drive capacity 20 to 30 H.P.



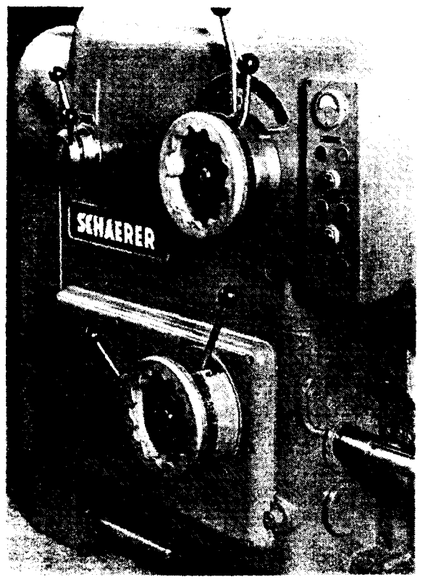
SCHAERER-Lathe, 320 mm. centre height, with twin slide and one independent front and rear cross slide, boring tailstock, and pneumatic chucking attachment.

Today SCHAERER-Lathes are installed in leading factories throughout the world, where high precision and great cutting capacity is required.

The Hydraulic Copying Unit "SCHAERER-PROFILE D9", suitable for fitting to lathes of all



Copying Unit "SCHAERER-PROFILE D 9" suitable for fitting to lathes of different types.



View of main drive and feed box. Setting of speed, feeds, and threads by hand wheels.

types, is remarkable, too. This copying unit distinguishes itself by its high accuracy. In all cases, where special copying lathes will not pay—because of the low output capacity—SCHAERER-Lathes with hydraulic copying attachment are preferred.

The blocks illustrated will give an impression of large manufacturing programme and the variety of application possibilities of SCHAERER-Lathes. They are well-known in the whole world.

PELS Straight Sided Crank Presses

Satisfy all claims for technical perfection. They are built in three different series, i. e.

type PIKs mainly for stamping, cutting, and shearing purposes, of small operational capacity and high speed,

type PIK for a wide range of operations and small table area,

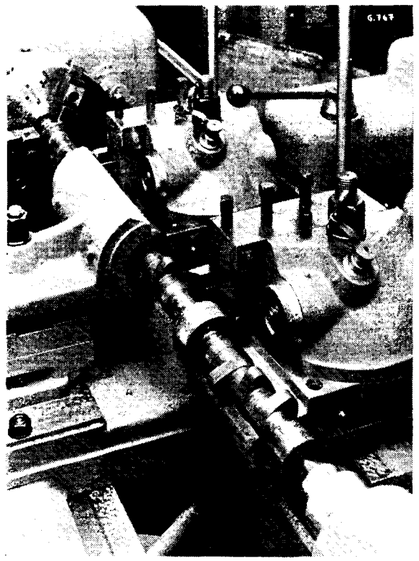
type P2K for a wide range of operations and big table area, for press powers of from 100 or 125 tons respectively up to about 1000 tons.

Presses of types PIK and PIKs have single point suspension, those of type P2K double point suspension.

The press frame consists of bed, header, and uprights fabricated of heavy steel plate and stress relieved after welding. These components are joint by welding to form a single-piece body, or, in the case of presses above 250 tons and with large table area, by preloaded steel tie rods. The boxshaped components are properly stiffened by ribbings to increase their strength against dynamic stresses. Both the uprights are made of folded plate sections with welded-on tension plates and allow to provide openings to make the tooling accessible from 4 sides.

The ram slide is also welded of heavy steel plate and its boxlike shape stiffened by adequate ribbings. It is guided by long adjustable prismatic gibs along the 4 inside borders of the uprights. The vee gibs of the small size crank presses are adjustable and fitted to the ram slide, while those of the bigger size presses are mounted to the uprights. The adjustable gibs are armed with plastic foil, the

opposite ones of special quality cast iron. The weight of the ram slide and partly that of the tooling is balanced by compressed air cylinders. A reversible electric motor actuates the ram slide adjustment transmitting its power through a gear to one or two threaded spindles which are guided in cylinders. Accordingly, only axial pressure stress is put on these spindles. The ram slide adjustment way is limited in



Copying of cams of a Diesel engine camshaft with 2 hydraulic copying slides.

both directions by limit switches. In case the ram sets on tool parts during the adjustment operation, the drive of the regulating gear will be automatically stopped by a safety device.

To protect the tooling and to safeguard the press against overload, an oilhydraulic overload safety device can be fitted. A pressure pad below the small ends of the connecting rod can be adjusted by preloading to any desired load within the admissible range of pressing force. A pilot lamp mounted on the control panel flashes immediately the adjusted press power has been reached. When the predetermined pressing force has been exceeded by 20%, the overload security cuts off the press automatically.

In case overloading takes place within the range of before 40° before lower dead center, the press drive will be automatically declutched. The ram slide is then to be brought to top position in the reverse direction. Will the press, however, be overloaded in a position closer to the lower dead center, the crank drive will continue its way through the bottom center with blocked ram slide. Only during the return of the connecting rod, the ram slide will again be carried along and stopped in the topmost position.

Sometimes, a mechanical overload security in the place of the hydraulic one may be sufficient. It works on the principle of measuring the elongation of the press frame or of two tie rods diagonally opposite to one another.

The press is fitted with a detachable bolster plate, which will get Tee slots for tool fixing. In accordance with conception adopted on principle for all PELS Straight Sided Crank Presses, the press has cross shaft drive. The crankshaft liable to bending and breakage, has been omitted. In its place, gear wheels with cast-on eccentric hubs running on fixed wheel pins in closely mounted gearings form the crank drive.

The complete drive is arranged inside the head of the press. The flywheel and the first driving shaft run in roller bearings, all the high speed wheels have helical gearing assuring an almost noiseless operation of the complete drive. By mounting the flywheel on a hollow shaft bearing flanged to the press body, the driving shaft rotating inside the hollow shaft bearing is completely relieved from flywheel weight and belt pull.

The single disk friction clutch has given full satisfaction for a good number of years. It is electromagnetically controlled and actuated by compressed air. The friction blocks can be exchanged without any considerable dismantling work. Also, the single disk friction brake is electromagnetically controlled, released by compressed air and rapidly and dependably engaged by spring pressure. It is designed for very high operating frequencies, the renewal of the friction blocks takes little time.

The press is controlled by an electromagnetic two-hand safety engaging gear. A selector switch allows three settings :

1. *inching,*

   by pressing down the push button, the ram slide can be moved up or down over short bits of the stroke, the ram remains in motion as long as the key is kept pressed.

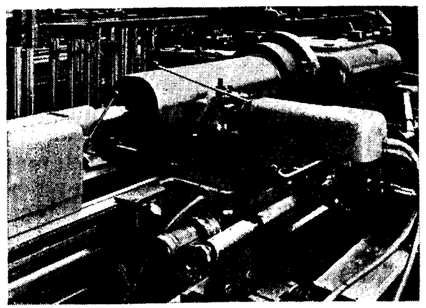
2. *single stroke,*

   by actuating the switch-on key during the down stroking of the ram slide, the latter performs a full stroke cycle and remains stopped in top position.

3. *continuous run,*

   after engaging the press works till it is stopped by pressing a switch-off key, the ram slide returns to top position.

During "single stroke" and "continuous run", the ram slide can be stopped in any position by pressing an emergency key. The ram slide movement is indicated by the hand of a dial in the control panel. In the right side upright, a cam shaft with 10 cam disks will be installed, out of which 6 cams are available for the synchronous control for the transport and working movements, when the press is inserted in a production train.

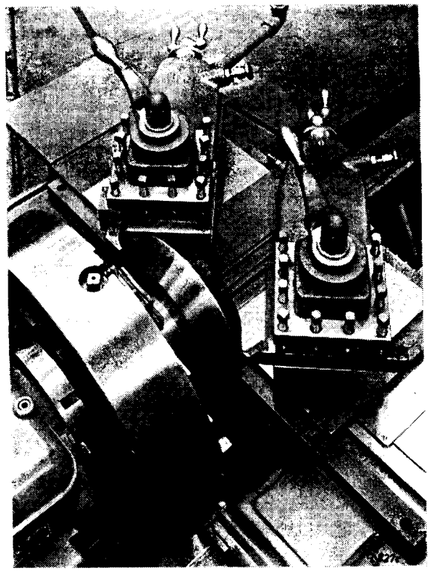


Copying of a four-edge mold with the hydraulic non-circular copying unit.

In the ram slide a number of knock-out bars are incorporated brought into action by adjustable stops on both sides of the press headpiece.

A flywheel brake stops the flywheel within abt. 15 secs. after switching off the motor.

The press is equipped with the so-called cascade circulation lubricating system. Thereby, the lubricant is pumped from a tank in the press bed through filters and two pressure adjustable distribution lines to the sliding faces, bearings and gear wheels. The quantities can be regulated by time switches with impulsing device. The oil flowing from the lubricating



Machining of a taper with twin slide and power traverse.

points is caught in the headpiece, the overflow is conducted over connecting rods and ram slide back to the collecting tank. In case of failure of the lubrication, the press is automatically stopped, while a pilot lamp flashes on the control panel.

Particularly marked lubricating points are fed in the usual way by hand guns.

To avoid accidents during continuous run of the press, we recommend to instal light barriers in the front and at the rear of the press. Strip lights are fitted inside the press opening on both uprights to improve working conditions. The headpiece with the press drive can be made accessible by inspection platforms and ladders.

It is also possible to instal a pneumatic drawing cushion in the press bed, either of the uncontrolled type, or of the controlled type with control slide and electrically regulated stroke adjustment.

IWK Hydraulic Self-contained Straight Sided Plate Shaping and Deep Drawing Presses

These presses are built with a maximum press power of from 160 up to 1000 tons. They are either single acting, for ordinary shaping, stamping, flanging, beading and pressing work, if necessary equipped with hydraulic cushion or ejector, or double acting with downstroking blankholder.

The press body consists of bed, header and uprights, these parts fabricated of heavy steel plate are stress relieved after welding. They are joint by welding to form a monobloc press frame, or in the case of presses above 315 tons and with large table area, by preloaded tie rods of steel. To make the uprights specially resistant against transversal and torsional forces and dynamic stress, they are made of folded steel plate reinforced by ribbings and welded to form bok shaped bodies. The bolster plate of forged steel is screwed on to the bed and has Tee-grooves for tool fixing, a centering hole and an arrangement of holes for the drawing cushion pins.

The ram slide being rigidly fixed to the piston shaft is a welded boxlike structure and extremely resistant against bending and twisting forces. It is guided by 4 prismatic gibs along the 4 inner borders of the uprights. The guide gibs are adjustable, they allow to work with the smallest possible clearances guaranteeing a high degree of accuracy. Its bottom surface bears Tee-grooves and a centering hole. In accordance with capacity and table breadth of the press, a number of knock-out bars are fitted inside the ram slide, their movement can be regulated by spindle stops on both sides of the press frame. The press power is exercised on the ram slide by one or two pistons, their cylinders are mounted inside the header. Oil pressure below the piston disk effects the return movement of the ram slide.

Moving below the ram slide and guided along the same 4 gibs as the ram slide, the blankholder is pressed down by 2, or, in big size presses, by 4 cylinders, the return movement being effected either by 4 adjustable spindles or by 2 separate push back cylinders. The blankholder can be coupled to the ram slide by bolts, the press power of all downstroking cylinders acting jointly.

The blankholder satisfies all demands in regard to self-adaptable downholding. The central opening is reduced by annular plates forming part of the tooling. The guide gibs are adjustable. During the drawing operation the downholding pressure is maintained by oil escaping from the annular space below the main piston and can be infinitely varied.

All the cylinders for ram and blankholder are made of cast steel and have a polished interior surface. Long guide bushes for the piston shafts are fitted, the cylinders are sealed by multiple packings with bilabial rings of wear resisting synthetic material.

The pistons, whether of the disk type or the plunger type, are made of chilled cast iron of high surface hardness or high quality steel. All differential disk type pistons bear bronze guide rings and packings to prevent leakage from one cylinder room to the other and dropping of the ram during a stand-still of the press.

Below the bolster plate the hydraulic cushion is fitted. Piston or pistons and pressure platen are rigidly fixed to one another. The pins standing on the pressure platen and penetrating the bolster bear the drawing cushion ring clamping the rim of the blank during the drawing operation against the annular face of the die. A special pressure regulating valve is fitted to the cushion. Generally, the cushion works as a passive one, during the downstroking of the ram it is pressed down by means of the pressure pins and follows the raw again on its way upwards till its upper adjusted position is reached and the top of drawing cushion ring and drawing stamp lie in the same plane. During active work the drawing cushion is controlled by a slide connected to the electromagnetic controls, it can then be used as ejector or for reverse drawing.

The operative oil pressure is produced by a multi-piston axial pump with dependable capacity regulator. In the place of the formerly common slide valve for distribution, a reversing control system is employed offering the advantage of a smooth reversal of the ram movements in the stroke end positions.

The capacity regulator varies the stroke of the pump plungers in relation to the pressing resistance. Rising resistance reduces the pump output, the motor input remains thus practically constant. The motor drives the pump by a flexible coupling. The pump works without valves or packings and owns its convenient lubricating system regulating the lubricating

pressure in accordance with the load put on the press.

The press power of ram, blankholder and drawing cushions can be varied within wide limits. All adjusted pressures are to be read off on the gauges jointly fitted to the manoeuvring board. The pressure regulating valves we employ have an uncommonly wide range of adjustment.

In accordance with the respective height of tooling and drawing depth, the ram slide stroke can be confined at liberty in chosen top and bottom positions. In this way, it is possible to realize for every stroke cycle the shortest and most economic lengths of stroke. Any exceeding of the maximum stroke length is impeded by solid stops.

When performing punching or trimming operations intermediate pieces are put on stops making the ram slide or blankholder to set on them immediately the punch has broken through the material and avoiding any percussion in the hydraulic system.

On the manoeuvring board fitted to the right side upright are arranged, beside the pressure gauges, the push buttons and an emergency switch, up to 3 selection switches, one for selecting the desired operation cycle: "inching", "single stroke" or "continuous run", one for switching on and off the drawing cushion or putting it on active or passive operation, and one for connecting or disconnecting the backside control panel.

"Inching" is mainly used when setting or trying out tooling. When "single stroke" has been selected, one complete stroke cycle will be released. By a time-log relay the ram slide can be kept for a short predetermined period in the bottom position. This is particularly important for coining work. Once the press has been regulated for "continuous run", the succession of stroke cycles will go on till the press is stopped. The duration of the feeding will be determined by the time-lag relay for the top position of the ram.

To protect the operator against accidents, we recommend to instal two hand; two men or four men safety controls, light screens or electric interlock guards. Light screens are automatically switched off during ram return and feed periods.

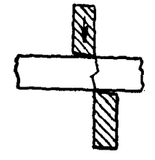
In order to catch the ram and blankholder slides while downstroking in rapid motion, before they set down on the material, an electromagnetic guide motion slide is closed and the descending slides braked by turning the pump back to its central position. At the end of the return stroke, the ram slide is braked too.

Oil filters are provided to keep the circulating lubricant clean and to protect it against the effects of deterioration by ageing. If operating conditions demand it, oil cooling or oil heating can be fitted. These are thermostatically controlled.

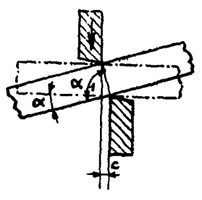
Due to the excellent finish of all components, the minute deflection of the press frame and the perfect parallelity of bed, ram slide and blankholder, work-piece sizes can be most accurately held and maintained. Owing to this fact, to the rigidity of the press and to its oscillation-free working, tool life is uncommonly long.

PELS Billet and Slab Shears

Billet shears are wanted for high numbers of cuts and uniform evenly cut surface on the sections as they can be obtained by sawing. Billet Shears which cut on the diamond, usually do not allow to achieve uniform cuts with perfect rectangularity and free of burrs and core protrusion, without blade changing when cutting steel of different composition and a tensile strength of from 55 to 140 tons/sq. in. The reason for it lies in the bending of the off-cuts during cutting which produces obliquely cut faces. The smaller the tensile strength, the more oblique the cutting plane. This inconvenience was tried to be removed, already in former years, employing so-called up-clamping devices, they did, however, not give full satisfaction, as the up-clamping forces were too small.



CUTTING WITHOUT CLEARANCE



CUTTING WITH CLEARANCE ANDANGULAR FEED

At this new PELS billet shears, blade beam and up-clamping device form one pincer-like system. The design is protected to IWK by patent rights in Germany and foreign countries. Due to the high

downholding pressure and an up-clamping power proportional to the cutting force, the face of the off-cuts shows the properties mentioned below. No supplementary mechanical power or working capacity is needed for up-clamping.

This new type billet shears works with simple rectangular blades. They produce almost square off-cuts with negligible deformation and without core protrusion. The shears is designed in such a way that the up-clamping device cannot impede the cutting operation. The big number of cuts to be obtained with this shears gives a comparatively high efficiency.

The advantages of the newly developed PELS Billet Shears are focussed and explained below :

(1) High production figure by automatic working. The working cycle is automatically performed by the new PELS billet shears. Having engaged the roller table drive, the inserted billet is fed into the machine, knocks against the back stop and releases the cutting cycle, causing in quick succession clamping down by the downholder, withdrawal of the back stop and cutting. After throwing out the off-cut and stopping the blade beam in the upper dead center, the cutting cycle is repeated. It is not necessary to engage the shears by hand each time the material is put against the back stop. Hand operating will unavoidably cause time losses and rejects when the wanted exact length of the off-cuts has not been maintained.

While the idling speed of the shears of 315 and 630 tons shearing force are 28 and 26 per minute, the production figures vary with the off-cut length. Considering idling times, the number of cuts will be abt. 12—15 with an off-cut length of say 4″—5″, and 5—7 per minute when the off-cut length is 20″ approximately. The output figure in tons per hour is consequently increasing with the length of the cut pieces.

When cutting on the diamond, loss of time occurs owing to bent billets which impede the performance of the cutting operation and require readjustment of the downholder. Such disturbances are unknown for shears with horizontal blades, because the billet can be turned on the roller table and put on that one of its four faces on which it lies almost flat.

(2) Outstanding quality of cut. The excellence of the cuts depends on a conveniently big upclamping force, on the correct selection of the clearance between upper and lower blade and on the pre-determined cutting rake, i. e. the angle between blades and severing plane vertical to the billet axis. If upclamping force is lacking or insufficient, the material when cut will be bent, torn or curved. The horizontal clearance between upper and lower blade edges must be regulated in accordance with the height of the section and the quality of the material, as a rule the clearance amounts to some 7 to 10% of the height of the section.

A sketch shows the actual conditions. Cutting without clearance gives a broken face. If the billet, when being cut with the required clearance, is fed horizontally, the cutting plane in the billet runs obliquely, as shown by the dotted line. In order to achieve a square cutting face, the billet is to be introduced with a slight inclination.

Experience teaches that proper cuts can be obtained, when cutting on the diamond, provided.

(a) the blade is relief-ground over the full breadth of the material, what is obviously feasible for one section only.

(b) the Vee-shaped edges of the blades must have an angle of more than 90°, the correct size of the angle depending on the elongation of the material. This means cutting on the diamond can be achieved just for one section of material of a certain quality. Already slight deviations from that section or differences as to the elongation cause improper cuts. In case, the rounding-off radii of blade and billet do not coordinate, a burr or even a core projection will be squeezed out which is rather an unwanted impediment during a further transport. This formation of burr or core projection is generally the rule for cutting on the diamond, because it is practically impossible to adapt the blade section to the varying rounding-off radii of the billet.

(3) Off-cuts to close limits. From automatic cutting performed by the PELS Billet Shears with upclamping device and backstop result off-cuts with unusually close longitudinal tolerances, since the shears engages immediately the material contacts the backstop. For billet shears, which are not started by means of the backshop, generally far bigger tolerances must be admitted for the off-cuts.

(4) Simple blade shape. The shape of the blades for the new PELS Billet Shears is rectangular. For square steel bars, the upper and lower blades are, as a rule, interchangeable and possess 4 cutting edges each. Contrary to this, cutting on the diamond demands a special set of blades, and further more with relief-ground backs for different qualities of the material, if properly cut faces are to be obtained.

Nevertheless, off-cuts produced by cutting on the diamond show rather varied cut faces. The face on the remaining billet gets nearly always curved, while the opposed face on the off-cut becomes concave, besides, it shows an obliquely severed face due to lack of upclamping. The curvature on the face on the remaining billet is sometimes that big, that the upper blade cuts into it forming a nose, which is undesirable and demands eventually to be removed in an additional operation.

When cutting round sections of low tensile strength, also the new PELS Billet Shears has to be equipped with relief-ground profilated blades. Due to the most effective upclamping device, however, proper and square cuts will be achieved. Extreme core projection and forming of a nose on the cut face by the upper blade—as mentioned above—will certainly not occur.

(5) relatively rapid blade exchange by effective measures. The backstop and the downholder of the PELS Billet Shears are pivoted on hinged in order to change the blades with ease and to change the shears from smaller to bigger billet sections. Once the personnel have got accustomed to this work, they will take 20 to 30 minutes to perform it.

The blade clearance, too, can be rapidly set, owing to the special design as described above, simply by inserting or removing shims under the lower blade.

The obvious advantages of the new PELS Billet Shears lie in the high quality cuts that can be obtained, the accuracy of the length of the off-cuts, the high effective output and the easy maintenance.

MATISA BALLAST CLEANERS

EASTERN REGION, BRITISH RAILWAYS, have just taken delivery of the first of three of the latest model Matisa Ballast Cleaners, type 8CB5 to be ordered by British Railways. This type ballast cleaner has a higher rate of output than previous models, is mounted on motorised traction bogies, the excavating chain is hydraulically driven and powered winches are provided for handling the heavy excavating gear and conveyors.

In WESTERN GERMANY, an order for the 31st MATISA B-60 Automatic Ballast Tamper has been placed. It will be fitted with the MATISA Automatic Levelling Equipment.

The BRAZILIAN NATIONAL RAILWAYS have ordered numerous items of MATISA equipment, in particular 81 Lightweight Ballast Tampers with motorised trolleys and 6 B-60 Heavy Ballast Tampers, destined to mechanise important track works.

In MAURITANIA, a MATISA Flash-butt Welding installation for welding rails into long lengths is in operation. The welding of 75,000 rails in 30 months has been entrusted to MATISA for a new mineral ore railway, in the construction of which numerous other items of MATISA equipment will be used.

The EGYPTIAN RAILWAYS have taken delivery of 6 MATISA Heavy Duty Automatic Ballast Tampers.

INDIAN MACHINE TOOL INDUSTRY PROGRESS AND PROBLEMS

By An Engineering Correspondent

THE Machine Tool Industry is the main plank on which modern industrialisation is based. In the ultimate analysis, the capital equipment required for large-scale industrialisation is dependent solely on the capacity of a country's machine tool industry. In other words, it is this industry that could be called the key to any industrial progress. This can be well evidenced from the rising requirement of India's machine tools particularly after the implementation of its First Five Year Plan. Against its consumption of about Rs. 3 crores of machine tools—Rs. 47.31 lakhs required indigenously, and the rest about Rs. 2.5 crores through imports—the consumption in 1960 is estimated to have reached Rs. 30 crores, of which only Rs. 5.5 crores of graded machine tools had been available through indigenous sources, the rest having been imported.

STATE INITIATIVE

As by its very nature, the machine tool industry does not hold out prospects of large and quick returns and the capital involved is substantial, the Government found private capital unwilling to invest large amounts required in the industry in the already existing 'Capital-shy' conditions in the immediate post-independence period. The Government, therefore, stepped in, and entered into a technical collaboration agreement with one of the best known machine tool manufacturers in Europe, viz. Messrs. Oerlikon Machine Tool Works, Buehrle & Co., for setting up a medium/heavy machine tool manufacturing unit in this country. This agreement was signed in 1949.

The Hindustan Machine Tools factory at Jalahalli commenced construction of the project in 1953. The period between 1953 and 1956 was, however, not a very happy chapter in its history. It came in for a good deal of criticism in the Press and the Parliament. A British expert commissioned to give his views of the Project in 1954 described it as 'a dismal failure' and proceeded to predict that HMT would be 'a colossal financial failure'.

PROGRESS OF HMT

A change, however, came in the latter half of 1956. The factory's plant capacity was carefully re-assessed, and a programme of multiple shifts was worked out and implemented. Simultaneously, as a pre-requisite to planned production, a comprehensive training programme was evolved, and an enlarged training centre was set up.

As a result of these and other steps, the factory turned out 135 lathes against its target of 57 in the year 1956—57. The factory exceeded its plan targets in the subsequent years, and against its plan target of 400 for 1960—61, the factory achieved a production of 1002 machines in 1960, and the output is running at the rate of 100 machines or over per month since August 1960, i. e. a rate of production of over 1200 machines per annum against the end of Second Plan target of 400 machines per annum or 300% over the target.

Simultaneously, the factory has diversified its production, and at present, it turns out a wide range of 90 different types and sizes of machines, against its original production programme for only one type of machine. It may be mentioned that since 1956, the factory has been contributing substantially to the country's machine tool industry. While it accounted for about 25% of the country's total production in that year, its contribution in the subsequent years has been of the order of almost 50 to 60 per cent. During the year 1960, it can be safely said that of the estimated production of about Rs. 5.5 crores worth of graded machine tools, HMT's contribution has been about Rs. 3.5 crores. The factory which employed 86 highly paid foreign technicians in 1956 was completely Indianised in 1959.

EXPANSION PROGRAMME

The factory has already undertaken an expansion programme of building a second factory slightly larger than the original factory. Its progress since 1956

enabled it to build for itself adequate financial resources, after wiping off a heavy initial development and commissioning expenditure of nearly a crore of rupees. These resources are now being ploughed back into this second factory which will be completed without any assistance from the Government of India or other outside source in the record time of 14 months.

The total estimated expenditure in connection with this second factory will be Rs. 287.81 lakhs, of which Rs. 114.35 lakhs will be foreign exchange expenditure. The programme is already under way and when completed, the factory will be able to turn out over 2000 machines per year. Thus, the annual output of the factory is estimated to be over Rs. 7 crores with the share capital remaining at only Rs. 5.31 crores.

NEW SERIES OF MACHINES

Very recently, the Bangalore factory had one more achievement to its credit. It turned out a new High Production Turret Lathe completely designed and built FOR THE FIRST TIME IN INDIA WITHOUT ANY FOREIGN COLLABORATION. The factory will shortly go into bulk production of these Turret Lathes for the market.

This new machine, which is the first to be completely designed by HMT's engineers is to be one of a new series of turning machines which the factory proposes to design and build without any technical collaboration from abroad.

Modern in its design technique, the machine is in line with the latest machines designed and developed in Europe. The production of this machine marks the first step towards the factory's attempt at attaining self-sufficiency in design and development.

It is understood that the country absorbs about 150 machines of this type annually, rising to 300 in five years, and the production of these machines in HMT will consequently result in the saving of about Rs. 6 crores worth of foreign exchange during the third plan.

Recently, the Hindustan Machine Tools concluded an agreement with the Machine Tools Division of Messrs. Renaults, a well-known French firm, and also with a number of State-owned machine tool units in East Germany for the manufacture of further types of machine Tools. Consequent upon these agreements, HMT will embark upon the manufacture of special purpose machines for automatically producing components on a mass scale. These machines would be designed specially in each case.

TWO MORE UNITS

It is proposed to set up two more machine tools factories in the public sector with an ultimate capacity equal to the duplicate size of HMT i.e. each unit capable of producing 2000 machines per annum. These two units will be built and run by HMT without any foreign collaboration, entirely by Indian Engineers.

In the field of heavy machine tool manufacture, the Government has already finalised collaboration agreement with a firm from Czechoslovakia which is now preparing a detailed report for a project to produce about 10,000 tons heavy machine tools per month. Similar offers have been received from U.K., West Germany, and Polland, and all these are being examined by the Government.

WIDE GAP

In spite of all these activities in the Public Sector, there will be a wide gap between the country's requirement of machine tools and indigenous production, as the demand estimated at Rs. 60 crores by 1965 is fast out-stripping the growing capacity of the domestic industry.

The industry has yet to make great leeway. Private Sector in the country will, therefore, have to make similar efforts if the output is to be anywhere near its expected requirements.

SMALL SECTOR

While production in the organised sector is concentrated on the graded medium duty machines, the bulk of the output in the small-scale sector is of ungraded and lighter duty types. It would be interesting to note that while there are only about 15 units manufacturing graded medium duty machine tools, including the three undertakings the sector, there are about 344 units manufacturing ungraded lighter duty machine tools.

In order to make as many different types of machine tools within the country as possible, the approach of the Planners has, so far, been to canalise and encour-

age the manufacturers to undertake the production of different types of machines. However, in view of the increasing demand, and in the light of our rising requirements, the Government have recently decided to allow manufacture of similar machines by more than one unit.

The Government are prepared to consider technical collaboration agreements for all types of machines depending, however, upon the terms, particularly in regard to payments etc.

Yet, another field in the spare of machine tool industry in metal working machinery like rolling mills, hammers, hydraulic press, wire drawing machinery, and foundry equipment. Although there has not been much activity, at present, in this field, it is a matter of great satisfaction that some improved metal working machinery like rolling mills and other machinery needed in steel plants are proposed to be manufactured in Government's Heavy Machinery Engineering Corporation at Ranchi.

Among the private enterprises, Messrs. Godrej & Boyce Ltd., and Messrs. Atlas Works Ltd., have extensive plans to increase their production of sheet-metal machinery. With these plans under way, it is expected that the output of machine tools in India (including metal farming machinery) would reach the level of Rs. 30 crores per year by the end of the Third Plan, i.e. 1956—66, against the country's anticipated requirement of about Rs. 60 crores per year by that period.

SOME PROBLEMS

The industry has quite some problems to face Apart from the usual difficulties like shortage of foreign exchange, technical and managerial personnel, the other difficulties are—

(i) Finance :

Industries require heavy initial investment with slow pace of returns ;

(ii) Replacement Needs :

For India's machine tool units, to turn out quality products, it is essential that they are able to replace their machinery at reasonably regular intervals ;

(iii) Tool Room Capacity :

In the case of most of the machine tool units, for manufacture of tooling e.g. Jigs, Fixtures, Special Tools etc., Tool Room capacity is inadequate, and in some cases even unsuitable. It may take years before any of these equipments could be made indigenously. The only source, therefore, to acquire such equipment, is imports, which in turn is dependent on the availability of foreign exchange ;

(iv) Availability of ferrous and non-ferrous metals :

Machine tool production requires a large variety of ferrous and non-ferrous metals. Grey Iron Castings constitute about 70 to 80 per cent in terms of weight in each machine tool. Pig Iron is the most important raw material for Foundries producing grey iron castings ; and

(v) Another difficulty which is currently experienced is the bottle-neck in regard to the supply of hard coke. In fact, low ash-content coke has been a bottle-neck during the Second Plan Period. The situation is expected to improve before long when the total carbonisation capacity of the country is stepped up.

It can be expected that with the setting up of manufacturing units for high strength low alloy steels, constructional alloy steels, alloy tool steels, stainless steels, and heat resisting steels, many of the difficulties experienced by the Indian Machine Tool Industry would be removed.

From the foregoing, it will be obvious that although the Indian Machine Tool Industry has expanded quite fast and has been able to step up its production, it has to meet a great challenge.

With further plans for country's industrialisation, its requirement of machine tool will be growing, and the machine tool industry has to do its best to reach the stage of near self-sufficiency, if not self-sufficiency. The Machine Tool Industry's main task is to relieve the country of its main bottle-neck to rapid progress, namely, the foreign exchange shortage by building the mother machines that build all other machinery needed by our increasing number of factories for manufacture of all the goods and services required to raise the standard of living of our rising population.

STATISTICS REGARDING THE PRODUCTION OF MACHINE TOOLS IN INDIA FOR THE PERIOD 1951—1960

Calender Year	Annual production In Lakhs	Production at HMT In Lakhs	Indication in terms of points with 100 in 1951 as the Base Year	Increase in indigenous production without consideration to HMT's Production	Rise in terms of points on account of production at HMT
1951	47.31	—	100	—	—
1952	44.37	—	94	—	—
1953	44.08	—	93	—	—
1954	50.02	—	106	—	—
1955	74.40	—	157	—	—
1956	120.22	28.80	254	193	61
1957	250.84	124.00	530	268	262
1958	376.00	195.20	795	382	413
1959	439.00	246.40	928	407	521
1960	550.00	306.20 (948 Machines)	1163	361	802

With 100 points in 1951 as the Base Year, the increase in indigenous production of machine tools by the end of 1959 works out at 928 and has gone to 1163 in 1960.

HMT's production accounts for over 50 per cent of India's Indigenous production from the calender year 1957.

If HMT's production is not taken into account, the ultimate rise in indigenous production by 1960 would be only 361 points.

Automatic Electric Storage Water Heaters

With the increasing availability of electric power, the use of electrical appliances at home is on the increase. The safety of operation as well as safety to the equipment and personnel are of major importance to be taken into account while designing such appliances. Bearing these in mind the Indian Standards Institution has prepared a draft Indian Standard on Automatic Electric Storage Water Heaters.

This draft standard covers thermostatically controlled storage type electric water heaters designed to provide a ready supply of hot water at a maximum temperature of 85°C having nominal capacities between 6 litres and 250 litres and having voltage ratings up to 250 volts. However, electric water heaters and wash boilers which are used for obtaining boiling water and do not have thermostatic controls, are not covered by this standard.

* * *

MILD STEEL WIRE ROD FOR MACHINE SCREWS

On the recommendation of the Tariff Commission, Govt. of India, the Indian Standard Institution has prepared a draft specification for Mild Steel Wire Rod for the Manufacture of Machine Screws (By Cold Heading Process).

The draft standard covers the requirements of mild steel wire rod up to 20 mm. diameter suitable for the manufacture of machine screws by the cold heading process.

This draft standard (which is in English) will be shortly circulated to interested producers, consumers, and technologists for eliciting technical comments, which will then be taken into consideration before finalizing the draft as an Indian Standard.

TURRET MILLING MACHINES

In the following pages the Technical Director of a leading British company sets out the reasons for the recent growth in popularity of light vertical milling machines with motorised heads.

By James Selby, M.I.Mech.E., M.I.P.E. *

THE GENERAL TREND

MOST of the post-war developments in production milling have been the logical results of rising labour rates, making it economic to get faster machining times at the cost of greater capital outlay on Plant. We find, therefore, in most new models a substantial increase in power, together with large international standard spindle noses and sturdy arbors designed to contain the static and dynamic deflections which have, for so long, dictated the rate of metal removal in most milling operations.

Quick power traverse is no longer considered a luxury, pendulum cycles are becoming common and, therefore, backlash eliminators, or at least backlash limiting devices, are becoming standard.

These, however, are mainly the tools of batch and mass production for Plants operating to a planned schedule. What of the toolroom or the small jobbing shop, handling with skill and dexterity a wide variety of "one off" jobs, whether they be jigs, fixtures, dies, moulds, press tools, prototype components, or spares?

THE CASE FOR THE TURRET MILL

During this same period there has developed, with quite remarkable pace, a great demand for a range of machines which may broadly be classified as Turret Milling Machines, a typical example of which is illustrated in Figure I. At first sight machines of this type seem to be the direct antithesis of the developments described above, but on closer examination one can see that Turret Mills have come into favour because they also meet the demands of economics — those of an entirely different situation.

The merit of these modern light "verticals" is the great versatility which they offer when fitted with the wide range of attachments which they are designed to take. The addition of one of these machines to a small Plant can provide not only additional milling capacity, but also slotting, punch slotting, die sinking, cam milling, jig boring, drilling and tapping, all

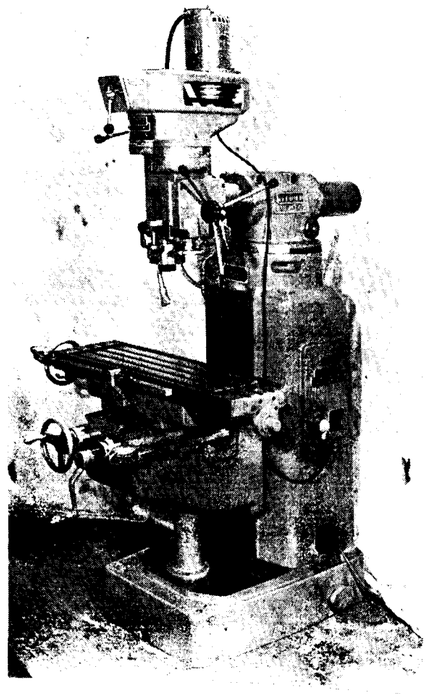


Fig. 1.

with practically no time lost in converting from one operation to the next.

DESIGN OF THE HEAD

The model seen in Figure I shows a basic Turret Mill which is obtainable either with a round overarm as illustrated, or alternatively with a dove-tailed cast overarm, and in either case the rear end is adapted to receive additional heads for slotting or for other functions. The machine is available either for hand feed only, or with the motorised power feed box which can be seen at the right hand end of the table. The milling head itself, as shown in Figure I, is a very simple and robust unit, having 10 spindle speeds ranging from 100/2600 r. p. m., and one rate only of quill feed advancing 0.002" per spindle revolution. The patented spindle and feed drive is of unusual construction, and is illustrated for its technical interest in Figure II.

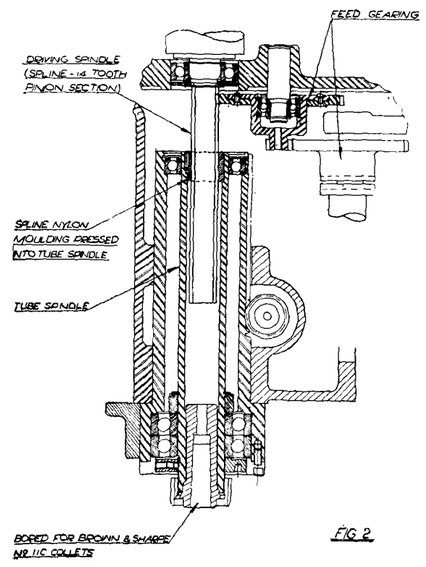


FIG 2.

It will be noted that the final drive shaft has a splined extension projecting down into the spindle, which is, in effect, a tube with a nylon moulding pressed into the top portion to establish the necessary splined relationship for a quill movement. The spline is actually a 14 tooth pinion section, so that it serves as a driving pinion for the simple feed motion, as well as driving the spindle. This construction locates the larger bearings where they will be of the greatest service, i.e. carrying the very rugged tubular spindle.

One inherent feature of this design is that one cannot use a draw bar, and in fact the spindle nose is bored for Brown & Sharpe No. 11C collets, so that parallel shank tools can be held directly in the spindle with a minimum of overhang.

Figure III shows the standard adaptor for taking tanged or tapped Morse shanks, the former being positively retained in the adaptor by an ordinary set screw before loading into the spindle.

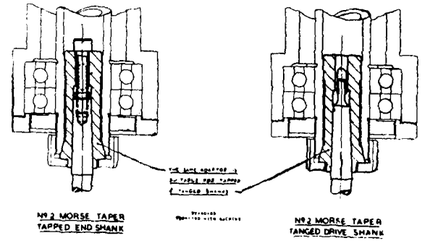


Fig. 3.

Figure IV shows the alternative No. 2 head which is interchangeable with that described above. This is of a more sophisticated construction, providing three rates of quill feed in both directions, speed overload clutches, and a slightly greater range of speeds. The spindle nose in this case is No. 30 I. S. T., complete with a No. 2 Morse adaptor, and a draw bar passes right through the spindle.

Both heads have automatic trips, fine and coarse hand movement to the quill, and a reversible drive.

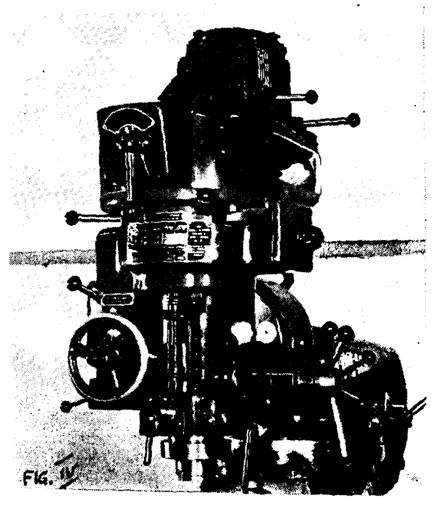


Fig. 4.

* Technical Director, B. Elliott (Machinery) Ltd., London.

The front bearings mounted in these spindles are Precision pairs suitably pre-loaded which, in addition to providing ample resistance to the fluctuating loads imposed by milling cutters, are also capable of yielding an excellent fine bored finish from a single point tool.

It is, therefore, appropriate to offer with these models precise work table positioning equipment for the boring of the holes at pre-determined centre distances on ordinates at right angles.

JIG BORING & SLOTTING

In Figure I the model TR1 (Turret, roundarm, No. 1 head) is shown fitted with troughs designed to take standard end measuring rods with micrometer heads and terminating with a dial indicator, this equipment having been applied both to the longitudinal movement of the table and to the transverse movement of the saddle.

Figure V shows an optical measuring system in which the glass scale rule carries graduations guaranteed to be accurate within 0.0001″ per foot.

It is not suggested that these machines should be used to bore holes for gear centres, dies, etcetera, to the limits expected from an expensive, single purpose

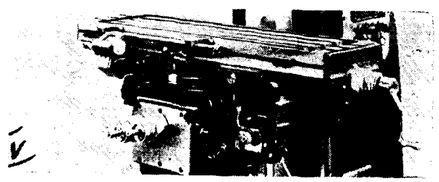


Fig. 5.

jig borer. The knee type construction and similar factors make it impossible to hold the various movements to the degree of squareness which one would expect from a traditional jig boring machine, but it is partly because of a more realistic approach to the manufacture of drill jigs that the usefulness of Turret Mills for less precise jig boring is coming to be recognised.

How often one has seen a most costly jig borer with a first class operator producing minor drill jigs for small components to limits of 0.0002′ on centres, in order to drill bolt holes with 1/32″ clearance!

In Figure VI there is shown a motorised slotting attachment, which can be mounted on the rear end of the overarm and brought into use as required simply by swivelling the overarm through 180° on a vertical axis. The most interesting feature of this attachment is that it can be supplied as a plain slotter or as a

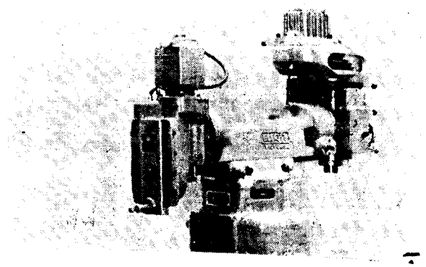


Fig. 6.

combined slotter/punch shaper, in which case the mode of operation is changed simply by making half a turn on a selector knob.

DIE SINKING

The machine shown in Figure VII is a Turret Mill provided with No. 1 head and round overarm and arranged for die sinking by scanning. In this case the jack screw which elevates the knee assembly is engaged with an elevating nut, which itself has a vertical movement up to 4″ deriving from a hydraulic servo cylinder. When copy milling, the stylus, carried on a cantilever beam attached to the side of the head, bears with a pressure of 12 ozs. upon the master former, which passes under it with the longitudinal movement of the work table; the servo cylinder causing the whole table and knee assembly to rise and fall as the contour demands. At the end of each pass the table dogs, extended far enough to reach the tripping device on the front of the knee, operate electric contacts contained therein to perform two functions, viz:—

(1) To effect reversal of the feed motor at the right hand end of the table.

(2) To energise a solenoid valve so that hydraulic fluid is conveyed to the pick feed device on the cross traverse screw, thereby putting on an increment of cross traverse, the amount of which may be pre-set, for the next pass of the cutter over the work and of the stylus over the master.

The response of the servo to the deflection of the stylus is at the rate of 9″ per minute per 0.001″ of stylus deflection, and from this data can be calculated the degree of error occurring on steep inclines for any given rate of table feed.

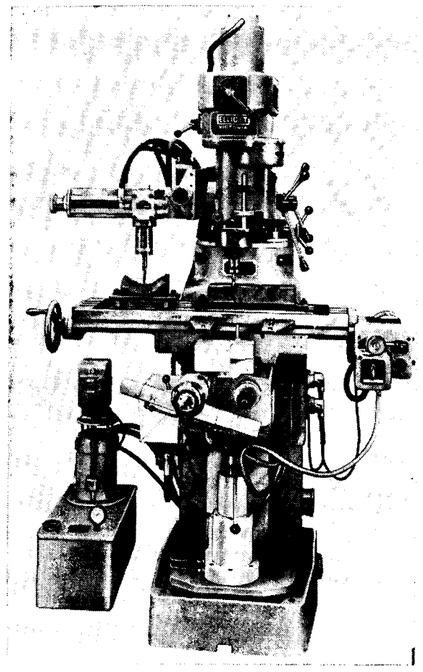
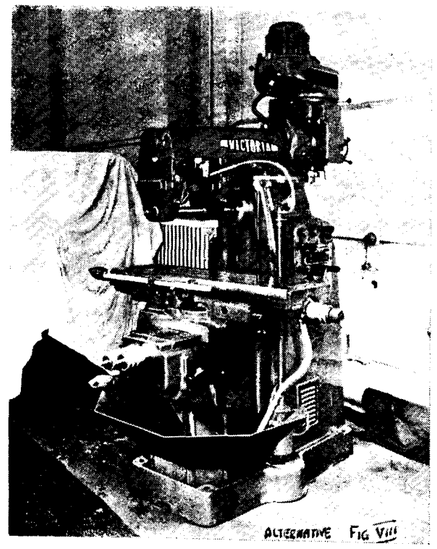


Fig. 7.

In practice, it is customary to use a stylus 0.004″ to 0.008″ larger in diameter than that of the cutter when roughing out, so as to ensure that no errors are created which cannot subsequently be removed by a finishing cut taken at a slower feed rate. For this final scanning, the stylus is replaced by one which is only 0.001″ to 0.002″ larger than the cutter. The table trips, to which reference is made above, can have adapted to them curved or other irregular templates, so that the length of the scanned stroke carries automatically as the saddle moves along the knee. Thus, for example, one could machine a circular work-piece with the stroke lengthening and shortening again as the operation proceeds, by adapting two semi-circular templates to the trips.

Another possibility, not illustrated in this article, is to replace the cross traverse screw with a servo cylinder so that the profiling movement is a transverse one. This arrangement can be used in conjunction with two Rotary Tables operated from a common



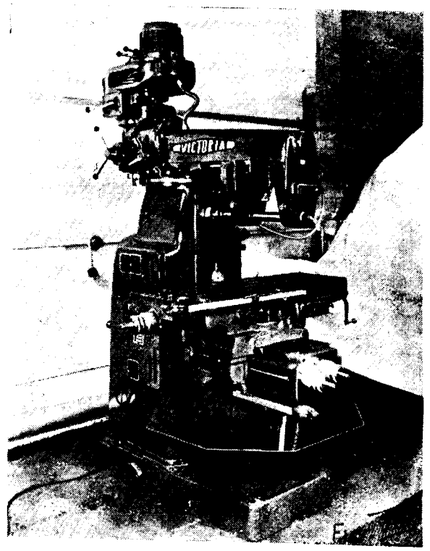


Fig. 8.

power source to produce any type of circular cam, the stylus bearing against a template mounted on one of the rotating tables, whilst the cutter engages the blank rotating synchronously on the second table.

COMBINED MODELS

In addition to the possibilities described in the foregoing paragraphs, Turret Mills have obvious inherent advantages, in that by combined adjustment of the cross-slide and of the ram it is possible to perform machining operations beyond the area of the work table surface itself. For the final development in this field, however, one must go to the combined Turret Mill and Universal Miller, as shown in Figure VIII. In the example illustrated the maker has adopted appropriately enough the name 'Omnimil'.

This machine from ground level up to, and including, the horizontal spindle is a standard Universal Milling Machine with power feeds in all directions. As such, it allows of all normal horizontal milling operations, including heavy face milling, straddle milling, gear cutting, helical milling, the generating of constant rise cams, the cutting of clutch teeth, etcetera. Yet upon removing the arbor and swivelling the overarm through 180°, the machine becomes in effect a Turret Mill.

In this case, slotting and punch slotting, as well as vertical and universal milling attachments, are mounted on the column as required, taking their drives from the horizontal spindle instead of being separately motorised.

A point of technical interest arises in connection with the method of table reversal when scan copying on the Omnimil. Since the feed movement is mechanically driven from the column, and the table direction lever will come to rest in Neutral if actuated by a table dog, the hydraulic copying version of this machine has a separate cylinder attached to the manual control lever, so that whereas on the Turret Mill the table trip reverses the table feed motor, on the Omnimil it causes pressure fluid to enter the above cylinder which, once started, will continue to move until it has taken the manual control through Neutral and into Reverse.

In the manufacture of the machines described in this article, one of the attractions to the user is that he has a wide choice of features from which to make up his own specification to meet his current needs, whilst noting that the remaining extras can be added at some future date.

Prices are usually attractive because of the extensive use of standard parts. Thus, in the case of the Omnimil, the greater part of the machine is built from components already being produced in economic batches and fully tooled for the manufacture of standard Universal Millers.

INDO-SWISS ALARM CLOCK PROJECT

The Government of India has approved the proposal of the Delhi firm of Union Watch Company to set up a project in India for the manufacture of alarm clocks with the technical and financial collaboration of the Swiss firm of Enicar S. A. of Lengnau. The Delhi firm is already manufacturing clocks at present with imported components.

The new Indo-Swiss project, it is learnt, will be operated by a new company called Enicar India Ltd., in which the Swiss firm will share a part of the equity capital of about Rs. 50 lakhs. The project envisages an annual capacity of 3,00,000 alarm clocks a year. Initially the clocks to be produced by the new firm will have 50 per cent of imported components, and it is proposed to produce Indian alarms clocks with 100 per cent indigenous components in about four to five years. Production is expected to start in about 18 months from now.

The Government has also approved the collaboration of the West German firm of Kasper and Company of Pforzheim with Asika Time Industries (Bombay) in a project for the manufacture of wrist watches. The project is sponsored by a consortium of seven leading watch Importers called Asian Clock and Watch Industries and will be operated by a new firm called Asika Time Industries. The factory is likely to be located in Coonoor and the capacity envisaged is about 3,00,000 watches per year. This will be the third project for wrist watches, the other two being that of Hindustan Machine Tools and that of Indo-French Time Industries (Bombay).

The new projects, with those approved earlier, are expected, when they go into production to meet India's requirements of watches and clocks substantially if not fully.

NEW POLISH MACHINE TOOLS FOR EXPORT

By An Engineering Correspondent

THE continuous widening of the range of machine tools produced in Poland has resulted in a considerable increase in exports of this line in recent years. At the same time the interest of industrial and trading circles in the dynamically developing Polish machine tool production has grown above expectation. Apart from the considerable increase in the volume of production, the reason for this lies above all in the great expansion of the range and modernisation of a number of machine tool models now produced. Old models are being replaced by completely up-to-date versions. The new machine tools meet all the latest technological requirements in this line of production. In other words, they are highly efficient, economical and easy in operation and maintenance, highly automated, and ensure fine precision and long service.

The outstanding feature of Polish machine tools is their high output, obtained through designs according to the world's top cutting tool technology, which makes for highly efficient machining. Up-to-date tools can be used to the best advantage in Polish-made universal machine tools because of their strong power drives, rigid construction and a wide range of speeds and feeds, ensuring the machining of various materials at optimum conditions.

The wide range of auxiliary equipment available for Polish universal machine tools guarantee their versatility for small and medium lot production, which is a very important factor in their economic utilisation.

The most essential development trend in the Polish machine tool industry is the movement towards comprehensive automation which is definitely entering up-to-date factories.

Many types of Polish machine tools are highly automated. Some of them aroused admiration of visitors to the 29th and 30th Poznan International Fair.

In the lathe division, besides fully automatic fixed-centre turret lathes, such as the BPU-4, 7/8, 12 and automatic turret lathes, models ATA-20 and ATL-40, production has lately been started of the TGB-10 copying lathe, with a programme of repeated automatic working cycle; the TMB-20 semi-automatic multicut lathe; and the TOA-40 Semi-Automatic Copying Lathe for wheel sets. For such machines we produce a number of hydraulic templets allowing much better used of universal machine tools in serial production of intricate turned parts at low cost.

A new achievement of our machine tool construction is a price of Auxiliary equipment for Automatic copying, model ATKB-12, which enables the TPC-40 Lathe to produce complicated parts semi-automatically.

The use of an electromagnetic templet in the KNA-110 Boring and Turning Mill considerably extends the production capabilities of the machine, and allows the machining of large parts so often used in modern designs.

Coming back to automatic lathes, a few words about two new models, the BPU-8 and the ATA-20. The BPU-8 Single-Spindle fixed-centre turret lathe is an original Polish construction. A number of patented features, such as the trip-dog for precision turning of several diameters eliminating the influence of the inaccuracy of machined cams, or the guiding and clamping device giving a larger output by cutting down idle time, place this machine in the highest class of this type of automatic lathes.

The ATA-20 Automatic turret Lathe has a large range of spindle speeds from 62 to 3,660 r. p. m., in two divisions of 40 speeds each. It is used for big-lot or mass production from rod stock or forgings, castings and other semi-manufacturers, and for this purpose has a very large assortment of auxiliary equipment for milling splines, templet threading and cross-

section boring, which is made possible by automatic cycle braking of spindle. Among many new design features there is a noiseless moving workpiece support which does absolutely no damage to the rod stock and ensures extremely noiseless operation. The cam of the turret attachment is placed on the outside of the machine for easy access and observation.

Of the grinding machines in series production the SWB-20 External Grinder is equipped with an active feed attachment. This allows a semi-automatic work cycle since, besides the automatic disc sparking, it gives an impulse to stop the grinding when the exact dimension is obtained, even with very small tolerance, and guarantees higher precision and machining efficiency.

In the group of milling machines, mention should be made of the new Semi-Automatic FCA-31 Tracer Hobbing Machine and the interesting FGC-25 Contactless Profiler. This machine has been designed for profiling intricate three-dimensional surfaces, e. g. dies for the plastics industry, matrixes, templets, etc. The working principle of this machine is that an electric spark between the tracer and the surface of the master model steer the tool by means of an electronic system and electromagnetic coupling. The use of a spark pick-up makes it possible to maintain a stable air gap so that the master model can be made of almost any kind of material (e. g. metal, gypsum) covered with a paint conducting electricity.

Another up-to-the-minute machine is the CRB-710 Saw which works automatically, from feeding the material for a set length to stopping the machine when the required number of pieces have been cut. The complete automation of this machine, as well as the short time and ease of adjustment allows one man to operate several CRB-710 Saws at the same time.

In the way of machines for plastic forming of metals, Poland produces new types of mechanical and hydraulic presses, and universal and guillotine shears. As auxiliary equipment to these machines Polish factories manufacture equipment automating the pressing process, as double roll feed, grip feeders, pull feeders as well as automating units with their own electric motors, devices for straightening and lubricating the band, the reeling and unreeling drums.

One of these machines is the new 100-ton PMS-100A Eccentric Press with a rigid welded body, two button and pedal steering, electro-pneumatic friction coupling as well as a pneumatic ejector. This increases the safety of operation and makes possible all kinds of strokes by the upper platen, required of up-to-date presses.

The NG-8 Guillotine Shears have been praised by users in Poland and elsewhere. The latest model has a number of improvements, such as adjustable table, optical instruments to facilitate the setting of the metal sheet, etc.

In order to reach such considerable achievements in the field of machine tool design the Polish industry needed many things, including: years of experience in this field dating back to the beginnings of the world's machine tool industry; specialisation by factories in the production of various types of machines; prime quality materials used in the manufacture; the latest word in technological manufacturing methods and constant research work by the laboratories and designers.

The " Metalexport " Foreign Trade Enterprise, sole exporters of Polish machine tools, strives to put the newest Polish machine tools on the world market at the earliest date possible. They hope that these machines may be of interest to purchasers from highly industrialised countries seeking efficient machines adapted to modern technology and industrial organisation.

Full technical and trade particulars may be obtained by writing to " Metalexport ", Warszawa, ul. Mokotowska 49.

IMPROVING METAL BY VIBRATION

Supersonic vibrations, according to a report from the USSR Central Institute of Ferrous Metallurgy, when applied to molten steel gives the metal vastly improved structure and properties. It was found that in some types of steel the treatment increased permissible deformation four-fold and allowed three-times the previous elongation.

Special Machine Tools for Railway Workshops manufactured in Poland

By An Engineering Correspondent

POLAND is one of the few countries which produce machine tools for railway yards. The "RAFAMET" Works in Raciborz Poland specialise in this field. The Sole exporter are METAL-EXPORT, ul. Mokotowska 49, Warszawa, Poland.

Machine tools for railway workshops can be divided into three groups:

(1) Lathes for machining wheel-sets,

(2) Burnishing lathes for machining wheel-set axle journals,

(3) Vertical boring and turning mills for machining wheel components.

1. Lathes for machining wheel-set are built in ranges covering all diameters of wheels and track gauges used.

The wheel lathe 1TCH/A is designed for machining new and worn wagon and tender wheel sets with tread diameter of 1100 mm. ($43\frac{5}{16}$ in.) and maximum axle length 2430 mm. ($95\frac{11}{16}$ in.), for track gauges within the range of 1435—1524 mm. ($56\frac{1}{2}$—60 in.). The semi-automatic wheel lathe 3TCH/A is for machining new and worn wagon, locomotive and tender wheel-sets up to a tread diameter of 2050 mm. ($98\frac{1}{2}$ in.) and max. spacing of the plates 3400 mm. ($133\frac{7}{8}$ in.), for track gauges within 1000-1676 mm. ($39\frac{3}{8}$—66 in.). The semi-automatic wheel lathe

TLA-140 is designed for machining new and worn wagon, tender, electrical and Diesel engine locomotive wheel sets—as well as for a certain range of steam locomotives, up to a tread diameter of 1400 dia. (55 in.) and axle length 2620 mm. (103 in.), for track gauges within 1435—1524 mm. (56½—60 in.).

The semi automatic wheel lathe TLA-112 is intended for machining new and worn wagon, tender, electric Diesel and steam locomotive wheel sets up to a tread diameter of 1120 mm. (44 in.) and max. axle length 2710 mm. (106 in.) for track gauges within 1000-1676 mm. (39⅜—66 in.). The electric drive of this lathe, through a Ward-Leonard system, enables stepless adjustment of speed.

2. Turning and Burnishing Lathes TBG and TBG/U, are designed for turning and burnishing axle journals on wagon and tender wheel sets. Centre height 634 mm (25 in.). The lathes TBG are supplied for one track gauge only, specified by the customer, while the lathes TBG/U are universal machines for track gauges within 1435—1676 mm. (56½—66 in.).

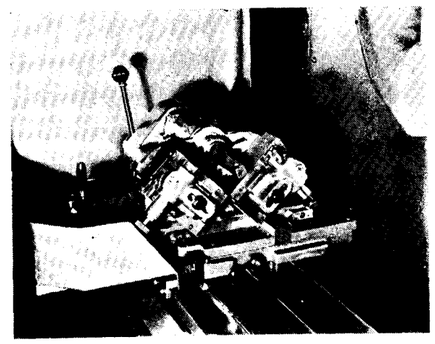
3. Vertical boring and turning mills are for machining new and worn tyres and wheel centre discs on railway wheel-sets. The mill KO 10/A has a table of 1550 mm. (61 in.) diameter, and can be used for machining tyres up to a diameter of 1250 mm. (49¼ in.) The mill 2½ KBE-4 has a table of 2300 mm. diameter (90½ in.), and is for machining tyres up to a diameter of 1900 mm (74¾ in.).

"Jones-Shipman" Crush-Form Grinding Machine with Automatic Cycle of Operation

THIS machine is an adaptation of a standard "Jones-Shipman" Model 1012 Crush-form Grinder of proven design and having the same predominant features for precision form grinding.

It is arranged with power driven vertical wheel feed and rapid return, hydraulic table traverse giving infinite variation of table speeds up to 80 ft. per minute, and provided only with hand cross feed for setting purposes. All controls can be electrically interlocked to a Master switch giving automatic cycle of operation.

The Master switch has two positions, "ON" and "OFF". If the table starting lever is turned to the run position, neither the table nor the vertical feed will operate until the Master switch is turned to the "ON" position.



With the Master switch turned to the "ON" position, and the table "START" and "STOP" lever turned to the "run" position, nothing will happen until the button labelled "START CYCLE" has been depressed, but what happens then is dependent upon the position of the second switch, which has three positions and controls the feeding operation. The three positions on this switch are "UP", "AUTOMATIC", and "DOWN". With this switch set in the "UP" position, the feed hand wheel will remain at the top, or "UP" position, despite operation of the "START CYCLE" button, but when the "START CYCLE" button is operated, the table will run and reverse continuously, and the table movement can then be stopped, either by use of the "STOP-START" lever or by usage of the electrical control labelled "RETURN CYCLE", which is, in effect, a stop button, so that with the feed switch set to "UP", the "START-STOP" button having been depressed, the table runs normally under the control of the "STOP-START" lever and its throttle controls. It can thus be run during setting operations, etc.

The same effects occur when the switch is set to the "DOWN" position, except that, in this case, the feed will move downwards to its bottom limiting position and remain there, again for the purpose of setting operations, etc.

If, however, the switch is set to "Automatic", the following cycle of operations will occur.

When the "START-STOP" button is depressed, the table will move from its run-out position to bring the workpiece under the wheel, and will commence reversals to a stroke length as set by the reversing dogs, and continue to reverse. The feed hand wheel will commence rotating downwards at a minimum feed rate of approximately .075″ per minute, which gives approximately .0006″ per stroke at 120 strokes per minute, the maximum feed rate being approximately 3″ per minute.

These two operations, i. e., table reversing, bringing the workpiece under the wheel and feeding downwards, will continue until the feed reaches a predetermined downward position, and at this situation a contact will be broken, which causes the feed rapidly to reverse upwards to its utmost stop and causes the table reversals to break down, running out to the left until stopped by the operation of the limit switch arrangement previously described.

The maximum depth of feed which can be covered will be approximately from 0 to .22″.

An ordinary over-riding feed arrangement on the face of the handwheel allows the feed to be set downwards as required, to compensate for wheel wear. A clamp, also accessible from the face of the handwheel, allows the feed handwheel to be decoupled from the automatic feed arrangement for setting or hand control operations.

Specification for 72" Spline Grinding Machine

THE machine has a capacity of 72" between centres and has a working stroke of 84" of which 66½" is useful grinding length, the remainder being occupied in "run-out" over the tailstock to the two truing positions. The centre height of the machine (workhead centre to table top) is 7" and the range of vertical adjustment of the wheelhead measured between the wheel spindle centre line and the work centre line, is from 3½" to 11½". The machine is capable of grinding zero work diameter with a wheel worn down to 7" diameter or 13" work diameter with a new 10" diameter wheel.

Note that the wheel centre line will not reach the work centre line for the purpose of grinding centres. Centre grinding can be accomplished by the use of a small portable grinding attachment (not supplied with the machine).

The wheelhead support column has no cross traverse, the necessary diamond positioning for side arc truing of the wheel being obtained from movement of the truing arrangement mounted on the table.

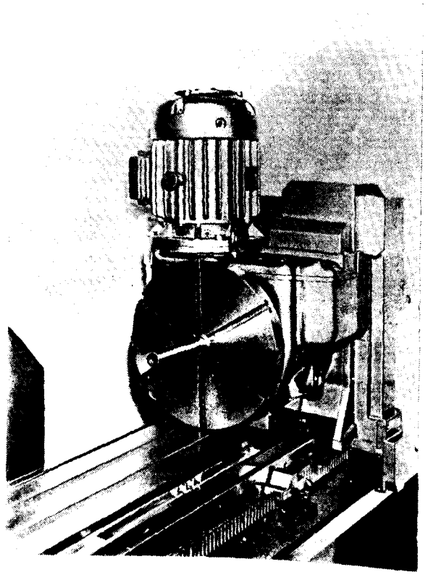
The bed of the machine is a single casting, equipped with normal vee and flat sliding surfaces and an adequate number of foundation bolt and jacking points. The table is practically fully supported by the bed, i. e. at maximum stroke there is only a very short overhang of the table slide ways. The slide ways are covered by half-guards but this half-guard system is supplemented by a covering belt which renders the slide-ways and the whole interior of the bed, fully covered.

The upper table surface has a dove-tail section and all the table equipment is clamped to the dove-tailed section. This arrangement enables the table equipment securing bolts to be easily accessible and out of the way of cross slides, etc., on truing device and tailstock.

The wheelhead support column is a large stable column, bolted directly to the back of the bed. The vertical slide for the wheelhead is bolted to the face of the column, and is slightly adjustable for angle, so that alignments concerning squareness of the wheel can be secured by an adjustment, leaving only a linear motion of the wheelhead to be arranged for by normal machining and scraping methods.

The wheelhead slide is a long slide, fitted with square gibs. Three taper adjusting strips are provided at each extremity of the wheelhead slide; these ensure a snug fit in both planes of the wheelhead to the wheelhead slide. The wheelhead is vertically adjustable by means of a handwheel working through a worm wheel and screw. The complete feeding system, including the feed screw, is entirely submerged in an oil bath.

The wheelhead feed handwheel gives .050" per rev. feed with an additional fine feed arrangement graduated in, and capable of moving the wheelhead by, increments of .0001".



Balance chains lead from the top of the wheelhead over ball bearing pulleys at the top of the wheelhead column; the balance chains are attached to a long cylindrical balance weight. The balance weight is made up of slotted sections which can be pushed onto a hanger bar, so that the total weight can be adjusted, and so that the balance weight can be assembled and removed in sections through a cored hole in the back of the wheelhead support column.

The wheel spindle housing is a demountable unit ; it is clamped at the front, or operating end, the rear end is mounted in an adjustable plate, this adjustment again being concerned with the maintenance of coincidence in one plane, with the line of traverse of the main table.

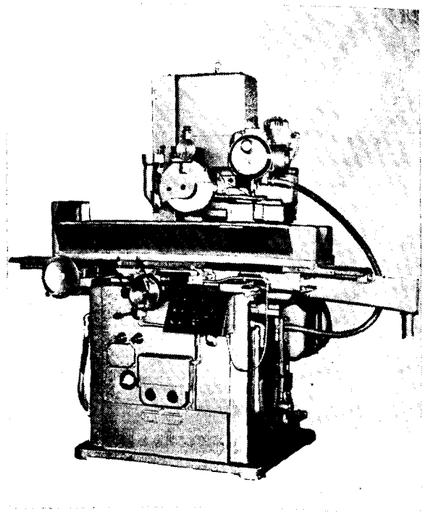
The wheel spindle is nitralloy, running in lead bronze bearings ; thrust arrangements are provided for by a central collar engaging two sliding bronze shoes. An external adjusting knob provides a means of adjustment to the " nip " of the two shoes on the thrust collar.

The wheel spindle can be moved over a range of $\frac{1}{2}$" in the direction of its axis, and through its own bearings, by moving the complete thrust arrangement, using taper wedge methods controlled by a thumb wheel on top of the wheel spindle. Axial movements of the wheel spindle can be registered on a dial indicator, the whole arrangement providing a fine side feed motion which, due to the fact that the sliding member is itself the wheel spindle, gives adequate sensitivity. Axial movements of the wheel during warming up from cold to normal running temperature cannot be avoided, but their effects are kept to a minimum by keeping the running temperature as low and as constant as possible. To this end, the wheel spindle bearings are of a type which tends to run at constant temperature, setting its own clearances to suit, and wheel spindle lubricant contains fair proportion of Kerosene.

The wheel spindle nose is extended to allow the usage of wide wheels or pairs of wheels, it has a taper nose. A section through wheel spindle nose, showing the types of wheel collets possible. Wheel collets can be provided to suit user requirements, they are omitted from this present quotation and will be quoted for separately upon establishment of requirements.

Returning to the table equipment, the indexing workhead is hydraulically operated from its own self-contained unit, but is electrically signalled into and out of action. The accuracy of indexing is dependent solely upon a notched plate, a pivoting indexing pawl is kept in contact with one face of the notch, both by a plunger under spring load, and by hydraulic torque. The maximum number of notches catered for as standard is 48. This figure can be extended to suit special requirements at extra cost. One index plate having 48 notches, with masking plates to give 2, 3, 4, 6, 8, 12, 16 and 24 divisions, is provided with the machine ; extra index plates can be quoted for separately. To change the indexing sequence it is necessary to change only the index and/or masking plates.

The tailstock has a main sliding member supported on dove tail guides. For maximum stability, the vertical adjustment of the tailstock is provided for by arranging the main frame as a pivoted member, the pivot centres being set so that small vertical increments do not significantly alter the cross adjustment. There is a sliding base provided, upon which cross adjustments can be made.



The truing arrangements has enclosed sliding members and arrangements are made for securing a cross traverse having a range of approximately 3" each side of centre, in order to produce side truing effects.

Hydraulic power supply for the main table comes from an external oil tank, the position of which can be seen on the drawing, which also shows the position of the coolant tank. The maximum table speed is 60 ft. per minute.

Electrical arrangements are not built into the machine. They are contained in a cabinet, floor-mounted, alongside the supply tank, as can be seen in the arrangement.

The major hand control is a combined " stop-start ", speed control, and hand traverse engagement lever. This is a lever having a " joy-stick " movement in that centrally positioned, it is capable of a short movement towards and away from Operator, this movement taking place in a gate. In the " off " position the lever is spring loaded to the rear of the gate, away from the Operator, and in this position the throttle governing the table speed is completely shut off and the main pump is running against reduced pressure, thus conserving power. From this position, the lever can be rotated anti-clockwise and this has the effect of engaging a hand traverse mechanism which must be disengaged by returning the lever to the centre position before power movement of the table can be engaged, thus forming an inter-lock.

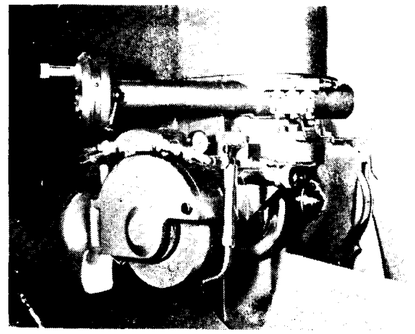
With the lever again at the central position it can be pulled slightly towards the Operator. This movement applies full working pressure to the system and positions the lever in the gate so that it can now be moved in a clockwise direction. The table will then move at a speed depending upon the extent to which the lever is rotated clockwise. A stop is provided so that the same traverse speed can be engaged repetitively.

To stop the machine, the lever is centralised this will shut the machine throttle and the lever will spring inboard to give the reduced pressure effect, also providing a look against accidental disturbance.

As heretofore described, from this centre position either the hand traverse or the power traverse may be engaged.

Reversing of the table is effected by a reverse lever operating a pilot valve which controls a main slave valve, which then reverses the table. This system is good enough for ordinary surface grinders where variability in over-run, (due to variation of oil temperature and table speed), is of little account, but it has been extended to secure a reverse with a relatively accurate and stable reversing point. There are provided, in addition to the reversing lever, three plungers, operated upon by the inclined under surface of three dogs attached to, and moving with, the table. Two of these dogs are concerned with reversing, the third dog, (the one on the extreme left), is concerned with stopping the table in the position in which the wheel is directly over the leftmost or side truing diamonds, this coincidence being assured by adjustment of the truing device in relation to the position of the extreme left-hand dog, or vice-versa.

A control switch is provided which switches the indexing operation either " in " or " out ". In the " out " position, indexing will not take place, and if the table is started with the indexing set at " out " it will, subject to indexing interlocks described hereafter, run continuously between limits of stroke set by the reversing dogs, at a speed set by the amount of opening of the throttle.



As either dog approaches the reverse lever, the inclined under surface of the dog depresses a tappet, or plunger, which is, in effect, an exhaust throttle valve which slows down the movement of the table prior to contact with the reversing lever, so that the movement of the reverse lever occurs always at a constant low speed, irrespective of the throttle setting. By this means, constancy of reversing point is achieved within tolerable limits.

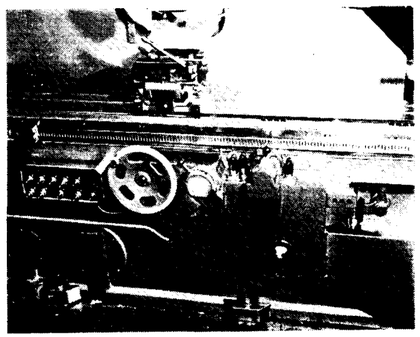
The reversing lever is also " joy-stick " mounted, i. e. it can be pulled against a spring towards the Operator. When it is so pulled the right-hand dog will still remain effective but the reversing lever will miss the left-hand reversing dog because of mechanical clearances effected by side movement of the reversing lever, accompanied by hydraulic internal action which render ineffective the slowing down normally associated with the left-hand reversing dog. Thus, by pulling the reverse lever outwards and setting it to move the table to the right, the left-hand reverse dog will be by-passed. The table movement will continue until the extreme left-hand dog operates upon another tappet, which again slows the speed of the table.

The table speed will be reduced to a crawling speed and an internal arrangement, operated by continued depression of the tappet, will switch the oil supply over to the pressure reduced conditions under which the

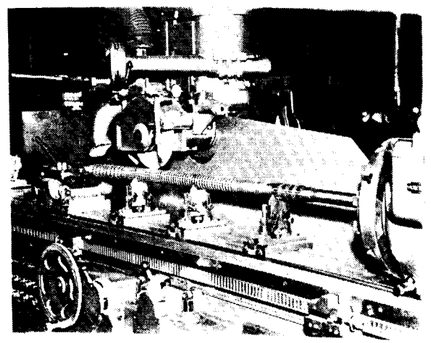
table will not move, thus, when automatically stopped in such fashion, the hydraulic system is running under reduced load. The reversing lever will remain set to move the table to the right, although the table will be stationary. Side truing may be carried out at this position. Movement of the " stop-start " lever can then engage the hand traverse and the table can be hand wound leftwards to the radial truing position. Hand traverse may then be disengaged and the throttle re-opened. The table will not move leftwards, however, until the reverse lever is thrown over to cause it to so move, or, reversing lever may be thrown over to cause the table to move to the right before the throttle is opened, in which case the table will move to the right when the throttle is opened.

The foregoing describes the conditions with the indexing operations switched " out ". With the indexing switch " in ", the table will run leftwards and reverse normally at the workhead end, and will then run rightwards and come to the left-hand reversing point, slow, down, and throw over the reversing lever.

Attached to the workhead is a cam which can be rotated through 90° by contact with an indexing dog, the dog being slidably adjustable on a carrier (" index rail "), at the right hand end of the machine. This dog should be set to operate the index cam as soon as the wheel is out of the cut, and just before the left-hand reversing point is reached.



The signal to index is given when the index cam is rotated through 90° by the index dog. When so rotated, a spring loaded index locking plunger engaging a notched index disc in the workhead is hydraulically withdrawn. A hydraulic motor causes the workhead to rotate until an index pawl has been lifted out of one notch and commences to fall into the next notch. When the index pawl falls, rotation of the workhead spindle is reversed and the engaged notch is forced back against the index pawl. When the index pawl is completely engaged, the spring loaded locking plunger is released and supplements the reversing torque from the hydraulic motor, to keep the index pawl firmly against the face of the notch. The only purpose of the spring loaded plunger is to hold the workhead spindle locked in the event of failure of electric or hydraulic supply to the workhead.



While these operations are going on inside the workhead, four separate inter-lock bars have engaged themselves with the 90° rotation of the index cam. The movement of the solenoid valve causing the spring loaded locking plunger to withdraw, protrudes a lock bar into the path of rotation of the index cam ; so long as this lock bar remains in the engaged position, the index cam cannot be rotated backwards through the 90° of movement which was imparted to it by the index dog and which caused the indexing operation to start. The solenoid operating the valve which causes forward rotation of the workhead spindle, also protrudes a locking bar in the same fashion, independently having the same effect.

Movement of the indexing pawl protrudes a lock bar and the movement of the index locking plunger also protrudes another lock bar. Thus, unless four conditions are fulfilled, the index cam will be locked in the indexing position. Furthermore, the lock bars give the reverse interlock condition, so that, until the index cam has been mechanically rotated to the index position, solenoid valves and locking plungers are mechanically locked. This has the effect that, even if the workhead were to receive a faulty signal

to commence index, the signal would not be obeyed unless the index cam has been properly rotated by contact with the index dog, in which case, if the index dog is properly set, the wheel is out of the work.

The four conditions are :—

(a) The solenoid providing oil supply to the locking plunger is switched off.

(b) The solenoid providing oil supply to the hydraulic motor is set to rotate the workhead spindle against the index pawl, engaging a notch.

(c) The index pawl is fully engaged with a notch.

(d) The locking plunger is fully home.

The fulfilment of these four conditions means that the workhead is properly indexed and allows all lock bars to release the index cam. Unless all lock bars have released the index cam it will be locked, so that if, for any reason with the work not properly indexed, the table starts to move leftwards into the cut, the indexing cam will not rotate.

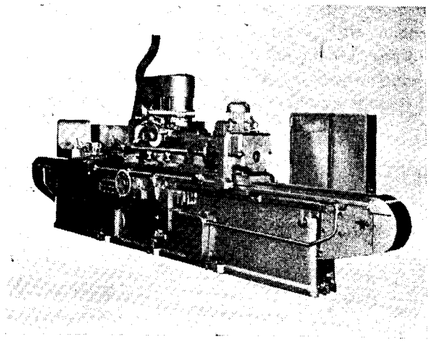
The index rail upon which the index dog is mounted is not rigidly fixed, but is held by spring loading to such a degree that it will not move when the index cam contacts the index dog, with the index cam in such a condition that it is free to rotate, which signifies that the work is correctly indexed.

If, due to the workhead not being correctly indexed, the index cam is locked by any one or all of the four lock bars described, any movement of the table tending to move the wheel into the work will result in a linear movement of the spring loaded index rail. This movement operates a valve which allows the main valve of the machine to drop immediately to the " shut off " position, thus stopping the table and picking up the reduced pressure conditions.

In normal operation, with the index switched " in " rightwards movement of the table will cause the left-hand reverse dog to operate a slowing down plunger and to throw over the reversing lever so as to set the table to move to the left. Just prior to this, the index cam will be rotated by the index dog and cause indexing to commence. The movement of the index cam also breaks electrical supply to a solenoid operated valve which must be energised to allow the table to reverse into the cut. On contact with the left-hand reversing dog, the table will not reverse, but will delay until the solenoid circuit is restored.

The solenoid valve will not be re-energised until all lock bars in the workhead are clear of the index cams, signalling a " safe to proceed " condition. The table will then pick up its leftwards stroke and run the wheel into the cut.

Additionally, there is provided a button which will, when depressed, cause the workhead to rotate continuously; it can be stopped at any desired



indexing position by releasing pressure on the button. This button is operative only when the indexing cam has been rotated 90° by contact with the dog on the index bar, in which condition, if settings have been correctly made, the wheel must be out of contact with the work.

As a further safety measure, the continuous running button will not operate until the " stop-start " lever has been moved to the " stop " position ; it will also not operate unless the index is switched " in ".

The index cam is also provided with an interlock, so that it can only be rotated by contact with the index dog. This arrangement is to guard against interference by hand with the index cam.

Steadies are not mentioned in the foregoing text, they vary according to user requirements and will be quoted for as required.

NUMERICAL CONTROL SYSTEM ON PRECISION MILLING MACHINE

Equipment designed for continuous numerical control is to be fitted to a (CONTIMATIC 1520) precision milling and boring machine (exhibited by the Newall Engineering Company Ltd.) which is to be shown at the European Machine Tool Exhibition, Brussels, September 3—12.

The system has been developed by an electronic engineering firm to effect economies in the production of simple components, and to permit the automatic production of workpieces of complex shape, particularly those where accuracy of form and position associated with a superior finish is essential. The system not only provides for continuous control of all axes simultaneously, but can also govern a single motion of any combination of the movements available.

Thus, with a high output potential, the type of machine equipped with this system gives considerable scope for employment—it may be used for conventional jig boring with positioning under tape control: and it may also be employed for precision milling under manual or tape control.

To overcome the problem of available cutters not being precisely the correct size, the system includes a Cutter Radius Correction Control which enables a correction for variation of cutter diameter to be set into the controller, and so modifying the tool path to one appropriate to the particular cutter in use. In addition, this control can be used to make roughing cuts, employing only one tape for both roughing and finishing.

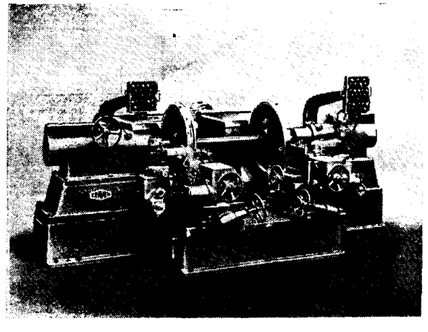
Recent Development in Machine Tools for Reconditioning Railway Wheels and Axles

THE new Craven Friction Roller Drive Wheel Lathe is indicative of the changing requirements in railway workshops as a result of the rapid change over from steam to diesel and electric motive power. The lathe effects important economies in work setting times and is provided with automatic profile copying equipment; it is admirably suited to re-turning wheel sets at frequent intervals to maintain the requisite high degree of tread and flange form accuracy on diesel and electric traction wheel sets.

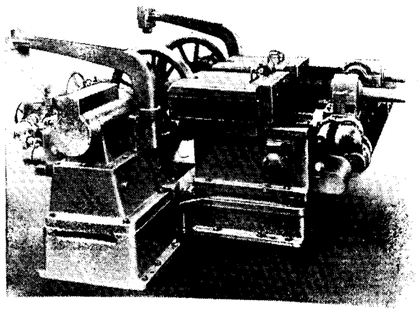
This recent development provides for the use of carbide cutting tools for re-turning brake and skid-hardened wheel sets with plain or roller journal bearing axle boxes in position. The wheel set is carried between revolving centres and the "Craven" patent drive is by a pair of friction rollers to each wheel. The rollers are tapered and engage the wheel rim at an angle, each pair being mounted in independent and opposed sliding blocks, which are hydraulically operated to provide a fully balanced, self-contained thrust of sufficient pressure to transmit the necessary driving torque. The adjustment between each pair of rollers adequately accommodates wheels of varying width.

The friction roller drive saddles are separate, but advance in unison to the driving position and are electrically tripped to maintain a correct relationship between the driving rollers and the tread, within the wheel diameter range of the machine.

The hydraulic supply for operating the roller grip is by a motor-driven dual pump unit, and after the grip has been applied the driving pressure is maintained during the driving operation by one pump only.



In this wheel lathe the wheel sets are supported between centres and are driven by hydraulically-loaded friction rollers.



Rear view of the machine showing the two driving roller saddles and the main motor and gear box.

The drive is by a 48 h. p. two-to-one commutator motor through a three-speed gear box, giving an infinitely-variable range of cutting speeds between 50 and 160 feet per minute.

The machine is fitted with the "Craven" patent electrically-operated profile copying equipment on each tool rest to re-machine simultaneously the tyre profiles of both wheels.

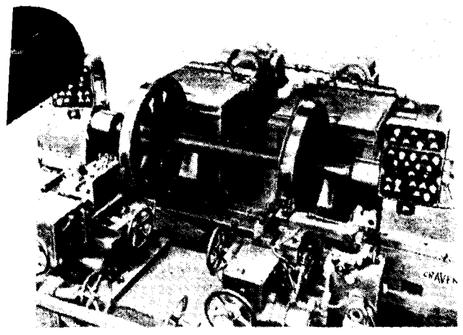
The tool slides are set to the correct gauge, and have transverse adjustment, to setting gauges, for accommodating the various wheel diameters. Hand adjustment, power feed and quick power traverse are provided in both the longitudinal and transverse directions on each tool slide. Separate variable-speed motors provide the power feed longitudinally and transversely, and when profiling, these motors are automatically controlled by a tracer head stylus applied

to a template. The feed motors are also used for the quick-power traverse of the slides in both directions.

The "Craven" electrical copying equipment obviates cams or clutches and uses a single round nosed or square section tool to complete the tread and flange form in a continuous profiling operation. The arrangement is in no way dependent upon the use of electronic valves and, being of the most robust construction, is ideally suited to the arduous conditions encountered in railway workshops.

Electrical control is embodied in two swivel-mounted push-button stations on the machine.

A selector switch determines the direction of stylus approach to the template and ensures the correct sequence of longitudinal and transverse movements. The profiling motion is started and stopped by the appropriate push-button switches, and rapid approach



Each tool rest has an independently-controlled set of profiling equipment.

of the stylus to a point near the template (with an accompanying advance of the cutting tool towards the workpiece) can be made by pressure of a special push-button. Subsequent release of the button allows the advance to continue at copying speed until contact with the template is made, when profiling proceeds automatically under the influence of the stylus.

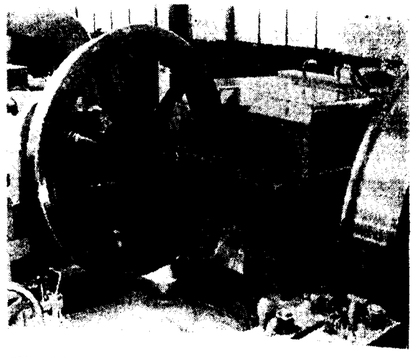
During normal production operations, speed variation of the two profiling motors, when approaching flanges etc., is effected automatically in accordance with the contour of the template. Means are included however, whereby the operator may have complete speed control of the motors through hand-operated variometers, a feature which has definite advantage when dealing with badly worn or brake hardened wheels.

A separate electrical control button enables the tool to be withdrawn momentarily from the work, at copying speed, for inspection or other purposes, and then to return and resume cutting automatically without loss of contour form. A further control for use in emergencies or upon the completion of the operation, withdraws the tool at high speed to a position of safety clear of the workpice and finally brings the whole motion to rest. The moving members can then be quickly traversed back to the starting point preparatory to the commencement of a second cut or operations on a new pair of wheels. Additional safety contacts illuminate a warning light on the control station in the event of over-deflection of the stylus and further lights indicate that the equipment is ready for copying or that copying has actually commenced.

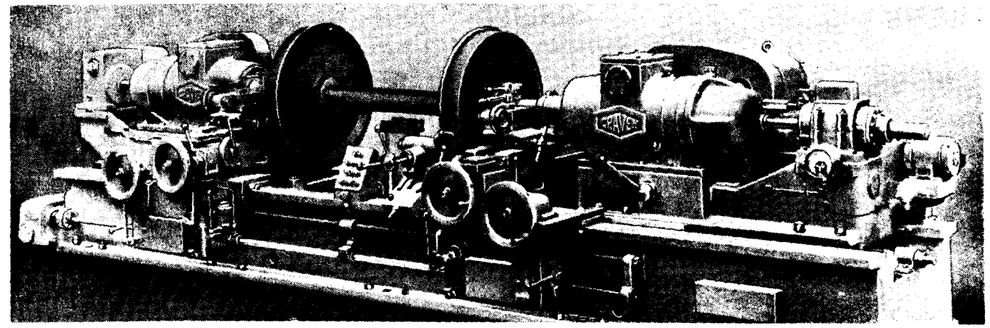
This type of machine will accommodate any gauge, and wheels from 30 in. to 48 in. or 36 ins. to 60 in, diameter, the tread and flange form being determined by the template.

The machine illustrated deals with wheel sets of 4 ft. 8½ ins. gauge with wheels from 36 in. to 60 in. diameter, which are loaded into the machine by overhead crane or similar lifting equipment.

Alternatively, the machine can be provided with tool slides able to move outwards by power motion to permit of wheel sets being rolled in and raised to centre height by lifting jack incorporated in the machine.



The friction rollers are of tapered form and drive on to both faces of the two wheel rims.



A new "Craven" axle lathe, designed for the exclusive use of carbide cutting tools and suitable for machining the journals of new or used axles.

A new "Craven" High Speed Axle Journal Finish Turning and Burnishing Lathe has also been introduced recently. Arranged for the use of carbide cutting tools, this machine is suitable for turning and burnishing the journals of new or used axles, with or without their wheels in position. It will admit axles up to 8 ft. 6 in. long and wheels up to 3 ft. 6 in. tread diameter.

The axle is supported between spring-loaded centres and is driven from both ends simultaneously by driving plates, with knife-type driving dog inserts, secured to the rotating spindles of left and right hand head stocks. End pressure to engaged the dogs and to transmit the torque is applied by hydraulically-operated longitudinal movement of the right-hand headstock upon an intermediate sandwich plate.

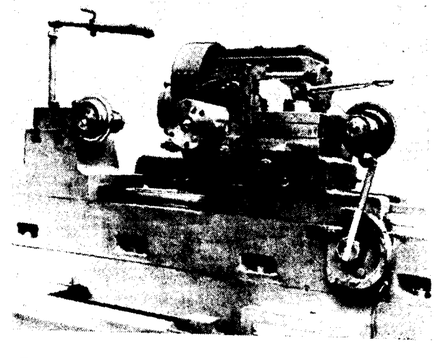
The two headstock spindles rotate on roller journals and are driven by two separate 10/5 h. p. two speed motors electrically synchronised to rotate in unison, giving spindle speeds of 300 r.p.m. for turning and 150 r.p.m. for burnishing. Spring-loaded centres permit the slight axial movement of the right-hand spindle and of the workpiece, which takes place when the driving dogs are engaged.

There are two saddles with sliding and surfacing feeds, for turning both journals simultaneously. The front rest on each saddle has a two-station tool turret, one station carrying a special turning and radiusing tool holder and the other a front burnishing roller. The rear rest carries a rear burnishing roller only. Feed drive is obtained from a separate two-speed motor and two-speed gear box, which gives fine speeds for turning with carbides and course feeds for burnishing.

When burnishing the front and rear rollers applied, and the necessary pressure is exerted by simultaneous hand adjustment of the two rests through a single transverse screw with both left and right hand threads. End float in the screw bearing permits the rollers to accommodate themselves to the journal without imposing side thrust on the lathe centres.

Rotation of the total turret prepares the front rest for turning. The two rests, together with the transverse screw and its bearing are then moved forward en bloc by single lever action, to bring the cutting tool into its operating position and to move the rear burnishing roller clear away from the workpiece. The rests are automatically locked in this position.

The design of the tool holder enables the turning tool to be clamped in its normal position for cylindrical



Drive is transmitted to the two end faces of the axle by driving plates with knife type dog inserts mounted on the two headstock spindles.

turning, but to be quickly released and swivelled about a vertical fulcrum by handlever to produce either hand of journal radius.

An electrical wheel lift is provided for raising the wheel set into line with the machine centres after being rolled into position on rails. A hand brake quickly brings the workpiece to rest and assists in the withdrawal of the driving dogs.

The left-hand headstock has electrically-operated longitudinal adjustment upon its sandwich plate for setting to suit different lengths of axle. Both headstock assemblies have hand adjustment upon the bed.

NEW EXPRESSES FOR INTERSTATE TRAVELLERS

Two new air-conditioned expresses for the run between Sydney, capital city of the State of New South Wales, and Melbourne, capital city of the State of Victoria, will go into service when the uniform gauge line is completed.

Easter, 1962, has been set as the target for the introduction of these trains.

The trains hauled by two 1800 h.p. locomotives at express speeds, will represent an investment of nearly £2 million.

The required 34 carriages (including spare ones) will be of gleaming stainless steel and built by Common Wealth Engineering Co. at its Granville (N.S.W.) Works.

The sleepers will be similar in style to new roomette and twinette carriages that the same company is already building for the Sydney-Brisbane journey; and will bring the same high standard of travel comfort to the Melbourne-Sydney run that The overland now provides between Melbourne and Adelaide.

Each train (of 14 carriages) will consist of roomette and twinette sleeping carriages, a dining car, a club car, a brakevan, and a power car that will generate electricity for heating, lighting, cooking and air-conditioning.

Each bed in the train will have a foam-rubber mattress and individual reading light. The berths, when folded, will provide seating for daytime travel. Wash-basins, W. C., mirror, wardrobe, and other facilities will permit the utmost privacy for the traveller. Chilled drinking water will be on tap and a venetian blind on each window.

Every sleeping carriage will carry 340 gallons of water; and while the double berth twinette cabins will have their own hot and cold showers, travellers in the single berth roomette carriages will be able to enjoy the same luxury in shower rooms at the end of their carriages.

BED SITTING ROOM

With each train, there will be a de-luxe twinette sleeping carriage that will have in the centre a bed sitting room complete with arm chairs, and at one end two family units each comprising two twinette cabins linked by a connecting door.

The dining car, with stainless steel equipment in its kitchen, will serve 48 passengers, in one sitting, with three course meals or light refreshments.

CLUB CAR

Light refreshment will also be available in a Club Car. This carriage will be divided into three sections by armour-plate glass. Its lounge will seat 40 passengers and there will be a writing table and small portable tables for the convenience of travellers.

Other features of the Club Car are refrigerated cabinets for cold drinks and ice cubes; water and coffee urns; cupboards; service table; sinks and drainer; shelves and racks, together with power points for toaster and hot plate.

STAINLESS STEEL CONSTRUCTION

Spot welding, based on the latest overseas structural practices, will be used in the construction of the new carriages which will be sheathed with the first Australian rolled stainless steel manufactured for railway carriages.

One hundred and eighty-seven tons of this steel, which will be made at the new Unanderra (N. S. W. South coast) mill of the Commonwealth Steel Co., will be required. It will be delivered in coils, and the giant strips, fluted for strength and rigidity, will give the carriages a characteristic appearance. A total weight saving of 84 tons per train (equal to two sleeping carriages) will be made by the use of this steel and, of course, no painting will be required.

A two-inch-thick lining of fibre glass insulation will keep noise down to a very low level, and, at the same time, help to maintain the comfortable temperatures provided by the air-conditioning plant. Twenty miles of electric cable will be used in the trains.

Both roomette and twinette carriages will have 20 berths, and the de-luxe twinette cars, 18; making a total of 198.

Dependable G-E diesel-electrics chosen to haul ore through African jungle

Seven General Electric universal model diesel-electric locomotives will soon be operating in the tropical jungles of central Africa. These 1330-hp locomotives were ordered by the French Mining Company COMILOG (Compagnie Miniere de l'Ogooue) to haul thousands of tons of manganese ore daily to a coast port 300 miles away.

From the mine site located along the Ogooue River near Franceville in the Gabon Republic, the ore will be hauled 50 miles by cableway to the railhead at M'Binda. There it will be loaded into ore cars for the 300-mile rail trip to the port of Pointe Noire.

General Electric diesel-electric locomotives were chosen to haul heavy ore trains in the extreme African climate for these reasons:

DEPENDABILITY In tropical Africa where COMILOG's locomotives will be operating, the temperature ranges up to 96° F. and the humidity reaches 100%. Annual rainfall averages 85 inches, with tornados and violent winds common from October through May. Here a locomotive meets a severe test of reliability—and G-E diesel-electrics have already proved themselves in similar conditions.

EFFICIENCY Interchangeable electrical controls and equipment proved in millions of miles of world-wide service assure maximum use of engine horsepower, ease of operation, and outstanding performance from a locomotive designed to take hard working conditions.

ECONOMY Heavy-duty 4-cycle diesel engine, specifically designed for low fuel consumption, reliability, and long life has established a standard for operating savings and low maintenance on the world's railways.

Dependability . . . Efficiency . . . Economy – just three of many reasons why COMILOG and other progressive locomotive users throughout the world rely on General Electric universal diesel-electric motive power.

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