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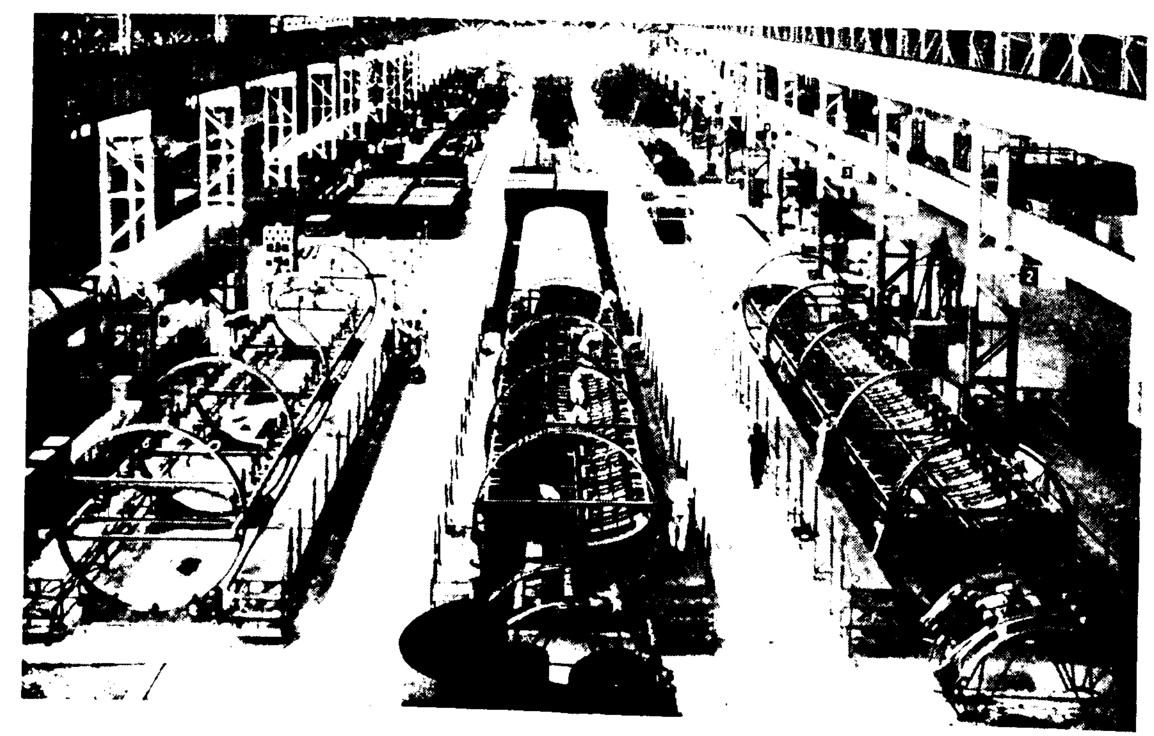
FOREIGN RAILWAYS WORKSHOP SUPPLEMENT



THE INDIAN RAILWAYS WORKSHOP MAGAZINE

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Foreign Railways Workshop Supplement

CONTENTS

Pioneers in Electric Traction

By J. C. Way, A. M. I. E. E., M. I. Loco. E.

Supplying electric locomotives and coaches to railways in various parts of the world, including India, Metropolitan-Vickers Electrical Co. Ltd., are now applying their vast resources to A. C. industrial frequency traction.

METROPOLITAN-VICKERS Electrical Co. Ltd., and its predecessor, The British Westinghouse Electric and Manufacturing Co. Ltd., have specialised in electric traction since the workshops were erected at Trafford Park, Manchester, in 1902.

The first traction order, which was for the complete electrification of the Mersey Railway (an underground line below the River Mersey between Liverpool and Birkenhead) was received in 1901, and the equipment was commissioned as early as 1903. This order, together with another placed shortly afterwards in 1902 for the electrification of London's Metropolitan Railway, established the new Company in the traction field, and thereafter, right up to the present day, Metrovick and its predecessor have kept abreast of the demands and requirements of the times, and not infrequently pioneered new developments. During the first World War and in the years following, Metrovick supplied much of the existing equipment for multiple unit trains on the Southern Region of British Railways and 1500V D. C. traction equipment was manufactured and supplied in such widely separated parts of the world as New South Wales, Argentine, Holland, Spain, and Russia.

MAJOR ADVANCES

There were major advances after the first World War. The success of the 41 freight and 23 passenger locomotives made for the Great Indian Peninsula Railways and their capacity to haul and brake (regeneratively) heavy goods and express trains on gradients of 1 in 37 under most difficult conditions was an achievement that caused considerable interest in railway circles. The introduction of 3000V D. C. operation with locomotives in South Africa and motor coaches in suburban service in Rio de Janeiro and Warsaw demonstrated the ability of the Company to produce reliable designs for a system that had, up to that time, not a very wide application. Those early 3000V equipments were so successful that the Company has now made and designed more motor coach equipments operating at this voltage than all other manufacturers in the world put together, and more complete locomotive equipments than any other manufacturer.

After the second World War, large quantities of motor coach equipments were ordered from India, Brazil and South Africa to operate at 3000V D. C. Australia at 1500V D. C. and British Railways at 600V D. C. 3000V D. C. electric locomotives were supplied to South Africa and Brazil, and 1500V locomotives to New South Wales. The 3680 H. P. locomotives for New South Wales, which are still in course of delivery, are the most powerful locomotive of their type to have been built in Great Britain. In addition, British Railways were supplied with complete regenerative electrical equipments for 58–1868 H. P. 87 ton, 1500 volt mixed traffic Bo+Bo locomotives, and complete regenerative electrical equipments for 7–2760 H. P. 102 ton, 1500 volt Co-Co type locomotives. These locomotives operate over the Pennine Range between Manchester and Sheffield.

Metrovick also built one of the first gas turbine locomotives to be put into operation. Trials on the British Railways showed that it could be used successfully when hauling specialised loads, and demonstrated the success of many other new features including a novel form of suspension which permitted good riding at high speeds with low weight transfer characteristics.

The field of diesel traction has been covered by orders received from the Western Australian Government Railways, C.I.E. (Irish Transport Authority) and British Railways. The Irish order was one of the largest single orders for diesel electric locomotives to be placed in this country and covered the supply of 94 locomotives—60 of 1200 H. P. and 34 of 550 H. P.

(Continued on page 3)

CARRIAGE PAINTING

WITH the vastness of the Indian Dominion and the network of Railways passing through varied climatic conditions as it passes from one part of India to another, after years of prolonged exposure tests, Fancutts Specification for painting of coaching stock was adopted. This process was used for a number of years with considerable success, but as it involved a thirteen day operation in all, it was felt that coaching stock could not be detained for so long, and hence in course of time, it was modified to suit the needs and conditions of the country.

The coach bodies in the past used to be entirely of timber, but with the passage of time and improvements which have taken place, the coaches are now also made of mild steel panels and there are a few also of aluminium.

The present specification consists of nine day operation which include the following processes:—

EXTERIOR

The mild steel panels are deceased and a protective primer applied prior to fabrication. The interiors of the panels are given two coats of Red Lead and allowed three to four days to dry in the construction shops. After complete construction of the coaches it is then sent to the Paint Shop, here it receives one coat of Red Oxide Oil Primer which is followed by a minimum of two coats of Brushing Filler. In the event of the plates being slightly dented these sections are filled up with Knifing Filler which is applied between the filler coats. The next operation consists of rubbing down between the filler coats with Pumice stone and Pumice Powder which gives a very fine surface to paint on.

This is followed by one coat of Synthetic Undercoating and allowed to dry overnight. The following day this is again rubbed down and given one coat of an approved brand of synthetic Enamel. The first

(Continued from page 2)

Experience has not been confined to D. C. traction only. Equipment for operating at 6.6 kV., 25 c/s. A. C. was supplied for use on the Thamshavn-Lokken Railway in Norway and the Lancaster-Heysham Line in the United Kingdom. In addition 26 traction motors and other equipment were supplied to the Hungarian State Railways for use in their Kando Locomotives in 1932.

The resources of the Company are now being applied to A. C. industrial frequency traction. A vast amount of research, design, development, and testing, is being undertaken for the purpose of providing the British Railways with sound, reliable equipment for the A. C., 25KV., 50 c/s electrification proposals to be carried out under their Modernisation Plan. Installations in France and the Belgian Congo have given an admirable background for this work, but the demands of an intense suburban service and the peculiarities of the British main line traffic require very special consideration.

LIKE INDIAN CONDITIONS

In some ways, these traffic conditions are not dissimilar from those anticipated on the Indian Railways, particularly in suburban areas. Robustness and long life with simple maintenance are features that are needed by both British and Indian systems.

The use of industrial frequency requires the incorporation of all available modern developments, such as new insulating materials in the motors to permit them to run at higher temperatures and to enable special features to be embodied in the transformer, which must be of an unusual shape, in the rectifying equipment which has to withstand the mechanical shocks and peculiar loading characteristics of railway operation, and in traction type switchgear which must be adapted for use with alternating current.

Should it be decided to use industrial frequency traction in India, these modern developments could be adapted for use in hot, humid, and dust-laden atmosphere of the country, but the choice between this and the old established D. C. system, either for a part or the whole of the railway electrification programme, depends on many factors.

finishing coat of enamel is rubbed down with cuttle fish Paint and water. This operation gives an extremely smooth base for the second and final coat of synthetic enamel which follows.

In the next operation the lettering is completed with the monograms stencilled and then the entire surface is flatted down with No. 320 or 400 waterpaper and finally a coat of varnish applied as a protective. As stated previously, this entire operation takes nine days.

INTERIOR :

Over the mild steel plates, teak veneered panels of a beautiful design are fitted. These are treated with two coats of Ragging Wood Filler which fills the pores of the wood and provides uniform smooth finish. Thereafter it is given a minimum of four coats of French Polish which enhances the beauty of the veneer greatly.

The ceilings are generally of three ply or masonite and occasionally of Hylam sheets, when available, although 3 ply is largely in use, the ceilings are painted with 2/3 coats of Flat Oil Paint over a coat of Primer.

In the past, different Railways used to have a different colour scheme but with Independence, the colour scheme has been standardised for all Railways which consists of Gulf Red for the sides and black for ends.

Although the general public are not aware nor appreciate the amount of work that goes into the making and maintenance of these coaches, the Railway Authorities are constantly thinking of improvements both in material for building of the coaches, amenities for the passengers and cooler and cheerful colour schemes to make the journey no matter how short or long, a pleasant one.

In order to maintain these coaches in an absolutely first class condition, the Mail and Express Coaches including air-conditioned coaches return after nine months for what is called 'C' class painting schedule which consists of washing down of the coaches all over again, and applying one coat of Undercoating, two coats Synthetic Enamel which is followed by lettering and a protective coat of varnish as previously. Other coaches return after 15/30 months for repainting.

Normally the 'A' class painting schedule which was explained at first, is followed by three 'C' class schedule of painting over a period of four years before the old paint is completely stripped to the bare metal and repainted again with the complete process.

It has been found that Alkyd types of resin give the best results for coach painting in so far as durability and exposure to the elements are concerned.

Very few of the public are aware of how much hard work has to be put in the painting of these coaches both internally and externally. Each operation requires careful examination and proper rubbing down before the next coat is applied and this care and attention must be maintained throughout the painting, otherwise the results will not be satisfactory. That the results are excellent goes to prove that men with many years of experience each in his own line, combine together to produce beautiful painted coaches for the general public. Unfortunately, the public do not appreciate this, in the way baggages are stacked against the walls of the compartments or the beautifully painted surface is covered with dirty hand-marks, no sooner the new coach is put on the rails.

In spite of this, Railway Authorities are constantly in search of improvements and better amenities for the travelling public. The recent being the use of Pliofoam cushions for the upper class coaches. For the lower class coaches they have increased the seating accommodation which originally allowed for 18" of depth but it now provides a minimum of 21". They have also designed a back rest which folds and forms into a bed.

Finally the interior of the coaches are painted in carefully selected pastel shades which harmonise with the upholstery of the coaches and gives a cool and pleasing effect.

The Design and Manufacture of Light-Weight Coaches

By Shri K. Swarup
Chief Administrative Officer, Integral Coach Factory, Perambur, Madras.

(Continued from I. R. W. M. May 1958)

IMPORTANT FEATURES OF THE DESIGN

TESTS have revealed that with the load of 45 tons distributed uniformly over the full length of the coach, a deflection of only 0.28" is reached and a similar figure (rise) when the load of 200 tons is applied over the buffers. This shows that this coach is a very rigid structure.

The adoption of the light-weight design affects the reaction of the vehicles subjected to extraneous forces. Extreme light-weight construction calls for suitable alterations of standard shapes so as to reduce the influence of sidewinds upon the stability of the vehicle. For this purpose it is desirable to use well-curved roof, extended downwards as far as possible, in order to lower the point of application of the wind pressure. This will also be of benefit as regards strength by virtue of the curved roof and adjoining portions of the side walls.

The springing of the light-weight coaches is also very important. As a matter of fact, any spring having a linear diagram has a spring constant 'c' which for a force 'P' and deflection "f" is given

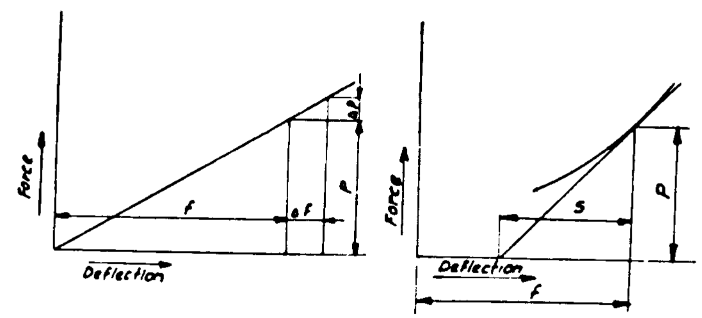


Fig. 13

by c=P/f. In accordance with Figure 13, a small additional deflection $\triangle f$ encountered when running over an irregularity means an additional force $\triangle P = \triangle f. c$. The load P carried by the spring corresponds to a mass $m = P/g$ and this is accelerated at the rate $a = \triangle P/m$, that is to say, for a constant value of $\triangle f$, the acceleration will be the greater the smaller P is, *i. e.*, the lighter vehicle will be subject to greater vertical acceleration—a fact well-known to passengers from their own experience, since the magnitude of acceleration determines the degree of riding comfort.

This undesirable tendency makes the use of springs with non-linear characteristics a necessity. The reduction of the mass of wheel sets is of considerable importance both to the vehicle builder and operator, as well as to the civil engineer, for it results in improved riding characteristics and reduced permanent-way maintenance expenses.

The action of the unsprung weight upon the sprung parts is of particular interest. The upward movement of wheels will deflect the body twice as high in the case of the heavy wheels assuming identical spring ratios in either case. Therefore it is very necessary to reduce the unsprung mass, if light-weight designs are to prove satisfactory. The smaller the unsprung weight in relation to the total load the better will the vehicle ride. This conclusion was arrived at by Davis and Cook as the result of their most interesting research on the motion of a railway axle. This is the reason why in Europe hollow-drilled axles carrying standard types of wheels are now being increasingly adopted.

The designs that are being adopted are shown in Figures 14 and 15.

Another very important factor to remember in the design of light-weight structures is that whilst it is possible to stress dynamically even the hardest steel right up to its yield point and compression, the permissible dynamic tensile stresses must be kept at much lower levels being far more dangerous. Therefore the light-weight structures and design should be based on compression rather than on tensile stressing.

The prevention of corrosion is of particular importance with light-weight vehicles, for it can result in rapid destruction of the thin-walled members

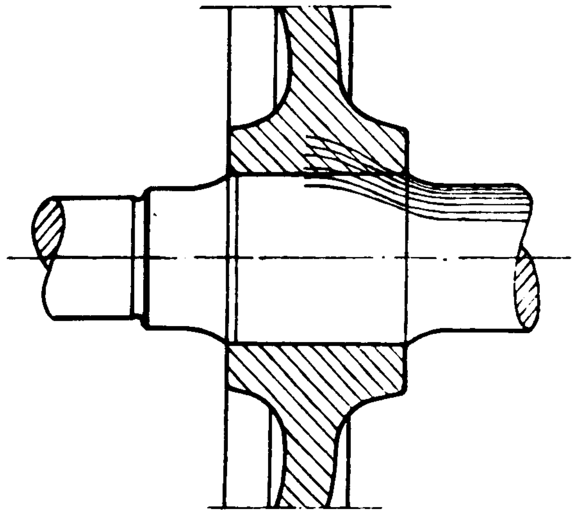


Fig. 14

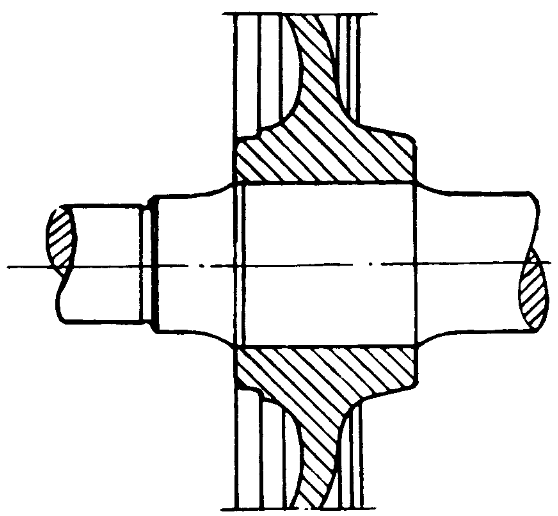


Fig. 15

and very appreciably reduce the tensile endurance limits. The methods of corrosion prevention will depend upon the use and function of the various components. The surface preservation is, therefore, of much importance in the case of the light-weight coaches, and the painting technique developed in the Integral Coach Factory, specially of Bitumen coating of the inside of the coach-shell needs to be particularly mentioned. The following table shows the result of atmospheric corrosion tests :—

	Loss in weight by corrosion
Mild steel	100
Copper bearing steels	78
High tensile steels—specially Corten	23
Stainless steel	Nil

DESIGN OF THE BOGIE

The bogie fitted to Integral Coaches is shown in Fig. 16. The riding comfort of a coach depends nearly exclusively on a good bogie construction. The bogie is the part which is most liable to wear and tear and therefore needs maintenance attention at regular intervals. Its behaviour in actual service contributes towards the efficiency factor of a coach. The weight of the bogie has been reduced by 26.5% in comparison with the I. R. S. bogie. This has been achieved specially by resorting to a reliable welded construction throughout the bogie frame and the bogie bolster. As already mentioned the unsprung weights have been reduced to the minimum and the wheel sets have been considerably lightened. A smaller wheel of 3′ diameter against 3′–7″ on the conventional I. R. S. wheels has been adopted because the axle load has been reduced by nearly 2 tons and therefore not much disadvantage will accrue due to the lesser diameter of wheels. The reduction in unsprung weights results in less wear and tear of the permanent way, wheels and other parts of the coach in general. Shocks from rail-joints transferred to the coach body which cannot be absolutely eliminated, can be reduced appreciably. The unsprung weights in the Perambur bogie have been reduced by 18.8% compared to the I. R. S. bogie.

The other feature of the bogie design is that the usual conception of axle boxes being guided in horncheeks has been eliminated. In this case the axle box is guided by two guides welded on the bogie frame which are working in an oil bath sealed against dust and water, thereby resulting practically in no wear and tear. They are further so constructed that they also act as shock absorbers for the axle box helical springs controlling the deflection of springs, similar to the shock absorber, arrangement in an automobile. This arrangement also eliminates the play between the axle box and the guide and ensures a better riding quality of the coach. (Fig. 17).

SPRINGING

Besides the axle box springs which are arranged on each side of the axle box, the bogie has also two laminated springs arranged longitudinally, on which the bogie bolster is directly supported. By arranging the laminated springs longitudinally on the bogie, long springs could be applied which results in softer action of the spring.

Further, the spring, leaves have a channel profile.

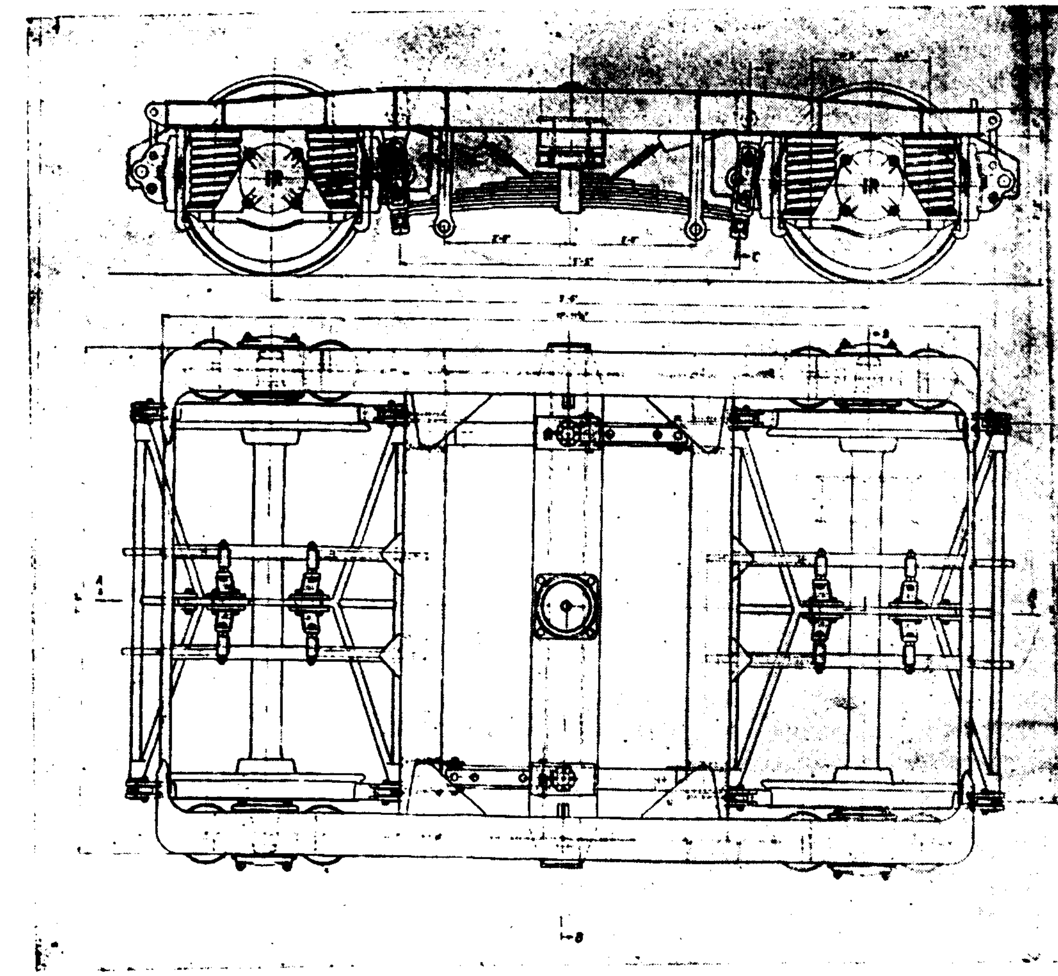


Fig. 16

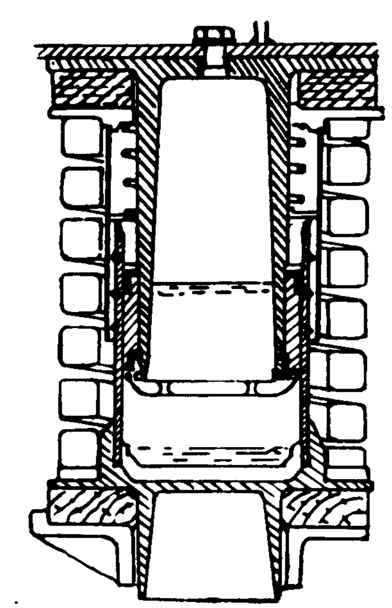


Fig. 17
Cross Section of Damper.

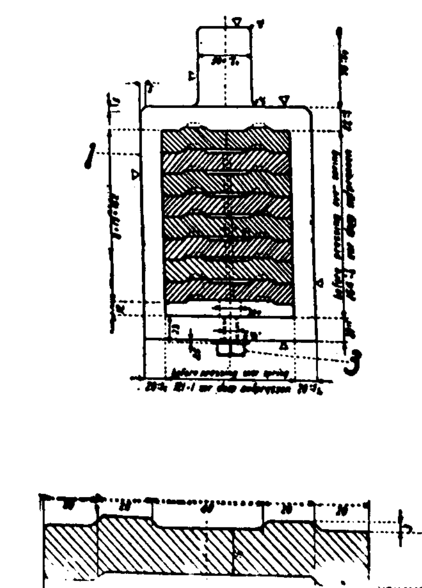


Fig. 18

(Fig. 18). This special profile provides the spring with a cavity throughout the whole length of the plates, after they have been assembled. These cavities provide an ideal means of permanent lubrication as they are capable of storing a considerable amount of lubricant. This results in an improvement of its shock absorbing capacity of the spring, enabling a softer cushioning of the coach—so important for comfortable travelling. Furthermore, it has to be mentioned that the spring leaves, before being assembled, are passed through what is called an "overstraining process" which makes it possible to load the spring to a greater extent without its showing any permanent deformation. The stresses, calculated in accordance with the usually known bending formula, are much higher than the yield point or even the tensible strength of the steel.

BOLSTER SPRING SUSPENSION

The bolster springs are suspended by swivelling hangers and these take up the lateral shocks as well as the side swinging of the running gear. These movements will therefore be not transferred to the coach body.

These swivelling hangers are suspended from the longitudinal members of the bogie frame in opposite angles in relation to the vertical. By this arrangement the bogie bolster and, consequently, the coach body are being centred into the longitudinal centre line of the bogie frame. The lateral swinging, transmitted from the running gear to the coach body when the coach runs over joints, crossings, etc., is reduced or even eliminated as a result of the restoring force developed. Experience has shown, that an angle of inclination, of about 7° for the hangers, gives the best results.

The bogie bolster is connected by means of two anchor links in the longitudinal direction to the bogie frame. These anchor links are an improvement over the present sliding plate guides located between the cross-member of the bogie frame and the bogie bolster. The anchor links are also much less susceptible to wear and tear and have the great advantage that an absolute-play-free-connection between the body bolster and bogie frame could be achieved which eliminates additional jerking while the coach is running.

BOGIE FRAME

The bogie frame is of a competely welded construction, welded together of a mild steel flats and plates, some of which are formed in press brakes to the required profiles. The design of the bogie is adapted to the special requirements of modern welding technique. Further, the design has been evolved after very accurate stress calculations and eliminates all pockets and corners, thus reducing the possibility of corrosion and ensuring accessibility for proper inspection.

Special attention has been given to the design of the connections between the longitudinal and the cross-members of the bogie frame, so that there is uniform stress distribution to the greatest possible extent.

BRAKE GEAR

With the usually known brake system in which the brake cylinder is fixed to the underframe, the braking force coming from the brake cylinder acts directly on the bogie frame, thereby subjecting the centre pivot to an additional stress. The braking arrangement on the Perambur bogie, however, is in such a way that this additional stress does not act at the centre pivot. This has been achieved by fixing respective reaction points for the brake rigging on the underframe. This results in a remarkable relief of force on the centre pivot, taking into consideration that the pull on the brake rod amounts to about 4.54 tons. The centre pivot is therefore subjected to less wear and tear and the free play of the bogie is unaffected during the braking period.

The brake block is designed in two parts consisting of the brakeshoe and the brake shoe-holder. Therefore, when worn out, the relatively cheap "wearing part" (brakeshoe) is replaced instead of the whole brake block.

OUTSTANDING FEATURES OF THE BOGIE

The outstanding features of the Perambur bogie can be summarised as follows :—

(1) The total weight of the bogie has been reduced by 26.5% as against the I. R. S. bogies.

(2) The unsprung weight has been reduced by 18.5% as compared to the conventional I. R. S. bogies resulting in much lesser wear and tear of the track and coaching stock.

(3) The wear and tear of the axle box guides has been completely eliminated.

(4) The movements of the axle box helical springs are controlled by built-in shock absorbers.

(5) The centre pivot is completely released of any additional reaction stresses from the brake gear.

(6) The conventional rubbing blocks for the bogie bolsters have been replaced by the anchor link arrangements which eliminates the jerky movements of the bolster.

The design of the light-weight coach having been discussed it will be interesting to know the production methods and organisation employed for manufacturing the light-weight coaches at Perambur. The design of the shell having been standardised for the Broad Gauge, and the requirements of the Indian Railways for such shells being in the region of 1,000 a year, it was possible to standardise methods of production on the same lines as in the case of an automobile. The organisation has therefore been streamlined and mass production methods have been introduced.

PRODUCTION METHODS ADOPTED IN I. C. F.

The so-called "Jobbing Layout" was chosen for the production of several details and sub-assemblies. 2,800 doors and 14,700 windows are required per year for the 350 body shells to be produced and, therefore, for the window and door shops it was decided to manufacture them in special departments according to the assembly line layout. Here the single machine tools and jigs are arranged directly according to the requirements of the flow of production, that is, where the layout places a machine along the line of the produced part. In the Main Assembly Shop, very detailed studies have been made and 11 stands have been provided in sequence for the main assembly. In the first stand the roof is assembled from sub-assemblies and components received from the sheet metal shop; in the second stand the roof so assembled is finalised for the main installation; in the third stand the underframe is similarly assembled from sub-assemblies and details received from the other manufacturing shops; the fourth stand provides facilities to finalise the underframe to be ready for assembly; the fifth stand is the main installation where underframe, sidewalls, end-walls and roofs are assembled together to form the shell; on the sixth and seventh stands the body shell is straightened after the welding of the minor details is completed and inspected prior to going through the painting process. In addition to these 7 stands, 4 other stands have been provided for the storing of the details and sub-assemblies required for the major assemblies. This belt must move every 4½ days, and as 6 such belts are functioning the outturn is $6 \div 4\frac{1}{2} = 1.3$ coaches per day per single shift. Similarly for bogies, a belt has been installed incorporating various stands for the manufacture of the bogie-frame and the final assembly. Annexure I gives the details of this belt, from which it will be noted that for each stand the parts the jigs, and the material to be used have been finalised. Time studies are now being conducted to finalise the number and the categories of men required for these different stands. In the manufacturing shops also extensive use of jigs and fixtures has been adopted and for the manufacture of 1,029 components and sub-assemblies, 1,009 jigs and fixtures have already been designed and further 200 jigs and fixtures are in the process of being designed and manufactured. Gradually every component, detail and sub-assembly will be manufactured using jigs and fixtures, in order to ensure interchangeability and good quality of work. Figs. 19, 20 and 21.

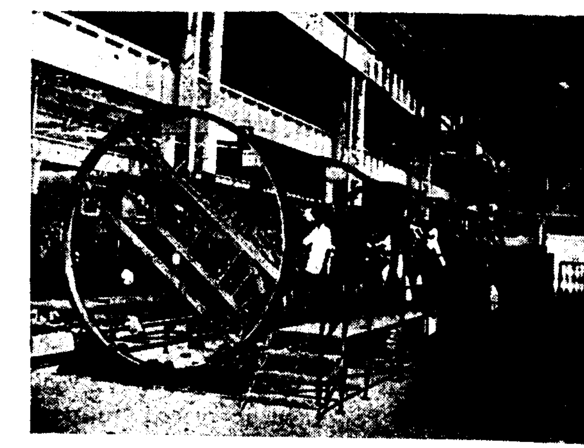


Fig. 19. Roof jig.

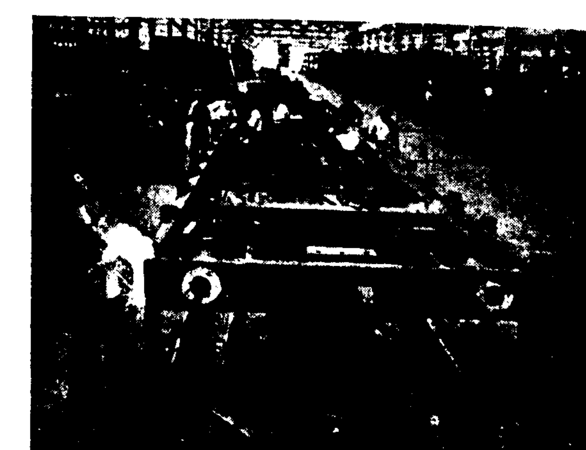


Fig. 20. Underframe jig.

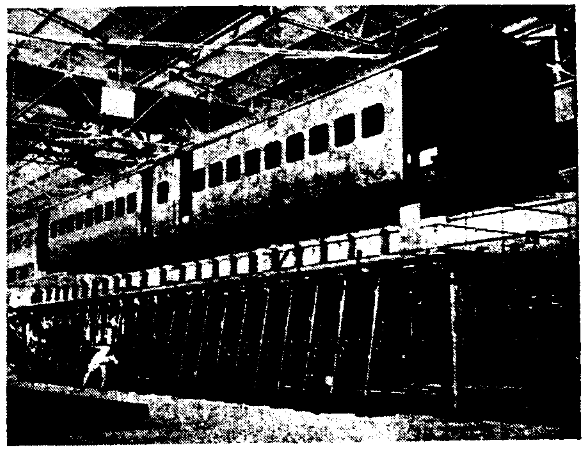


Fig. 21. Main Assembly jig.

Naturally in a mass production shop, quality control is very important. This is being introduced and inspection is arranged after every operation, in order to ensure an uninterrupted flow of correct parts on to the main assembly lines.

A Static Bogie Testing machine has been installed at the despatch end of the bogie assembly belt for testing all bogies after they have been assembled, to ensure trouble free service under actual running condition. A similar machine in each Railway Workshop will greatly help in the proper inspection of repaired bogie trucks. The static bogie testing plant is of 30 tons capacity and the equipment consists of a hydraulic ram through which the required load is applied on to the bogie and the Pendulum Dynamometer for reading and adjusting the load. The hydraulic ram (or pressure unit) is fixed to the horizontal beam of the testing frame and is balanced by suitable weights. The bogie truck to be tested is placed in position under the testing frame. By the manipulation of the control valve of the Pendulum Dynamometer, the required load is applied in a vertical direction on the centre pivot of the bogie bolster of the bogie truck. A load of 12.5/14.6 tons is applied to test the bogie under Tare load. The free working of the springs, shock absorbing arrangement and the bolster suspension, etc., are first checked up by the application and release of 20 tons load and the following measurements are taken under tare load conditions:—

(*a*) Height of centre pivot from rail level.

(*b*) Height of bogie side frame from rail level.

(*c*) Clearance between axle box housing and bogie frame.

(*d*) Clearance between bolster and bogie frame.

(*e*) Bolster spring camber under tare load.

A Dynamic Bogie Testing Machine has been ordered, so that bogie trucks can be subjected to dynamic loads by means of a pulsator arrangement. This machine which will be installed in the course of the next few months will enable a certain percentage of the bogies being subjected to all the rigours of working conditions encountered in service.

CONTROLS INTRODUCED

For efficient running of the factory it is necessary to provide for suitable managerial control so that the Administration can be sure of the implementation of its policy. With that object, the following controls have been introduced.

PRODUCTION CONTROL

A Production Planning and Control Department has been installed in order to ensure the full mobilisation of the man power and the machinery capacity. A master list of parts has been drawn up after dividing the coach into various sub-groups and indicating the details and sub-assemblies required under each sub-group. Certain commercial items and specialised parts such as castings, etc., are purchased. The raw material requirements have been standardised with particular reference to the indigenous capacity to manufacture the quality required.

The factory has been divided into Shops, Sections, and Load Centres, each Load Centre consisting of machines of similar manufacturing capacity. The capacity of each Load Centre is analysed in terms of the planned hours, and by a proper system of scheduling and machine loading, the load on the various Load Centres is evenly balanced in the production cycle. Overall schedules have been drawn up by the Production Planning Department for the complete production cycle from the commencement of indenting for raw materials right up to the completion of the coach. Detailed schedules have been drawn up for each batch order indicating the dates of commencement and completion of individual operations involved in the manufacture.

As a result of detailed operation studies, master operation plans have been drawn up for each part of the coach indicating the raw material required, the sequence of operations, the Load Centres to be used for each operation, special tools, jigs and fixtures to be used, and the setting up and operating times for

each operation. The preliminary work study has been completed for most of the operations, and time study has now been taken up by a special section organised for the purpose. Timings are fixed by actual study of the operations as also by building up elemental time standards from standard data.

The issue of work orders is controlled by the despatching section of the Production Control Section which utilises an Ormig, reproducing machine for the preparation of the material requisitions and the production documents such as job cards and route cards. The work orders are received by the Shop Progress Offices who further process the work orders as per the schedule. Progressing of jobs is done by a central Follow-up section of the Production Control and the Shop Progress Sections. These sections ensure that schedules are adhered to by following up and smoothening difficulties duly anticipating delays in order to take preventive action before there is an obstruction to the flow of production. The fixation of target dates by the system of scheduling adopted enables delayed items being pinpointed and progressed from day to day. Delayed items are currently indicated on dispographs.

An efficient system of storage has been introduced, which ensures that materials are in readiness for assembly at the proper time and proper place, and by proper scheduling all the confusion that arises out of a hand to mouth system has been avoided. Material salvaging is done by a special section.

The efficiency of load centres is computed by means of mechanical tabulation by Hollerith machines which also furnish particulars of idle time and other statistics for production control. The Production Planning and Control Department has been given due importance to enable it to run rather as the brain trust of the workshops where all the thinking is done and a day to day picture of the entire factory is presented by this department by suitable charts for the benefit of the Works Managers and the Administration.

COST CONTROL

The importance of cost control in the efficient functioning of the shops cannot be over-emphasised. After all, it is the cost which gives the true index of efficiency of the entire organisation. A proper cost accounting system has been introduced, so that material and labour costs of the sub-groups of the coach are obtainable for each batch of coaches manufactured. Variations in costs of batches are analysed to highlight to the Administration and the Works Managers, inefficient working if any, so as to enable them to take remedial action. Overheads, idle time, etc., are also fully analysed to enable proper exercise of control by the officers concerned.

BUDGETARY CONTROL

Budgetary control is currently maintained. The yearly budget for the factory is prepared for the different departments and shops in conformity with the Accounts Code and the actual expenditure against the budget provided for is watched by the Administration and the Works Managers to ensure that the anticipated trend is maintained.

STATISTICAL CONTROL

For the purposes of managerial control, statistics of performance of each section and shop and of the whole I. C. F. are maintained, mechanical tabulation being adopted in most cases.

ORGANISATION

Naturally the organisation of a mass-production unit has to be radically different from that of a jobbing repair shop. A mass production unit, even though Government-owned, has to compete in the market on a commercial basis and therefore the organisation must be fully alive to the developments, market conditions, etc., and at the same time exercise proper control on the activities of the factory to minimise wastage in material, labour and overheads. There must, therefore, be clear demarcation between the persons laying down the policy and the persons who have to execute it. There must be adequate time available for everyone to plan and improve the methods.

The present organisation of the Integral Coach Factory, where the Chief Administrative Officer has the Finance, Stores and Mechanical Departments under his unified control is very satisfactory and enables good co-ordination to be maintained and prompt action to be taken in case of an emergency. Perhaps this could be improved upon if only it was possible for the Chief Administrative Officer to procure material directly instead of through the central organisation.

GENERAL REMARKS ON MATERIALS REQUIRED FOR LIGHT-WEIGHT COACHES

It has already been explained that the light-weight design has proceeded from the static to the dynamic conception and therefore it is necessary to consider all designs from the dynamic point of view, *i. e.*, ability to do work and not to deal with forces as in the case of static considerations. The I. C. F. has come in for some criticism because of its reluctance to depart from the methods adopted, but it is hoped that from what has been explained and in view of the fact that in the light-weight coaches the weight of every component has been cut down to the bare minimum to obtain higher outputs, performance and speeds, it would not be advisable to depart from tried-out materials and methods, unless very thorough trials are conducted. Further it has also been explained that the prevention of corrosion is of particular importance with light-weight vehicles as it can result in rapid destruction of the thin walled members and can very appreciably reduce the tensile endurance limits. It is on account of these reasons that it is absolutely necessary to use good quality of steel which will be guaranteed for weldability and will not be liable for corrosion. The steel is, being imported for the time being but it is hoped that Rourkela would be able to meet the requirements of the Coach Factory.

The Administration is fully alive to the necessity for encouraging indigenous products and every effort is being made to do so by giving technical advice to the various Indian firms. It is, however, a matter of time when these things would develop to the strict specifications and inspections exercised in the I. C. F. and during the period of development there is no other recourse but to import some of these materials from abroad. What has been achieved already in this direction is noteworthy. In the first batch of coaches the cost of imported material was Rs. 34,895 per coach as against Rs. 14,955 worth of indigenous material. In the last batch the imported content of the coach was only Rs. 24,925. This will clearly indicate the rapid progress that is being made in this direction.

PERFORMANCE

It would possibly be in the fitness of things to mention here the performance of I. C. F. since it went into production on the 2nd of October, 1955. On that auspicious day, Mahatma Gandhi's birthday, our Prime Minister, Shri Jawaharlal Nehru inaugurated the production in the shops, when the assembly of coaches, from knocked-down components received from our technical collaborators in Switzerland was started. Since then, there has been steady progress and now all the six Assembly Lines have been fully established and are in production. (Figs. 22-23). In February 1958 itself the full production target of 30 shells a month was achieved, instead of in 1960—61, laid down in the Technical Aid Agreement. Achieving this two years in advance of the scheduled date speaks for itself of the performance of the Indian personnel at all levels.

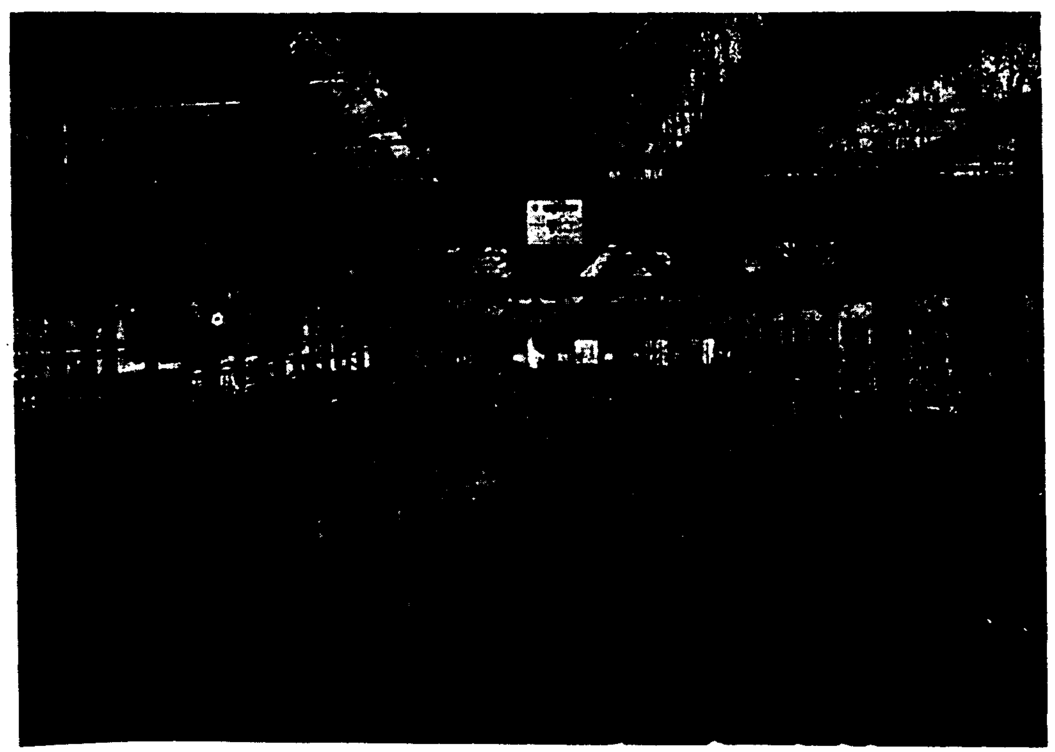


Fig.22. Main Assembly Shop at the time of Inauguration of Production (Oct. 1955)

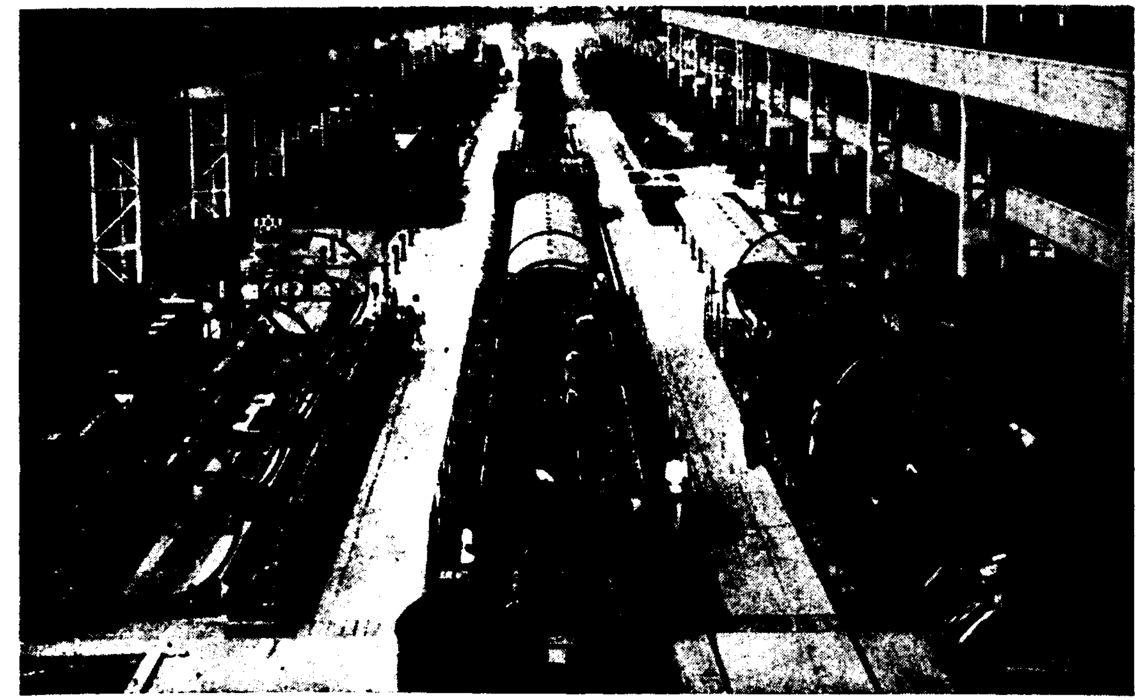


Fig.23. Main Assembly Shop as it is now (Feb. 1957)

It might perhaps be also interesting to mention that the I. C. F. is now producing allmost all the components, sub-assemblies and assemblies for which it was planned. As already mentioned, most of the imports consist of raw materials, specially steel. The latest batch cost reports show that the cost of the shell has come down to about Rs. 1 lakh, which is cheaper even than the Schlieren ex-Works price of Rs. 1,02,000, exclusive of vacuum brake fitting, limpet asbestos spray and exterior painting which amount to Rs. 5,750. The landed cost of a similar coach is Rs. 1,87,000. With greater efforts and with the overheads distributed over larger number of coaches, this price is bound to come down further.

IMPORTANCE OF MAINTENANCE ON THE RAILWAYS

The light-weight coaches in India bring a new era of passenger comfort to the Indian Railways. It is, however, very necessary that these coaches are maintained with the same care as one would give to his motor car and the public also co-operate in maintaining them to the high standards. It is only then that it would be possible to get the best out of these coaches.

Annexure I

BOGIE FRAME TO DRAWING NO. T—0—3—001/00 MANUFACTURING SECTION

In the Bogie Frame Manufacturing Section, each belt consists of 15 stages and the sequence of operations is as under :

1. Detail for Bogie Frame.
2. Bogie Assembly Jig.
3. Space for Stacking.
4. Bogie Assembly Jig.
5. Space for Stacking.
6. Welding on Trolley (Left).
7. Welding on Trolley (Right).
8. Welding.
9. Straightening.
10. Welding.
11. Setting.
12. Welding.
13. Straightening.
14. Finishing.
15. Inspection.

DETAILS FOR STAND No. 4

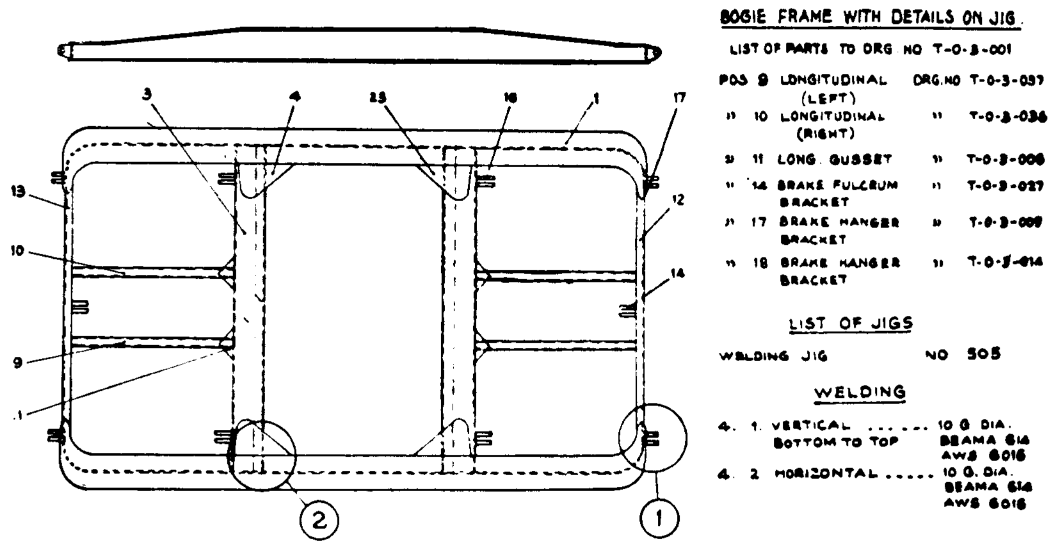


Fig. 24

For each stand the parts to be used, the jigs to be used and the material to be used have all been finalised. For example, Figure 24 illustrates the above particulars required for stand No. 4.

At the stage, the following further data are given :

(*a*) *Welding position*—Horizontal, turn to horizontal, vertical, bottom to top etc.

(*b*) *Welding direction*—This is shown on a separate sheet by the photographs with arrow marks.

(*c*) *Size of Electrodes*—The diameter of the required electrodes is given in gauges.

(*d*) The specification of the electrodes is given in two standards, *viz.*, BEAMA (The British Electrical and Allied Manufacturing Association) and AWS (The American Welding Society).

Work begins on Katni Rail Yard

Construction work of the new Katni railway yard, which will be biggest on Central Railway second only to the Mogul-Sarai Yard in entire country, has been started.

The new Katni yard, estimated to cost Rs. 103 lakhs, would be completed in 1962 and would have modern systems of yard operation.

The Katni-Murwara yard is an important gateway through which heavy goods traffic enters the Central Railway system. The main commodity passing through is coal from the Central India coal fields. Most of this traffic is for textile and other mills in Western India and a small proportion is for various industries in the Katni-Allahabad and Katni-Itarsi sections.

The present volume of traffic passing through Katni-Murwara yard is in the region of 400 wagons each way. This yard has been the limiting factor in the movement of coal traffic from the South-Eastern Railway to Western India for a long period. No large scale expansion of the Katni-Murwara Yard at its existing site is possible owing to non-availability of adequate land in the surrounding region. The tragets of production set for the Central India coal fields by the end of the Second Five-Year Plan period, however, made it urgently necessary for a yard of sufficient magnitude with adequate facilities being constructed.

THE MOSCOW METRO

By B. Meskin

EVERYONE who has occasion to see the Moscow Metro is struck by its spaciousness. It never even occurs to a visitor that he is deep down under the surface. Such is the abundance of air and light in the city's underground electric railway system known as the " Metro ".

Muscovites love their Metro and are proud of it. Architecturally it is the finest in the world. More than 50 different varieties of marble, granite and other finishing materials have been used to trim the stations and vestibules, and the picture panels and sculptural compositions give the stations a festive appearance.

ORIGINAL IDEA REJECTED BY CZARIST CITY ELDERS

Though the Moscow Metro has been in operation a little over 20 years, the idea of building an underground in Moscow first occurred much earlier. It was as far back as in 1902 that Moscow's ground was examined to see whether an underground railway could be built. But the city fathers—the city Duma —decided its fate. With undisguised cynicism, they said :

" Sure enough an underground will be more convenient and faster than the tram and the fare will be cheaper. But it will kill our tram."

And so the project was rejected.

Balinsky, a Russian engineer, worked out another plan providing for partly underground and partly surface railway, but that plan also met the same fate.

Thus, the initiative of building an underground in Moscow was buried.

IDEA REVIVED AND EXECUTED AFTER REVOLUTION

After the Great October Socialist Revolution Moscow began to grow very rapidly. Many factories, schools, residential buildings and scientific institutions were built and new streets and squares appeared. Moscow became one of the world's largest cities.

Along with the growth of the town and its population the city's transportation facilities were being developed. By 1931 the capital's population had gone up 73 per cent compared with the time before the Revolution, and traffic had increased more than four-fold. There, no longer, was enough room to expand the surface transportation network and a metro became an urgent necessity.

In June 1931, the Soviet government adopted a decision to reconstruct Moscow, and the decision provided also for the building of a metro. A year later, an army of workers, many thousand strong, started on the job.

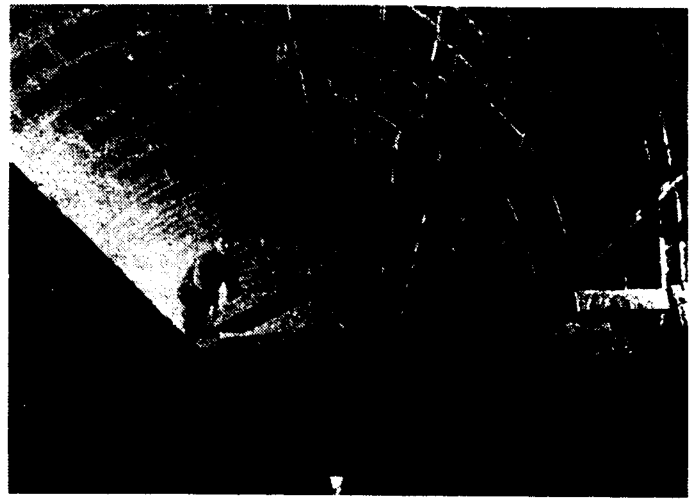
In New York it took seven years to build 20 kilometres (1 Kilometre = 5/8 of a mile) of subway, and it took London four years to build 10 kilometres. In the USSR 11.4 kilometres of tunnel were constructed in only three and a half years.

In February 1935 a train covered the whole route of the Metro's first section—from Sokolniki to Central Park.

SUBSEQUENT GROWTH

Twenty-three years have passed since regular traffic began on the underground railway, and during this time the Metro has grown beyond recognition. Mileage has increased almost sixfold and a considerably bigger number and variety of equipment has been brought into use. New types of coaches have been designed and bulit and an improved system of automatic blocking is widely used, ensuring a high degree of safety. Automatic and remote control operation has been widely introduced.

In choosing the direction of lines, the streams of passengers and conveniences were both taken into consideration. For instance, the purpose of building the Great Belt was to connect almost all railway stations, and to improve the service to the advantage of Muscovites and transit passengers.



Construction of a passenger platform of the USSR Agricultural Exhibition Station of the Moscow Metro.

The underground electric railway saves much time for the capital's people. It has practically abolished the concept of distances even in such a large town as Moscow. Today it is only a matter of minutes to go from one end of the town to the other, which took hours previously.

Passenger traffic has gone up considerably. While in 1935 the Metro carried some 180,000 passengers daily, this year it carried 2,500,000 and some days 3 millions.

FACING THE FUTURE

In the office of the chief of Moscow's Metro hangs a large map, and stretching lengthwise and crosswise like the web of a spider are the Metro lines. That is a map of the Metro in the future. Work on its construction does not stop for a single day. Next year new sections will go into operations.

The long-range plan for the Metro's development envisages construction in the next few years of more lines in the new and rapidly growing districts of the USSR's capital.

The Kolomna Diesel Electric Locomotive Works

By Y. Grafsky

THE locomotive emitted a low whistle, signifying "Step Aside", the factory gate opened and the locomotive moved out, its fresh paint gleaming.

That was not an ordinary locomotive, but as the inscription below the number read: "the last steam locomotive to be built by the Kolomna Works."

Kolomna, an ancient Russian town on the Oka, a tributary of the great Volga River, has been a centre of locomotive industry in Russia for a long time; its first steam locomotive was manufactured in 1869. Almost half the locomotives made in tsarist Russia were built by Kolomna workers.

After the October Revolution, the factory was completely reconstructed and line production was introduced. Production increased several fold. In 1949, 135 out of the 140 types of locomotives produced in the USSR were manufactured at the Kolomna plant.

And then, towards the end of August 1956, the factory made its last steam locomotive. Well, a machine like a human being, lives its day and passes out. No matter what you will do with a steam locomotive you will not get more than eight per cent efficiency out of it, which means that more than nine-tenths of the fuel consumed by the engine goes to waste.

Today, more productive and more economical engines are supplanting the steam locomotive, which has served man not at all badly. Its place is being taken by new locomotives—electric, diesel-electric and gas-turbo locomotives.

A new page in the story of the Kolomna plant opened when the factory went over to the manufacture of diesel-electric locomotives. Diesel electric locomotives have an efficiency of 25 per cent, develop higher speed than steam locomotives, and pull trains of 3,000 tons or more easily over the most difficult gradients.

Some specialists abroad assert that at least 10 years are required to convert a steam locomotive plant to one producing diesel electric locomotives. In Kolomna the job was done in one year.

What has changed in the factory?

The machine shops have gone over to a higher precision category. While before, most operations required a fourth to seventh precision category, second and sometimes even first category is required in machining diesel electric locomotive parts.

This required the installation of many new machines. While formerly in the section of the machine shop of which Romanov is foreman the holes for bolts in the connecting rod were scraped by hand, today several modernized machines have been installed, which, besides making it possible to mechanized a difficult labour-consuming operation, also makes possible the scraping to be replaced by grinding, ensuring greater exactness in machining the surfaces of parts.

Substantial changes have taken place in the production of castings. Three heating furnaces have been set up in the heat treating shop for annealing moulds, and in view of the considerable increase in the output of aluminium parts, the chilled moulds section of the non-ferrous metals foundry has been substantially enlarged and a new section put in, in which automatic machinery for skin-dried moulds has been installed, which does away with machining of the castings.

The assembly department too has changed beyond recognition. The only thing left from the steam locomotive days is the pits over which the steam locomotives were placed for final finishing and checking of the mechanisms. The shop has been enlarged to practically double its former size. You will not find there today the clouds of smoke over hanging the lights or the oil spots smeared all over the floor. The assembly shop has become cleaner, brighter and more spacious, and new sections have appeared: tubes, electrical, fitting and final inspection.

And the workers have learnt new trades.

(Continued on page 18)

Plans to Modernize Finnish State Railways

THE maintenance of Finland's network of railways and of its rolling stock has been greatly neglected during the post-war years because of lack of funds. Under such circumstances the condition of the railways has continuously deteriorated and the rolling stock has become superannuated.

The present plans for putting the State railway lines into good shape are here elucidated by Mr. Erkki Aalto, General Manager of the Finnish State Railways.

To improve the profitability and working condition of the State Railways has become a matter of great urgency. According to the plans made, the intention is to try to balance the economy of the railways primarily by lowering the cost level, and not by higher tariffs. And it is only by bringing the railways technically abreast of the times that such a reduction of costs can be realized.

At the moment the most important and immediate tasks to be undertaken for the technical improvement and rationalization of the railways are

1. Renewal of rails and bedding of tracks ;
2. Modernization and supplementation of locomotives and rolling stock ;
3. Completion and renovation of the signalling system and safety devices.

HEAVIER RAILS

Nowadays it is only in the southern regions and in Central Finland—where railway traffic is liveliest—that the tracks are laid with rails weighing 43 kgs. or more per metre. This rail weight is necessary for the fully effective operation of heavy and powerful locomotives. It is therefore planned to extend the heavy rail system to all main lines and to the most important harbour tracks as well; already during the coming summer considerable rail replacements will be commenced.

By the bedding of tracks the aim is to strengthen the superstructure to bear heavy traffic, and to reduce the effects of ground frost in wintertime. It has been proved that a packing of broken stones increases the carrying capacity of the rails by 25-30 per cent, and also that on the track sections laid with such stones, the welding together of the rails becomes possible. A fewer number of rail joints lessens the strain on the rolling stock and increases the comfort of passengers.

ELECTRIFICATION—THE FINAL TARGET

As regards the tractive rail equipment, the plans for modernization are divided into two parts: the use of diesel power, and the electrification of the busiest track sections. For replacing steam locomotives by diesel traction, the intention is to obtain 150 heavy diesel locomotives (50 of these would satisfy the replacement needs of passenger traffic and 100 those of goods traffic), 40 heavy shunting engines of 800 H.P., and a sufficient number of light engines for switching work. For the entire passenger traffic of a local nature the aim is to acquire 200—250 rail buses consisting of a motor-car and coach.

At present there are already five 900 H.P. diesel locomotives in operation, as well as 65 rail buses and 36 heavy railway motor cars, some of which are equipped with one and others with two 320 H. P. diesel engines. The number of light 320—350 H. P. shunting engines now in use is 16. To realize the replacement programme, orders have already been placed for procuring all the diesel-driven units required, and the fulfilling of the scheme will take place as funds become available.

However, locomotives using electric power are more efficient and more durable than diesel-driven equipment—and furthermore, their running costs are cheaper. For this reason the using of diesel power on Finland's main railway lines is only a transitory stage. Thanks to the development of atomic power for useful purposes, in the future cheap and sufficient electric power can be made available for the requirements of the railways, too. As soon as the plans for this electrification can be carried out in Finland, the diesel locomotives now in use will be transferred to branch lines where traffic is too small to make electrification profitable.

The total amount of electric power needed for electrifying the principal railway lines is about 50,000 kw. The work will take several years to accomplish. The State Railways are now drawing up detailed plans for this electrification, and within a couple of years the railways will be ready to begin the realization of the project; however, its fulfilment does not depend upon the railways, since the Government and Parliament decide such matters—in other words, it depends on when and to what extent funds will be granted for the purpose.

PLANS FOR IMPROVING THE SAFETY OF THE RAILWAYS

The third effective step in the rationalization programme is the extension of a railway block system to all the busiest railway sections. With such section blocks, several trains could run simultaneously in the same direction between the dispatch stations. As regards relay signal installations, to be connected with the railway block system—already in operation at some heavily-trafficked places—, the plan is to gradually introduce remote control, which will speed up the service and make the maintenance of train traffic cheaper than before. The devices that form part of the remote control system can be made to select the through rails, to set the necessary signals in the right position, and to safeguard the passage of the trains at the turn of a hand. To overcome the difficulties caused by the climate, experiments are being made with different snow-removing equipment which is already in use abroad. By the aid of these, the automatized rail points can be operated in wintertime, too.

With the continuous increase in traffic—the probable yearly augmentation can be regarded as 4-5 per cent—, in the course of time it would become necessary to construct double tracks on very many parts of the railway network. However, remote control signals will make the operation of the present lines sufficiently efficient so that there will hardly be any need to start building additional twin tracks.

The plans for modernization also include the adoption of teleprinters, radio telephones and radar devices, the further development of the mechanical handling of goods, the designing of passenger and goods wagons that are more serviceable, the promoting of automobile traffic connected with the railways, etc.

When realized, the measures planned will mean such a significant increase in the transport capacity of the Finnish State Railways that even the greater transport requirements of the future—brought about by the progress of economic life and industrialization—will be adequately met and at a relatively smaller cost than before.

(Continued from page 17)

For example, Yevgeni Barkov and his brigade used to assemble the steam-distributing mechanism—the heart of a steam locomotive, and now they have been given the task of assembling the main unit of the diesel generator and the power mechanisms.

The whole brigade had to be trained again. Barkov was sent at the factory's expense to Kharkov in the Ukraine to train at the diesel electric locomotive works in that city and the other brigade members were trained at the Kolomna works. The training did not cost them a farthing, while learning their new trades they received their average wages.

Special courses were arranged in the factory for hundreds of workers who had to learn new trades.

Lev Lebedinsky, the factory's head designer, told us that the plant was now manufacturing locomotives with 2,000 h. p. diesel engines and weighing 20 tons. However, they have completed the design of a new engine of 3,000 h. p weighing no more than 12 tons, and soon the plant will begin to produce them. In addition, they are working on the design of a gas-turbo installation for gas-turbine locomotives.

ASIAN RAILWAYMEN MEET AT ERIE (PENNSYLVANIA)

Railway representatives from India, Pakistan and Formosa met recently at the Locomotive and Car Equipment Department of the General Electric Company (U.S.A.) in Erie (Pennsylvania).

All three countries have, at one time or another, purchased GE locomotive equipment. During their visit, the railwaymen inspected GE's construction facilities and watched the company's new universal-type locomotive in production, Globe Press Service reports. The locomotive is known as a universal because it can be modified for use on any railway in the world, regardless of track, truck, altitude, grade and other restrictions, and it can be used for either freight, passenger or switching service.

Meeting at Erie were M. A. Baig, North Western Railway, (West Pakistan); M. G. Varma, South Eastern Railway (India) and Shih Yi Wang, Taiwan Railways Administration, Formosa. Baig and Wang made their tour under the sponsorship of the International Co-operation Administration, while Varma was in the U. S. to visit several locomotive manufacturers.

DIESEL-ELECTRIC LOCOMOTIVES FOR BRITISH RAILWAYS

HIGHLIGHTS OF MODERNISATION PROGRAMME

By John Rigg

BEFORE British Railways' £ 1,200,000,000 modernisation plan was launched in 1955 the only main-line diesel-electric locomotives in use were a handful of prototype under continuous test on ordinary services.

By June 1957, however, the last main-line steam passenger locomotive had been delivered to British Railways. In the same month the first main-line diesel-electric locomotive completed under the modernisation plan was handed over. This plan allowed for an initial batch of 160 diesel-electrics to be built by British railway workshops and by various manufacturers so as to decide the best type for development.

CONVENIENT DRIVING CONTROLS

This first locomotive was one of 20 mixed traffic locomotives built by the English Electric Company Ltd., at Newton-le-Willows, Lancashire, England. It weighs 72 tons, has a length over buffer beams of 43 ft. and is powered by an English Electric eight-cylinder diesel engine developing 1,000 b. h. p. at 850 revolutions a minute. Two exhaust-gas driven superchargers are used.

This locomotive has a maximum tractive effort of 42,000 lb. maximum service speed of 75 m. p. h. and a fuel tank capacity of 400 gallons.

An interesting feature is the layout of the cab. All driving controls are conveniently to hand, and are duplicated so that the engine can be driven in either direction.

Cab heaters, a breakfast cooker and windscreen wipers are also provided.

Diesel-electric locomotives are also being built for British Railways modernisation plan by the British Thomson-Houston Company Ltd., of Sheffield, Yorkshire, England. They are rated at 800 h. p. and are to be used primarily for main-line goods trains. The engine is a Paxman (Davey Paxman and Company Ltd., Colchester, Essex, England) 16-cylinder V-type diesel coupled to a 6-pole 500-KW generator rated 690/337 volts, 720/1,320 amperes.

TWO DRIVING POSITIONS

The driver's cab has two driving positions diagonally situated, at each of which a comfortable swivelling seat is provided. To the right of each position is a free-standing master controller incorporating essential indicators; to the left are the air and vacuum brake controls.

Mixed traffic locomotives are also being supplied to British Railways by the Brush Group of Loughborough, Leicestershire, England. These weigh 104 tons, have a 12-cylinder engine developing 1,250 h. p. coupled directly to an electric generator which drives four traction motors in the bogies.

This locomotive can be used for passenger service and is equipped with an oil-fired steam boiler for train heating.

Diesel locomotives—this time diesel hydraulic—are being built by British Railways at their own workshops in Swindon, Wiltshire, England. These are of 2,000 h. p. Already, the first of a number of diesel hydraulic locomotives, being built for British Railways by contractors, the North British Locomotive Company, at their Glasgow works, has had its inaugural run between London and Bristol.

TWO 12-CYLINDER ENGINES

This locomotive is driven by two 12-cylinder engines. These are turbo-charged V-type engines rated at 1,100 h. p. and 1,500 revolutions a minute. They are fitted with Napier turbo-charges.

The drive from the diesel engines to the track wheels is through an L306r-type hydraulic transmission. From the transmission to the final drive on the axle, power is taken through a carden shaft of Hardy-Spicer type.

Reverse gears are included in the transmissions, transmission oil being cooled by the engine cooling water. This gives a quick warm-up and prevents excessive temperature rises.

Each engine and transmission unit is completely separate and either can be cut out if desired. Electro-pneumatic controls are used. These are grouped for left-hand drive, one lever controlling the reverse, neutral and off positions, a second the engine speed.

Gear is engaged with the engine at idling speed giving a smooth take-up, and when the master reversing handle is in the off position, all controls are dead. In this position the key can be removed, which in turn locks the master control.

Interlocks prevent the reverse from being engaged while the locomotive is moving, and also prevent the application of power unless the gears in all transmissions are properly engaged.

AUTOMATIC SAFETY GEAR

There is automatic safety gear for stopping the engine in the event of excessive temperatures, oil-pressure failure or over-speed.

This new diesel-hydraulic locomotive measures 65 ft. overall and weighs 117 tons. Maximum speed is 90 m. p. h. and maximum tractive effort 50,000 lb.

Pure electric locomotives of orthodox design have been in use for some years on what is Britain's first main line electrification for both passenger and freight haulage—that between Sheffield and Manchester. An interesting type of electric locomotive is also used on the railways between London and the south coast resorts. It overcomes the difficulty of stopping over a gap in the conductor rail (at a level crossing, for example) by containing a heavy rotating flywheel whose stored kinetic energy is enough to restart a heavy train from rest.

Such locomotives are used for London-Newhaven boat expresses as well as freight trains up to 1,000 tons in weight.

MANUFACTURE OF SPECIAL STEELS

Sardar Swaran Singh, Central Minister for Steel, Mines and Fuel, has announced that plans are in a "fairly advanced stage" for the manufacture of tool, alloy and special steels, and that "we shall be ready to proceed within a few months on the project."

The Minister, who was presiding over the annual general meeting of the Steel Rolling Mills Association of India, has added that "unless we go ahead with this fairly quickly, we shall be depending, even at the end of the Plan, on imports for these steels. It would be wrong to import something that we can make ourselves. The progress of the plants has been so far satisfactory. There have been some delays here and there, but these delays have been inevitable and are insignificant in relation to the size of the problems we have encountered."

* * *

IRON ORE MINING IN RATNAGIRI

An assurance that Government would give all possible assistance to the iron-ore mining industry in the Redi region in Ratnagiri District for its proper development was given by Shri S. K. Wankhede, Bombay's Minister for Planning and Industries, while presiding over a meeting of the Redi Development Committee.

Redi, a minor port at the southern tip of Ratnagiri District, has been exporting iron ore, of which there are large deposits in the area.

The Minister said that Government was aware of the development taking place in that region and complimented the private sector on prospecting the mines and exporting iron ore to foreign countries. He added that due importance would be given to the region in the Master Plan for Industries which was under preparation.

* * *

OUTPUT AT SINGARENI COLLIERIES

Production from the Singareni group of collieries during the months of June this year was 1,68,329 tons as against 1,47,518 tons for the same month last year, according to an official release.

Production up to end of June 1 was 10,35,229 tons as against 8,97,343 tons for the corresponding period last year.

The Growth of the Railways in the Netherlands

ON the 20th September, 1839, the first railway in the Netherlands was opened between Amsterdam and Haarlem. The concession for this line, which was extended to Rotterdam in 1847, was held by the Hollandsche Ijzeren Spoorweg Maatschappij, called H. S. M. for short, which was founded in 1837. Soon after the opening of the first railway in the Netherlands a second railway company was established, the Nederlandsche Rhijinspoorweg Maatschappij, or the N. R. S. It owed its existence to the wish of King William I to have a railway constructed from Amsterdam via Utrecht to Arnhem. This line was completed in 1845. Subsequently, a whole series of concessions for constructing railways was granted, but owing to lack of capital the concessions were never taken up, with the exception of a concession for a line Utrecht—Zwolle—Kampen, which was constructed by a new company, the Nederlandsche Centraal Spoorwegmaat-schappiji, or the N. C. S. Since a cohesive system of railways was of the greatest importance for the Netherlands, after a great deal of controversy in 1863 a law was enacted which provided for the construction of railway lines by the State. For the operation of this State network the Maatschappij tot Exploitatie van Staatsspoorwegen, called the S. S., was formed. Many difficulties had to be surmounted in the construction of this State railway system, which comprised the main arteries of railway traffic, but gradually a cohesive railway system did at least emerge. The operation of this network, however, left much to be desired. There were too many large and small railway concerns and there was unhealthy competition. Tne Government studied various proposals for putting an end to this conflict of interests and in 1890 it concluded contracts with the H. S. M. and the S. S. The main lines were divided between these two undertakings, the N. R. S. being closed down. The lines were henceforth to be operated by the H. S. M. and S. S. "on terms which were as identical as possible on the basis of concentration and competition, employing in ample measure the common use of lines, stations and commercial establishments", as the history books put it. For 27 years this agreement continued to control the Netherlands Railways, until in 1917 an amalgamation of interests came about between the H. S. M. and the S. S. The need for this had already been felt for some time; in the war years 1914—1916 it began to be felt far more intensely. In 1916 the two companies requested the Government's approval of an amalgamation of interests and it took effect on the 1st January, 1917. It was a community of assets and liabilities, but not of capital or of reserves. This was accompanied by the winding up of the Nederlandsche Centraal Spoorwegmaatschappij and the Noordbrabantsch-Duitsche Spoorwegmaatschappij, so that by then all the railways in the Netherlands, with the exception of the local railways of Zealand—Flanders, became the property of the combined S. S. and H. S. M., under one name, viz. the Nederlandsche Spoorwegen or Netherlands Railways.

In the years after World War I the cooperating companies laboured under a great increase in operating costs, as a result of the rise in prices and the rate of interest. In connection with this difficult financial situation, in 1920 agreements were made between the railway companies and the State, under which the State granted a guaranteed dividend to the shareholders and in return therefore acquired the majority of the shares. Although in the years 1924 to 1930 the annual deficits did not recur, owing to an improvement in economic conditions, the financial position of the companies was still uncertain, in consequence of the inadequate depreciation policy which had been pursued for years. Arrears in this respect were estimated at 229 million guilders in 1928. This over-capitalization in the years after 1929, when, owing to the development of transport, the value of railway assets fell, constituted a serious obstacle in the competitive struggle with road transport, which was repidly developing. The economic depression which commenced in 1929 did not improve matters. This was the reason why a reorganization was carried out, the object of which was to establish the basis for a new and more economical structure of the business. In this reorganization, which was brought about in 1937, it was decided to liquidate the H. S. M. and the S. S. and to found the N. V. Nederlandsche Spoorwegen with effect from 1st January, 1938. Although the shares are held by the State, the Netherlands Railways are a concern which has the nature of a private limited liability company. This gives the Netherlands Railways a special position in the ranks of railway companies, as in many European countries the railways are a State concern. The economic position of the railways in the Netherlands is favourable; since 1941 the annual accounts have closed with a profit balance.

Year	Total receipts.	Profit balance
1946	fls. 262.9 mill.	fls. 7.9 mill.
1947	„ 285.5 „	„ 8.9 „
1948	„ 289.0 „	„ 0.0 „
1949	„ 285.7 „	„ 0.9 „
1950	„ 317.2 „	„ 1.4 „
1951	„ 331.9 „	„ 0.1 „
1952	„ 354.0 „	„ 5.5 „

DESTRUCTION DURING THE WAR

Before World War II the Netherlands had the best operated railway in Europe. Electrification was in progress. Of the then total network of 3,300 kilometres, in 1940 535 kilometres, or more than 16%, was electrified. On the main lines to the South, East and North the service was maintained with diesel-electric train units. The Netherlands Railways, however, came out of the last war very severely ravaged. If in May 1940 war damage was confined to rendering bridges useless and to considerable damage incurred by actual combat, inter alia in Rotterdam, all this was a nothing to the tremendous havoc caused to the railways by the occupying forces during the strike which commenced on 17th September, 1944, by order of the Netherlands Government in London. When liberation came on 5th May, 1945, the railways were confronted with a completely disrupted organization, mainly due to this senseless destruction. A few examples will serve to illustrate this clearly: of the 876 steam locomotives present on 17th September, 1944, only 126 were still available in May 1945; of the 1,499 steam-drawn passenger coaches only 146 were still usable; of the 28,861 goods trucks, only 445 were left; all electric and diesel-electric trains, totalling 950 coaches, had been destroyed or removed.

The track itself was also severely damaged. Only 18% of the pre-war net was still usable. During the occupation 116,000 tons of steel and 1,585,000 sleepers were removed. Immediately after the liberation the work of repair was tackled with the primary objective of obtaining a usable and cohesive network of railways. By the end of 1947 the most important work of repair had been completed by means of provisional measures.

For the period 1948—1952, inclusive, a programme was drawn up and put into operation for the definitive reconstruction of the most urgent facilities. From 1953 to 1958, inclusive, such work will have to be done as is essential to obtain a completely restored railway system. This definitive reconstruction will be accompanied by a modernization which will be most apparent in the form of traction, electric and diesel-electric, and from the signalling system. This modernization will bring about a rationalization of the organization, in that material available, consisting of a smaller number of units, will be able to attain greater transport achievements. The modernization of the signalling system will increase the capacity of the track and the stations. Although it has been possible so far to carry out only part of the work of repair and renewal, the Netherlands Railways, by making the maximum use of their restricted facilities, have already succeeded in attaining achievements in transport which quantitatively are considerably in excess of the pre-war figures.

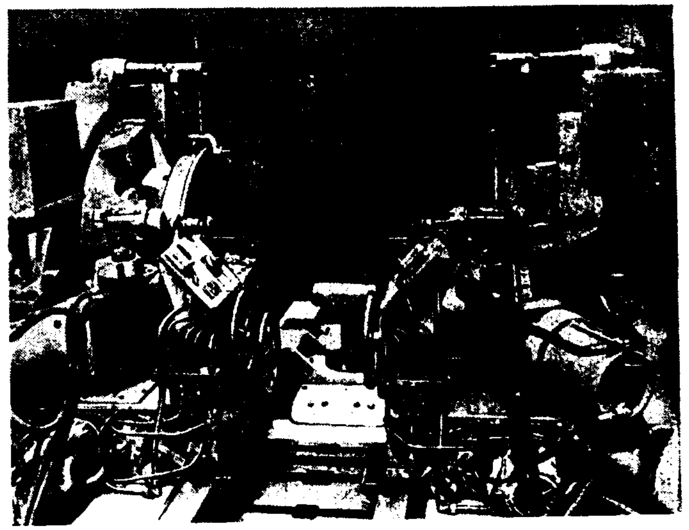
THE NETHERLANDS RAILWAYS AND INDUSTRIALIZATION

In a densely populated country such as the Netherlands—and the population is still growing—industrialization is an imperative need. Efforts must be directed at providing employment in industry for ever-increasing sections of the population, as the other sectors of economic activity cannot or can only partly absorb the increase. An important contribution towards the realization of industrialization is being made by the transport undertakings and particularly those which have a national character. This is thus a task for the Netherlands Railways. This task is a very extensive one and comprises both passenger and goods transport, for industry is in equally great need of a properly functioning apparatus for goods transport, as sound facilities for passenger transport. The former is important for a smooth supply of goods and a smooth despatch of products, the second is important for attracting workers to new industrial areas. A substantial contribution towards the creation of good transport facilities is being made by the electrification and diesel-electrification of the railways. In addition, the Netherlands Railways are stimulating the development of national industry by the many orders which they have placed with industry since the end of the war. The materials for post-war rehabilitation were largely supplied by Netherlands factories and in the process some industries have delivered products which could formerly only be procured in foreign countries. The repair of the essential facilities has not brought to an end industrial activity on behalf of the Railways.

(Continued on page 24)

A few Automatic Railway Wheelset Reprofiling Mounted Wheel Lathe with Built-in Hydraulic Copying — Hydrauto'matic Tour Sculfort

ONE of the major problems of Railway Engineers has always been wheel turning. The floor space required for wheelsets lined up waiting to be accommodated in the wheel lathes, and the slow throughput of the conventional type of wheel lathes, has led to more and more space being used to install more wheel lathes to keep the wheelsets moving through shops at a rate to match the movement of other components.



With the almost incredible increases (a) in freight and passenger traffic on Railways, and (b) in speed which requires more and more precision, the Mechanical Engineers are faced with the problem of maintaining the maximum rolling stock available for duty, which means that the time taken for repairs must be drastically reduced.

Sculfort-Fockedey, Vautier & Co., Maubeuge, France, who have more than seventy years experience in the manufacture of Wheel Lathes, have developed five years ago, a High Speed Wheel reprofiling Lathe with the sole purpose of reducing the floor-to-floor time for simultaneously re-turning new and worn wheelsets mounted on their axles.

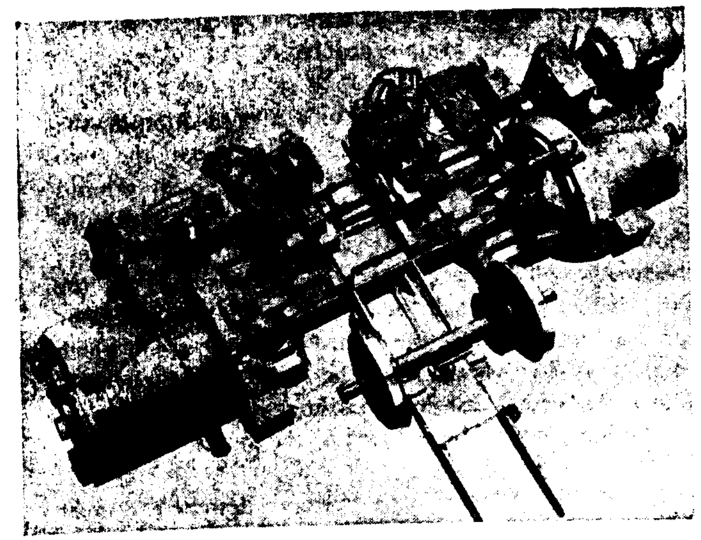
Together with the results accruing from the continuous operation of their equipment in the leading Railway shops the world over, they have made a detailed study of hydraulic and electric equipment, so as to reduce non-machining times to a minimum and speed up machining to reduce the effective cutting time.

The Sculfort Hydrauto'matic Wheel Lathe is a self-contained machine including all necessary auxiliaries and provision has been made for synchronization of the various operational sequences. As a result of such distinct individuality it can be installed in a special small shed in the middle of the wagon wheelset park, and is also capable of quickly reprofiling the wheelsets of an electric locomotive, which must not be long out of running, due to its high capital cost.

The most important saving in time has been obtained by eliminating the conventional overhead crane which cannot give fast centering, as the balancing of the axle requires manual control for height and longitudinal adjustment, and is not always available when required. This crane has a high initial cost.

The Sculfort Hydrauto'matic Wheel Lathe is completely open at the rear, thus permitting the simple installation of a traversing, lifting and centering device.

The cuttings fall straight down into the foundations of the machine where they are easily removed by means of two steel containers.

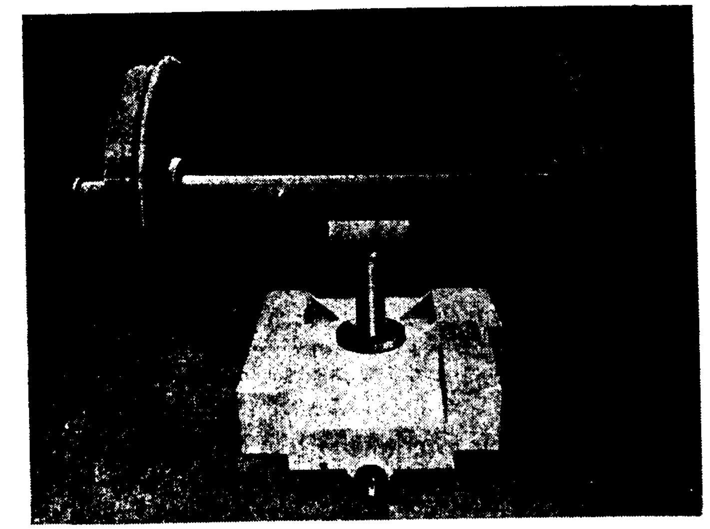


The lifting and centering device, arranged in the central part of the lathe, consists of a carriage which moves on a narrow gauge tract containing a hydraulic cylinder, the top of which can rotate 180°. With push button and end of travel control switches, this device picks up the wheelset, according to shop disposition, (a) on the tracks parallel to the machine axis and from a turn table or, (b) from the track at right angles to the machine axis i. e., parallel to the narrow gauge track upon which the lifting device runs, the wheelset in both cases having been previously rolled to the rear of the machine from the park outside.

On the lifting device the wheelset is brought to the machine, raised automatically to centre height and set in position to be received between centres.

This device ensures constant correct positioning of the axle; eliminating any longitudinal adjustments of the toolposts and permits the loading of axles fitted with brake drums, dynamo pulleys etc.

When necessary, the lifting device can incorporate a large table, also hydraulically traversed, so that



wheelsets can be picked up on the treads, in order to avoid dismantling any unit, for example an electric motor on electric locomotive wheelsets, which prevents the use of the normal elevating unit, which lifts at the middle of the axle. This lifting device can handle loads in excess of 6 tons, which is normally the total weight of an electric locomotive wheelset complete with motor.

When required, or when the general disposition of the workshop necessitates, the traverse of the lifting unit, can be eliminated, and the lifting and centering device attached to the bed of the machine, thus enabling the wheelset to be rolled to the machine centre, where it is automatically raised to the exact centre height.

The approach travel motion of the two headstocks then commences and two sleeves take up the axle and, against spring pressure retract, ensuring perfectly correct alignment of the axle, until the headstocks are in the working position.

Between each of the four drivers, the faceplates are recessed so as to enable the operator to watch the constant and correct centering of the axle.

It should be noted that *no collets* are required, since the axle centre is used as a reference for the spring loaded centre in the faceplate. The axle centre being also the principal reference for other operations on wheelsets, such as journal returning and burnishing.

Both headstocks are driven by a separate motor operating through a common shaft. The traverse of the two headstocks along the bed is controlled by end

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(Continued from page 23)

About 80 factories in the Netherlands regularly receive important orders for the construction of railway material and equipment. The Netherlands Railways have also co-operated in ensuring that products of foreign industries can be manufactured in the Netherlands under licence. For instance, the N. V. Spoorweg Sein-industrie at Bussum is making signalling equipment of an American type and the N. V. Werkspoor and the N. V. Heemaf have received orders for building locomotives of American design.

The Netherlands Railways are accounting for a considerable portion of industrial transport. For instance, the transport of crude oil from the oilfield in the North-East of the Netherlands to the refinery near Rotterdam is effected entirely by rail. Furthermore, a substantial part of the transport of coal from the mines in the South of the Netherlands and the transport of ores, fertilizers, building materials and agricultural produce is handled by the railways.

of travel limit switches which ensures that the wheelset is positioned correctly in relation to the toolposts, which are set only once, in relation to the gauge of wheelsets.

The locks for the two headstocks are interconnected with the travel and immediately the correct working position along the bed has been reached, the actuation of the hydraulic locks of front and rear bolts on each headstock, commences after the headstocks are locked in position, the drivers are automatically tightened by push button control.

Each face plate incorporates four drivers suitable for all diameters of wheelsets. Axles fitted with roller bearing boxes up to 23"×23", can be accommodated in the clear space between the drivers.

On request, the four drivers can be arranged so that they can be quickly adjusted in pairs to facilitate the handling of wheelsets of widely different tread diameters.

These drivers are individual hydraulic units, and the driving dogs have easily replaceable teeth in the end of a hydraulic piston. The approach of the dogs is simultaneous, the pressure being automatically adjusted by means of an equalising valve. This eliminates distortion of the wheel rim during machining. The steady and powerful grip is also constantly maintained during cutting.

The drivers are designed for (a) lateral action, i. e., the contact takes place on the external side of the rim, or, (b) for radius action, i. e., the contact takes place on the external underside of the rim, when the external faces have to be machined. Specially designed drivers are also available for special work, when required.

This method of gripping and driving the wheel sets contributes to a reduction of non-machining time as much as the features above mentioned, as also does, the central control station, at which only one operator stands.

Since the operational sequences on the Sculfort lathe follow each other quickly, all pushbutton controls — levers and hand wheels—loading and unloading unit—traverse motion and locking of headstocks—tightening of drivers—speed and feed control—rapid traverse of slides and depth of cut control etc., etc., have been centrally positioned at the front of machine and between the two toolposts. From this vantage point the operator controls the machine without having to walk to various positions, as is the case with conventional wheel lathes, with two front and two rear toolposts. Since the principal motions of the machine are hydraulic and electrically operated by push buttons, almost negligible physical effort is required by the operator, which is an aid to high production.

Due to the extreme flexibility of the hydraulic equipment it is possible at any time, during the actual machining operation, from the central control panel and from the left and right auxiliary panels, to adapt the machine to the cutting conditions dictated by the particular wheelset being reprofiled.

Since the operator always stands at a position on the transverse axis of the machine, and between the two toolposts, the top of bed of the machine is at ground level, he is able to synchronise one operation with another. For example, after completion of machining, the two headstocks are traversed outwards from the axle, before they reach their limit stops the operator can set in motion the wheelset carriage which transports the wheelset to the rear of the machine. This arrangement enables handling, setting and non-machining times to be reduced to the minimum.

The Sculfort Wheel Lathe has been designed to meet the large scale production requirements of modern railway systems without specially skilled operators. As a result of a rationalization of the machining process and well tested technique, together with a sound basic design, unequalled machining times can be easily attained.

The two toolposts designed for using solid carbide pastilles consist of a heavy base fitted on the bed for positioning according to wheel diameters. A cross slide is provided which incorporates all the feed arrangements. The upper slide comprises a hydraulic copying device, this consists of sensing unit equipped with a tracer contacting a template, the pressure being less than 1 lb. The copying slide motions are controlled by a hydraulic cylinder of 5 tons capacity.

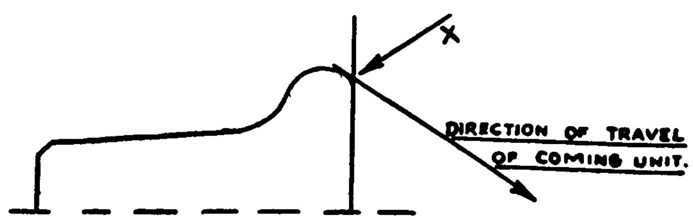


FIG. I

High speed traverse and return motions are controlled by lever. The copying slide operates at a fixed inclination to the work, eliminating any undesirable stress, enabling almost the whole of the effective profile to be machined at one pass, that is to say, outer chamfer, slopes on tread, the flange over its maximum diameter, and also a portion down the external faces. (see fig. 1)

After machining the inside face, the very small portion of the flange shown at X in fig. 1. is blended by a Carbide radius tool. The only manual adjustment here is the setting of the depth of cut after positioning the copying slide at the start. When necessary two passes, or a roughing and finishing cut, will be done in the same way.

The rationalization of the machining process ensures economical re-profiling of wheels. The wide variation in the amount of wear of wheels has led Railway

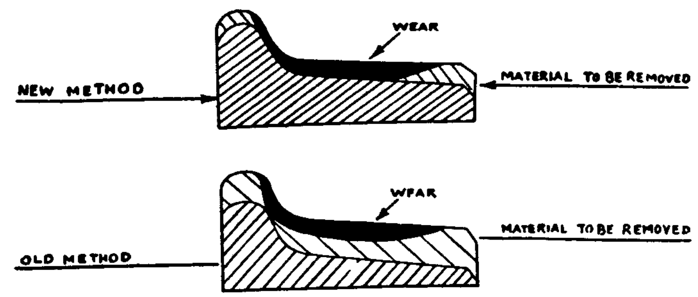


FIG. 2

Engineers to study profiles limits, and to establish a range of profiles for each amount of wear, so as to obtain maximum life from a wheelset. (see fig. 2)

Using a Tungsten Carbide Pastille, (the cost of which is very cheap), it is possible to cut through the different hardnesses of the tread which can vary from 75—80 Kg/m.² up to 200 Kg/m.², and so give the wheel a new profile without removal of any more material than is essential.

Depending on the amount of wear on a tread and the frequency of reprofiling, 5-6-7-8-9 or more, reprofilings may be carried out on a wheelset before replacing the tyre. Modern Railways all over the world now have a tendency to reprofile more often and to remove less material.

This economic necessity has induced the designers to incorporate, in the hydraulic copying device, a template carrier drum into which are fitted a number of templates equal to the tyre profiles to be machined.

Profile template changing requires only a fraction of a second, as the Barrel carrier can be revolved so as to introduce any one of a number of templates to the tracer.

The old system of profiling by cams requires skilled attention and the cams are prone to wear. Furthermore, a correct ratio between cam and tool size must always be maintained to ensure a true profile. The cost of one profile cam is approximately Rs. 2,500/-, and the cost of one Sculfort template only Rs. 150/-. The template length is about 6" but can be longer if required, and is 3/16" thick.

The Tungsten Carbide pastilles measuring 28mm×28mm×14mm thick, are fixed in toolholders of the clamp type and are not brazed to a mild steel shank. The pastille has negative rake cutting angles ground on each of eight radiused corner cutting edges, A new cutting edge can be presented to the work by merely unclamping the pastille and rotating it to a new corner.

Mushroom or Button type tools used on conventional type machines can only be used in two or three positions due to the comparatively large area of the button which is engaged in cutting. Button tools require larger horsepower for equivalent metal removal rates and take longer to change as it is necessary to undo the holding screw. Regrinding is also expensive and more complicated than with the flat Sculfort type square pastille. To ensure rapid break-up of chips a flat carbide chip breaker having dimensions 18mm×18mm×8mm thick is clamped on top of the pastille. The radius cutting edge of the Sculfort type pastille gives a far superior surface finish to the wheel than can be obtained with the old fashioned H. S. S. or Carbide Button tool.

Under normal working conditions, it is possible to machine about 30 pairs of wheels with one set of pastilles, that is two pastilles, one in each tool holder, before regrinding.

If care is taken to change the cutting edge before excessive wear or cratering takes place, several hundred pairs of wheels can be machined in the useful total life of a set of pastilles. When the pastille has been reduced by numerous regrinding to a minimum thickness, below which it is unsuitable for wheel turning, the pastille can be brazed to a mild steel shank and used as a conventional carbide tool on standard machining operations. The pastille can also be used as a chipbreaker on the wheel lathe. The negative rake ground on to the cutting edges of the Pastille enables the very hardest spots and sand inclusions to be machined with ease at high speed. See fig. 2.

An additional feature of the Sculfort machine enables the cutting speed to be reduced instantaneously (by finger tip push button control on the main panel, or the left or right auxiliary panels) should an exceptionally brake hardened or skid spot be encountered. Normal full speed can be regained in the same way. Also by rotating a simple graduated hydraulic control valve dial the rate of feed can be infinitely varied at any time during the profiling, for instance at the base of the flange where the depth of cut increases quickly. This ensures even wear at the pastille cutting edge and prevents excessive power consumption.

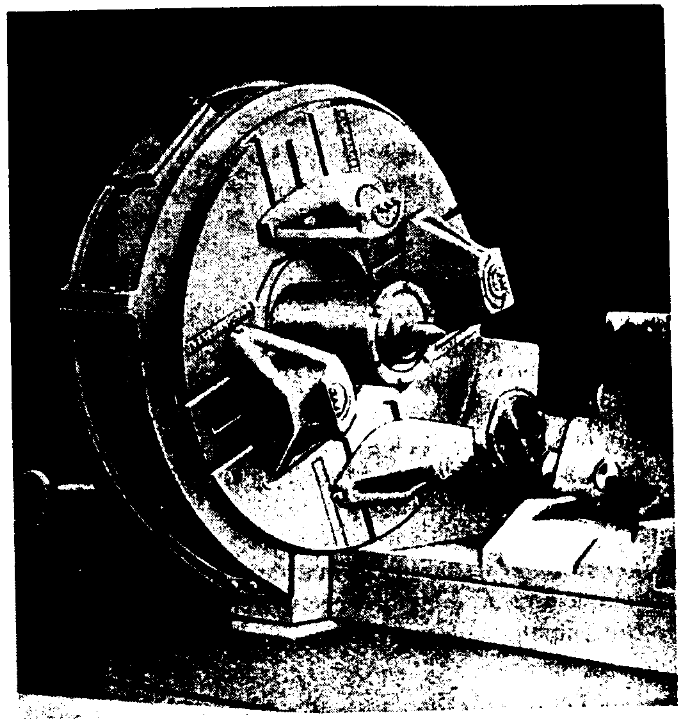
The feeds to each toolpost are entirely independent and the toolposts can operate at different feeds to suit cutting condition on the individual wheel. Feeds are infinitely variable up to 65mm./min. and are applied smoothly. NOT by ratchet or pick feed mechanism, the links of which wear quickly.

Each toolpost can accommodate an extra pastille so that two tools can be engaged in machining at one time. The purpose of the second tool being to remove excess material from the top of the flange at the same time as the other tool is doing normal machining on the tread.

The Sculfort Wheel Lathe is powered with a 75 H. P. two speed motor (a four speed motor can be supplied if required). This motor is for the main drive only and other motors are incorporated for the auxiliary motions. The power available is in excess of the amount which any type of tooling at present available, can absorb.

Sixteen spindle speeds are provided through reduction gearing, and range from 3.4 to 30 r. p. m. and are arranged in arithmetical progression so that the difference between speeds is small. The speed range offered gives peripheral cutting speeds from 40—300 ft. per minute. These speeds cover the requirements for cutting with either Tungsten Carbide or High speed Steel, if necessary.

A modern high speed heavy duty wheel lathe must offer many up-to-date features, together with ample power and rigidity. The Sculfort Wheel Lathe incorporates these essentials. The machine weighs 40



tons—front spindle bearings are 16½" diameter—simple maintenance—pressure lubrication—safety devices for hydraulic and electric controls and measuring equipment etc., are all embodied.

The machine is extremely well proportioned, and has been designed in such a manner that once the main bed is levelled and grouted in, it need not be disturbed, even if the bedways require re-scraping after some years use, since they are made detachable and independently adjustable, although firmly fixed to the main bed.

The headstock bearing surfaces are provided with easily replaceable bronze friction plates ensuring long life in service. This principle is also adapted for the tool holder slides.

Pressure librication is provided to the most important points of bed—headstock—toolpost and slides etc., using adequately protected pumps and piping systems. All outlets are equipped with individual flow rate regulating and control devices. The headstock gears are splash lubricated.

Since many of the functions of the machine are actuated electrically and/or hydraulically in automatic sequence, very special attention has been paid to safety and protective devices. To mention a few—traverse limit switches—safety valves—manometers on hydraulic systems—warning indicator lamps on pushbutton

control units, and finally, mounted on the main control cabinet, together with normal protective features, is an audible warning mechanism.

To ensure accurate dimensional production, measuring devices using micrometer screws, are fitted on tool slides and on the headstocks to enable simple, accurate and rapid measuring of wheel diameters.

In conclusion, the many special features incorporated in the Sculfort Lathe permit the reprofiling of wheelsets in less than ten minutes per set, floor to floor time. This figure is not as a result of a special effort on selected wheelsets, but is a normal production timing. A cutting speed of 65 metres per minute, a feed rate of 2.4 m/m per rev. and a depth of cut 3 to 5 mm.

Conventional wheel lathes utilize cutting speeds and feeds which are only half those used on Sculfort machines.

Designed as it is to meet the growing need of intensified output, the Sculfort Wheel Lathe is capable of revolutionizing the whole concept of Railway Wheel and tyre reconditioning, and slashing reprofiling costs by as much as 80% due to vastly increased out turn.

Methods of Chemical Analysis of Iron Ore

India is a major world supplier of iron ore and large quantities are regularly exported from various Indian ports. These exports are expected to further mount up with the canalisation of exports through the State Trading Corporation of India (Private) Ltd. With the setting up of more steel plants in the public sector, India's consumption of iron ore will increase considerably. The prices paid to the mineowners for iron ore are directly linked with the contents of iron, phosphorus etc. The Indian Standards Institution feeling, that a standard for the methods of chemical analysis of iron ore, will be extremely helpful in co-ordinating the methods followed by the public analysts engaged in analysing the export consignments and the laboratories attached to the steel plants, has brought out a draft Indian Standard Methods of Chemical Analysis of Iron Ore [Doc: SMDC 2 (66).]

The methods of analysis prescribed in this standard have been prepared with a view that they shall be useful as reference methods. Due consideration has been given in the preparation of this standard to the facilities available in the country for such analysis.

This standard specifies the methods for the determination of moisture, silica, iron, alumina, phosphorus, sulphur, titanium, manganese, calcium oxide, magnesium oxide, ferrous oxide, vanadium and combined water. For export purposes, the determinations of lead, copper, arsenic and zinc are sometimes required. Methods for these have also been prescribed.

Modifications of the procedures for the determination of various constituents have been prescribed taking into account the variations in the chemical composition as commonly found. No account has been taken of the unusual presence of a constituent like chromium which may be rarely found in iron ore.

* * *

NEW METHODS OF COAL MINING IN THE U.S.S.R.

New methods of mining are developing at rapid rates in the Soviet land. Opencast mining, the most advanced and economical method, makes up now a large branch of the Soviet coal industry. In the recent years alone, opencast mining has increased by 4.4 times and supplies now 20 per cent of the country's coal. By the end of the sixth five year plan period the quantity of coal extracted annually by the opencast method will exceed 120 million tons.

Underground hydraulic extraction of coal is also successfully developing in the USSR. Not less than 12 million tons will be mined in this way in 1960.

The Soviet Union has considerably surpassed the USA, Britain, and other capitalist countries in the development of research, experimental and industrial work of underground gasification of coal. There are industrial stations functioning in the coal areas of the country which have already produced thousands of millions of cubic metres of gas, obtained by underground combustion of coal. The number of such stations will be considerably increased in the near future.

The Underground Labyrinth— New York's Subway Systems

"MODERN martyrdom may be succinctly defined as riding on a New York omnibus....People are packed into them like sardines in a box.....The seats being more than filled, the passengers are placed in rows down the middle, where they hang on by straps like smoked hams in a corner grocery...."

That's the colorful manner in which one newspaper described the New York City transportation situation on October 2, 1864, when New York had a strapping population of 700,000 and the only means of public transportation was the horse-drawn omnibus, Globe Press Service reports.

Editorials cried for a modern transportation system. Planners nervously eyed several innovations, hoping to make a correct decision on which was best. One company even started to build pneumatic tubes, which would use air pressure to move the trains, and hope to hurtle passengers along in that manner. The venture failed.

Elevated trains—situated on tracks high above the city streets and held up by steel pillars—were also tried and achieved a certain degree of permanence (although the fact that they were steam-driven led many soot-covered passengers to the vilest denunciations). The last "El," as it was called, was torn down only in 1956.

Finally, in 1900, an idea long-discussed and often shelved was decided upon—New York's transportation system would go underground; the city would build a subway system, similar to that in London.

In March of that year, ground-breaking ceremonies were held in front of city hall. Four years later, the first subway, only a few miles long, was opened.

Today, from that crude beginning, New York's subway system has grown to become the largest in the world. If its routes were laid out straight, they would be long enough to run a single track from Buenos Aires, Argentina, to Santiago, Chile—a distance of over 700 miles.

Over these routes run 6,500 electrified cars, which carry an average of 6–million passengers per day—or, approximately three-quarters of the city's total population of 8–million.

By the year, the number of passengers amounts to 1,400,000,000. More than 35,000 transit workers are required to maintain the system.

Big? It certainly is.

Big enough? Apparently some people in authority don't think so, for the system keeps expanding in length and equipment.

Subway routes run under the Hudson River to neighboring New Jersey, and recently, the Transit Authority placed an order for more cars and other equipment.

Some 250 cars were placed in service last year. They have the latest propulsion equipment, built by the Locomotive and Car Equipment Department of General Electric (U. S. A.) at a cost of more than $ 7,800,000. Each car has a package of four G-E traction motors and G-E control equipment.

Reliable control equipment is an absolute necessity on the subway. Trains operate at speeds of upto 50 mph. and must be able to deaccelerate rapidly. "Dynamic" braking is another feature of the new equipment.

The new cars hold a maximum of 200 persons each, 44 of them sitting. They can be operated in trains of up to 11 units from a single control station.

This order was the fourth major addition of equipment in recent years to the rapidly-expanding subway system. In 1954, 200 cars were purchased. In 1955,

(Continued on page 31)

Brazil Modernizing Ports with Diesel Locomotives

BRAZIL, which has made great strides in bringing modern motive power to her railroads, is now modernizing the operation of her ports with new diesel-electric locomotives.

The country recently placed an order for fifteen 45-ton and two 65-ton diesel-electrics with the International General Electric Company (U. S. A.) in New York.

The locomotives will be manufactured by G-E's locomotive & Car Equipment Department in Erie, Pennsylvania. General Electric, S. A, of Rio de Janeiro, assisted the port authorities in determining their requirements, Globe Press Service reports.

The order was placed by Brazil's National Development Bank for the Port Administration of Rio and the Minister of Transportation and Public Works in the National Department of Ports, Rivers and Canals.

The locomotives will be used for switching freight cars delivered to the various ports by the Brazilian railroads. The purchase of these new locomotives is expected to greatly facilitate the exportation of Brazilian goods as well as the distribution of imported products.

Coincidentally, the order for the new equipment was placed during the 150th anniversary year of the opening of Brazil's ports. Until 1808, the country's commerce was restricted to Portugal. But in that year, Brazil was established as an empire, ruled by Don Joao VI, who opened ports to all international trade. A commemorative stamp was issued by Brazil early this year in honor of the former emperor.

The ports of Porto Alegre, Itajai, Laguna, Imbituba and Paranagua will each receive two 45-ton G-E locomotives in the new equipment order. Fortaleza, Natal, Recife, Maceio and Sao Francisco do Sul will get one each. The two 65-ton units will be used in the port of Rio de Janeiro.

Twenty-one other G-E locomotives are already in use in the ports of Rio, Santos and Paranagua.

The equipment purchases are part of an over-all plan by Brazil to modernize her system of transferring goods from the interior to seaports.

Extensive modernization has already been accomplished on five major railroads which purchased 88 main-line diesel-electric locomotives from G-E. These purchases were made in 1957 and are in addition to the more than 300 G-E locomotives already operating in Brazil.

The Switch from steam to diesel-electric power has helped Brazil save millions of Cruzeiros each year in coal imports.

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an additional 400 were bought and early in 1956, the system added 250 more cars.

What's going to be new in subways in the future? According to planners at General Electric, most heavily-populated cities are in great need of some form of rapid transit system and all will eventually have one.

The system would use self-propelled cars, would be modern, easy and economical to operate and would run either under the ground, as the subways, or above the ground along center malls or wide boulevards leading into the cities. Commuters coming in from the suburbs would have their choice of trains as they arrive, one after another, in ten or fifteen minute intervals.

Transportation planners do not want any repetition of the 1864 criticism that compared riders of public transportation to "sardines in a box".

Application of Cartridge-Type Roller Bearings on Locomotives

By

Locomotive and Car Equipment Department

General Electric Company (U.S.A.), Erie, Pa.

LOCOMOTIVES are now being fitted with all-purpose cartridge-type roller bearings that have been thoroughly proved for railroad service by use on thousands of freight cars

The bearing, outer housing and seals are completely assembled and lubricated with the proper amount of grease by the manufacturer, so that when received it is ready to press on the axle, Globe Press Service reports.

Engineers at General Electric's (U. S. A.) Locomotive and Car Equipment Department in Erie, Pa., have devised a simple means of applying this type of bearing to mine haulage locomotives and industrial diesel-electric switching locomotives in sizes ranging from 15 to 115 tons.

Moreover, existing locomotives fitted with conventional journal bearings can be changed over to roller bearings by a simple modification of the journal box and axle, and the addition of an adapter.

The adapter is designed to permit renewal of the pedestal wear plates, and installation and removal of the bearing without untrucking the locomotive. This is made possible by the fact that the thrust lugs of the adapter are located on the outside of the truck journal box guides.

Therefore, it is only necessary to block the truck equalizers and jack one corner of the truck sufficiently to lift them clear of the pocket in the top of the adapter. The adapter can then be lifted free of the journal unit and removed, giving access to the pedestal wear plates.

The bearings can readily be replaced by removing the adapter and pulling the old bearing off and pressing the new one in place, using a hydraulic jack. Ability to do all this without untrucking the locomotive will result in substantial savings of time and expense.

As already mentioned, the adapter is designed so that the thrust lugs are on the outside of the journal box guides rather than on the inside, as in conventional roller bearing journal boxes. This gives the added advantage of a more sturdy truck, since the lateral forces are taken on the outside instead of the inside of the truck frame.

As a result, the areas where the side frames are attached to the bolster receive compressive rather than tensile stresses, thus greatly reducing or eliminating the stress concentrations and fatigue in this area.

The third advantage of the cartridge type of roller bearing is economy. Since this type is a high production unit, its cost is relatively low. Maintenance and inspection are practically non-existent. The journal is fitted with a rubbing type grease seal that is very efficient. Depending on service conditions, this type of bearing can run for periods up to three years without the addition of grease.

To date, these economical, rugged bearings have been applied on 41 diesel-electric switching locomotives ranging in size from 35 to 115 tons. These are in service in steel plants in India and on docks in South America.

In addition to these applications, this type of bearing is now available on the standard line of diesel-electric industrial switching locomotives, and also on certain sizes of electric mine haulage locomotives.

Track Weight and Truck Type Considerations in Switching from Steam to Diesel Operation

*By G. T. Bevan**

ONE of the more important questions being asked by countries now undergoing the transition from steam to diesel or diesel-electric power is "how will it affect rail weight and axle loading ?"

These countries naturally expect dieselization of their railroads to result in increased hauling capacity and greater locomotive utilization, along with reduced locomotive maintenance.

But if their railroads become over-conservative in their specifications, they might fail to obtain all the advantages for which they are about to invest large sums of money.

This is particularly true in deciding whether to buy locomotives with A1A, B_o—B_o or C_o—C_o trucks and whether certain sections of line will have to be reconverted for heavier rail.

In general, the application of steam locomotives was dictated by certain track conditions. The counterweights on steam locomotive driving wheels produced a pounding effect (dynamic augment) which set up associated stress that had a detrimental effect on both rail and ties. Definite ratios of axle loadings to rail weights that compensated for this offset were established.

Diesel-electric locomotives do not have dynamic augment and, consequently do not produce the high track stresses encountered with steam locomotives. Therefore the rigid restrictions which applied to steamer axle-loading need not be followed.

However, when diesel-electrics entered the scene, these same rations were strictly adhered to—until motive power utilization became severely handicapped. Light rail sections were considered to be unsuitable for the conventional "heavy weight" (or all weight on drivers) of the B_o—B_o truck main line diesel-electrics. The demand for lighter axle loadings brought forth the A1A type truck. While this apparently solved the problem it had one great disadvantage. Compared to a locomotive of similar horsepower and total weight with B_o—B_o type trucks, the locomotive with A1A—A1A trucks has only two-thirds of its weight available for traction. This imposes a severe restriction on the tonnage it can handle and makes it undesirable for main line service.

Typical examples of what happens when A1A trucks are applied to locomotives of 900 and 1200 horsepower are shown in Tables I and II. In the case of the 900-hp locomotive, approximately [illegible]8% more tonnage can be hauled up a 2% grade when C_o—C_o trucks are used.

The Missouri-Kansas-Texas Railway in the United States was one of the first to realize these handicaps. According to a report by the Railway Sub-Committee of the Inland Transportation Commission prepared for the Economic Commission for Asia and the Far East, this railroad at first requested a 1600-hp locomotive designed to weigh 70 tons for branch line service. It was soon discovered, however, that greater utilization could be realized by operating existing main line 1600-hp, 120-ton B_o—B_o units over lines laid with 26 kg rail. Several highly successful demonstrations proved that old axle load limitations for steamers could be increased 15—20% for diesels without any detrimental effects.

The Maintenance of Way Department of another large United States railroad made a detailed study of track stresses in various rail sections under both steamer and diesel operation. The following conclusions were reached :

1. Rail weights could be reduced 18 to 20% when diesels were applied with the same axle loadings as with steamers. The report shows rail weighing 64 kg per meter required for a "heavy" Santa Fe type steamer (2—10—2) could be reduced to 53 kg per meter for diesels of the same axle loading.

2. Maximum tie plate loads resulting from locomotive operation could be reduced 47% by substituting diesels for steamers with the same axle loading.

* Application Engineer. (Locomotive & Car Equipment Dept., General Electric Company, U. S. A.)

3. Maximum resulting ballast pressures could also be reduced 47% by substituting diesels for steamers with the same axle loading.

However, certain other restrictions, such as older bridges and trestles, originally designed in the days of smaller steam locomotives, occasionally limited the application of new and higher capacity diesel-electrics.

Where light rail sections (25-30 kg per meter) are used, track usually is laid with low-grade ballast, and cross tie spacing is greater than for well-ballasted main line service. Consequently speed restrictions are imposed, irrespective of the type of motive power used. This makes it possible to operate the B_o—B_o type locomotive with its higher axle-loading.

A survey of the application of standard 1500—1600—1800 HP all-purpose road-switcher locomotives in the U. S. A. (Table III), shows that only a fraction of one per cent of those sold from 1946.

THIRD TRACK WEIGHT AND TRUCK TYPE XXX 1946

Through 1956 were of the A1A truck design. The only exception is in high-speed passenger service, where trains are operated at 128 to 160 kilometers per hour. Here the A1A design has proved quite popular. In this case, however, emphasis is on speed and these locomotives usually have higher horsepower capacity than is needed for branch line service.

An example of present thinking on U. S. railroads is found in the case of the dozen 1600-hp road-switchers purchased by an Eastern railway in 1950 with A1A—A1A trucks, see Table III. The Operating Department of this railway found itself severely handicapped with a "light weight on drivers" locomotive. After experience with A1A trucks it realized the handicaps this design imposed on tonnage hauling capacity and these units were rebuilt with B_o—B_o trucks in 1952. Several other U. S. railroads have since rebuilt locomotives of the A1A—A1A design in B_o—B_o or C_o—C_o types. The Milwaukee and Union Pacific are two notable examples.

Many years experience on the U. S. and other countries that have already passed through most or all of the period of transition from steam to diesel shows that a large majority of the lines laid with light rail sections can be operated very successfully with locomotives having either C_o—C_o or B_o—B_o trucks.

Table IV illustrates the advantages of using a C_o—C_o truck in preference to an A1A truck on two sizes of a well-known line of locomotives manufactured specifically for export. Approximately fifty percent more tractive effort is available at 20% adhesion for both locomotives with all-driving axles as compared to locomotives with two dead axles.

In concluding this comparison, it is worthwhile to point out that before a locomotive with an A1A-A1A truck design is specified, a very careful engineering study should be made to insure that its application is economically justified. In this manner, costly results of misapplication, as illustrated by past cases where this design was initially used, can be avoided

TABLE I
900 HP LOCOMOTIVE
COMPARISON OF HAULING ABILITY
A1A—A1A VS C_o—C_o TRUCKS

	A1A-A1A	C_o—C_o	% Difference
Total Weight of Locomotive (Metric Tons)	77	77	—
Total Weight on Drivers	51	77	50%
Number of Axles	6	6	—
Number of Traction Motors	4	6	50%
Tractive Effort Continuous Rating (kg)	15,422	19,777	28%
20% Adhesion Tractive Effort (kg)	10,300	15,400	50%
Trailing Tons on 2% Grade at 20% Adhesion Tractive Effort	330	522	58%
Number of Cars (20 Metric Tons)	17	26	53%
Train Speed on 2% Grade (KPH)	20	13	35%
Speed of Train with 330 Trailing Tons with C_o-C_o Type Trucks (KPH)	—	20	—
% Adhesion if Locomotive with A1A Trucks Hauled 522 Tons or 26 Cars up 2% Grade	30%	—	—

TABLE II

1200 HP LOCOMOTIVE COMPARISON OF HAULING ABILITY
A1A-A1A VS C_O-C_O TRUCKS

	A1A-A1A	C_O—C_O	% Difference
Total Weight of Locomotive (Metric Tons)	79	79	—
Total Weight on Drivers	53	79	50%
Number of Axles	6	6	—
Number of Traction Motors	4	6	50%
Tractive Effort Continuous Rating (kg)	15,422	19,777	28%
20% Adhesion Tractive Effort (kg)	10,600	15,800	50%
Trailing Tons on 1% Grade at 20% Adhesion Tractive Effort	770	1,196	55%
Number of Cars (36 Metric Tons)	21	33	57%
Train Speed on 1% Grade (KPH)	26	17	35%
Speed of Train with 770 Trailing Tons with C_O-C_O Type Trucks (KPH)	—	26	—
% Adhesion if Locomotive with A1A Trucks Hauled 1196 Tons on 1% Grade	30%	—	—

TABLE III

USA MARKET
1000 HP—1500 HP—1600 HP TYPE*

		A1A-A1A Trucks Road Switchers	Total Number Ordered Road Switchers
	1946	24	55
	1947	10	233
	1948	3	255
	1949	4	260
**	1950	12	1289
	1951	0	1105
	1952	0	861
	1953	0	1122
	1954	0	621
	1955	2	1071
	1956	0	965
		55	7837

Percent 0.7%

* Number Locomotive Units Sold with A1A-A1A Trucks for Local Branch Line Service in U. S. A.

** The Trucks on these 12 Locomotives were changed to the B_O—B_O Design in 1952.

TABLE IV

COMPARISON – WEIGHT, TRACTIVE EFFORT & ADHESION OF SELECTED MANUFACTURED TYPES OF LOCOMOTIVES
C_O-C_O VS A1A-A1A

Model	Truck Type	KG Axle Wgt.	KG Total Wgt.	% Wgt. on Drives to Total Wgt.	Con't T.E. (KG)	T.E. (KG) at 20% ADH	% T.E. Used at 20% ADH	% of Additional T.E. of Type A over Type B
(A) 900 HP	A1A-A1A	12,300	73,900	66.7%	12,750	9,850	77%	—
(B) ,,	C_O-C_O	12,852	77,112	100.0%	19,777	15,500	79%	58% *
(A) 1200 HP	A1A-A1A	12,150	78,900	66.7%	12,750	10,500	82.5%	—
(B) ,,	C_O-C_O	13,300	79,500	100.0%	19,777	15,900	81.0%	51% *

* at 20% Adhesion

Visitors Can "Drive" A Locomotive at Pan-American Railway Congress

"STEP in—drive a diesel-electric locomotive." That invitation awaits visitors to the Pan American Railway Congress, to be held in Buenos Aires from August 30 to September 13 this year, Globe Press Service reports.

It is part of an unusual and fascinating exhibit, which, in bright colors, flashing lights and rotating displays, outlines the history of railway motive power in the world, gives a complete description of the operation of a modern locomotive and lets the visitor take the throttle of one himself.

The display is called "Progress of Railways". It was built by General Electric (U. S. A.) Company's Locomotive & Car Equipment Department in Erie, Pennsylvania.

It is aimed at making the public aware of the importance of modern railroads to a nation's economy informing them of the advantages of the diesel-electric locomotive, and paying tribute to key personnel around the world who have played an important role in developing their countries' railroads.

The Pan-American Railway Congress represents the opening of a 12-nation tour for the display, during which it will be brought to almost every country in Latin America.

It was previewed at Erie, before GE's world-wide representatives, and at the Third International Exhibition in Bogota, Colombia, where more than 600,000 persons jammed to see it.

Weighing an impressive 50,000 pounds, the display will be shipped to Buenos Aires in time for the opening of the Congress. It will take approximately a day to set it up.

Entering the display area, the first unit the visitor sees is the "History Arch," topped by a gleaming silver rail, bearing the inscription: "A sound railroad transportation system is the key to a healthy economy".

On either side of the arch are illuminated color panels displaying pictures of six locomotives that revolutionized transportation or solidified the economies of nations.

The left hand panel shows the first steam locomotive, built in 1825 and officially regarded as the first practical, machanical source of power. Beside it is Thomas Edison's first electric rail car. Built in 1880, it was the second application of electricity in the world, following Edison's discovery of the light bulb. The third locomotive on the left hand panel is the first mainline railroad locomotive ever built. It was made by General Electric for the Baltimore and Ohio Railroad and had a top speed of 50 mph.—fast for 1895.

On the right hand panel are three locomotives of more recent vintage. They were built, respectively, 1924, 1949 and 1956. The first is the original diesel-electric locomotive, which has remained in service on the Central Railroad of New Jersey until spring of this year, when it was retired with much fanfare. Next, is the gas-turbine electric locomotive, which brought the jet principle to railroading. Just recently, 30 more of these locomotives were ordered from GE by the Union Pacific Railroad in the western United States. Finally, there is GE's revolutionary new universal locomotive, designed for easy adaptation to any railroad in the world and for any type of rail service—freight, passenger or switching.

The universal design was announced a year ago and 137 were ordered by Latin American countries even before the first was built. Among those countries are Mexico, Chile, Argentina, Colombia and Brazil.

Passing through the "History Arch," the visitor next comes to a display describing "how a diesel-electric locomotive works". With numbered parts, convenient reference material and varied colors, it shows how the diesel engine in the locomotive turns a generator which furnishes power to traction motors that turn the wheels.

Beyond this exhibit is another illuminated panel which reveals the operation of a modern diesel engine. It depicts, in easy-to-follow form, exactly how diesel engines are used in locomotives to give maximum power.

The next display shows how this "great power of the diesel engine is transmitted to the turning wheels" of the locomotive. It explains the electrical transmission and control equipment in GE diesel-electric lccomotives.

Then, the visitor comes to perhaps the most unique display of all—that labeled: "Step in—drive a diesel-electric locomotive."

This display is an entirely reconstructed cab of a modern locomotive, complete with dials, gages, throttle and brakes.

The visitor can sit in the operator's seat and look out the "window" ahead. The "window" is actually a movie screen.

When the "operator" eases back on the throttle, the scenery before him begins to move. The visitor gets the impression that he is actually driving a locomotive—an impression that brought squeals of delight from would-be rail engineers at the Bagota exhibit.

After the "engineer" has brought his "locomotive" to a halt, he can then take a look at two more displays showing him where such equipment he has just "driven" is in use.

The first lists the countries and railroads where GE diesel-electrics are in operation, and the second specifically deals with South America. With a huge map, it gives examples of rail transportation's vital role in these countries—a role that keeps getting bigger every day.

125-Ton British-Built Transformer Hoisted to Los Angeles Harbor's Rail Car

A 125-ton transformer built in England—the heaviest single piece of foreign cargo ever unloaded at Los Angeles Harbor—was recently hoisted from the British freighter PACIFIC UNITY to a special rail car on the wharf.

A 160-ton floating crane, largest of its kind on the Pacific Coast, handled the herculean task, Globe Press Service reports.

Using angle irons, the 21 × 10 × 14-foot transformer was welded to a 250,000 pound capacity rail car. The Port of Los Angeles' Harbor Belt Line then hauled the equipment off for installation at the Scattergood Steam Plant, a $ 61 million project now under construction at an ocean front site near Los Angeles.

English Electric Co. of Stafford, England, built the $ 247,210 transformer, which will be used to serve an area of 300,000 persons. Electric power will be stepped up from 18,000 volts to 138,000 volts when it is put in service.

Arrangements for shipping the British-built equipment were made by Mrs. Alice Keany, traffic manager for the Department of water and Power, Los Angeles. Mrs. Keany, one of the few women in the traffic field, said a second unit of the same size is on order for later delivery.

* * *

NEED FOR CONTROLLING CORROSION OF STEEL

Dr. B. N. Dey, retired Chief Engineer of Calcutta Corporation and a well-known Consulting Engineer, stated that India's planned six million ton steel production could be made to equate to a ten million ton steel production with effective corrosion-control.

In a statement, Dr. Dey said that it had been found that the higher the steel production of a country, the higher would be its corrosion. It had also been variously estimated that up to nearly half of a country's steel production was used up in replacing the corroded material, so that only half of its steel production was available for new construction.

"It is, therefore, profitable to spend something on effectively protecting and thus prolonging the life of the existing and projected steel work than to spend more and more on new steelwork as replacement", he said.

According to Dr. Dey, the cost of protecting and prolonging the life of steel by the latest methods being within one-tenth of the cost of producing steel, it is clearly a case of big economy.

Rebuilding Yugoslavia's War-torn Railway System

By Djordje Savicevic

Deputy General Manager, Yugoslav Railways.

For the last twelve years, the Yugoslav railways are engaged in the building up of their war-torn system to bring it on par with the railways of other advanced countries. The author narrates how the railways which have drawn up a Rs. 282-crore modernisation plan are tackling the enormous problems of rehabilitation. The investment will be utilised in buying new coaches, constructing new lines and attending to permanent way requirements.

AFTER the liberation of Belgrade, the Yugoslav railways were found to be in a derelict condition—less than one-third of the 70,000 wagons, one-fourth of the 4,500 carriages and only one out of the total fleet of 2,500 locomotives was, in proper working order. When the entire country was liberated about one-fifth of the locomotives and not a single line out of a total mileage of 6,525 was capable of railway traffic. All tunnels, bridges and culverts were either damaged or destroyed by the enemy.

It was a gigantic task for the country to rebuild a war-torn railway system. Thanks to the efforts and enthusiasm of the people, army, youth and railway labour, train service could be resumed by the end of 1945 almost on all lines and the repaired rolling stock could cope with the industrial needs of that time.

At the end of 1946, the railways were able to face with confidence the transport requirements of the first Five Year Plan. With all earnestness the question of renewal of the existing railway lines were taken in hand, new lines were constructed and the rolling stock repaired. The rehabilitation of the railway system is being continued till now and will last a few years more. It has been possible for the Yugoslav railways to repair the damages within the last twelve years or so and that too without any help.

Besides investments for electrification and industrialisation, vast sums of money have been spent on the renewal as well as on the building up of railway traffic. No less than 850 miles of new railway lines have been constructed and 15,000 wagons and about 500 locomotives have been procured.

After the war, railway coaches were either purchased from abroad or received as help from the United Nations Relief and Rehabilitation Administration. But during the last few years the Yugoslav industry has begun to supply other railways with require rolling stock. The help from the U. N. R. R. A. which consisted of 300 locomotives, was the only foreign aid which Yugoslavia received after the war to rehabilitate her railway system.

BETTER UTILISATION OF ROLLING STOCK

The railways have transported in 1956, 2.5 per cent more goods and 2.84 per cent more passengers than in 1938. This has been possible due to 2.6 per cent better use of carriages, 1.98 per cent of wagons and 1.81 per cent of locomotives. For providing the same amount of comfort and for meeting the industrial needs at the same rate as in 1938, the railways needed in 1956, 3,760 carriages, 52,600 wagons and 1,820 locomotives in addition to the existing stock which according to the present price would come to 335,000,000,000 dinars (Rs. 530 crores approximately).

It will be realised that without better utilisation of the existing holdings it was impossible to meet the country's needs only by increasing capacities by new investment. The investment of this huge sum would have shattered the national economy.

The years after the war necessitated the maximum utilisation of the rolling stock and the line capacity with the minimum of investment. As a result of this drive the railways transported in 1957 about 57,000,000 tons of goods and about 165,000,000 passengers or 36,000,000 tons of goods and 109,000,000 passengers more than in 1938, the record year in pre-war days.

OUTDATED LOCOS, COACHES AND WAGONS

It is but natural that the railways which endured widespread devastations during the last war, and still fighting against heavy odds for rehabilitation and for carrying the increased traffic will have manifold problems. Due to irregular replacements of basic resources, the railways are today handicapped by overaged rolling stock, old and outmoded structures and many other deficiencies. The value of the basic resources of Yugoslav railways at the end of 1956 amounted to 48 per cent of the buying value—a definite proof of the poor state of the holdings.

The Yugoslav railway carriages have on an average 50 seats and are capable of attaining a speed of 40 to 100 km. per hour (25 to 62 miles) while in Belgian railways average seating capacity in coaches is 81, and they are capable of a speed of 140 km. per hour (87 miles approx.) The technical portability of wagons on the Yugoslav railways is 16.6 tons approximately while that on the foreign railways is 21 tons. The Yugoslav railway wagons can move less speedily than wagons of many European railways.

The locomotives of the Yugoslav railways are also far behind the locomotives of some European railways both in strength and in speed. While Yugoslav locomotives cannot attain a speed higher than 100 km. (62 miles) per hour, other European locomotives are capable of attaining a speed of 140 to 160 km. (87 to 99 miles) per hour.

To keep the overaged locomotives and rolling stock in good working order is, no doubt, expensive; such overaged stock which is already inadequate can neither render the desired comfort nor attain greater speeds and carry higher train loads. All these adversely affect the transport capacity and the traffic economy.

In Yugoslavia, 98 per cent of the trains are being hauled by steam locomotives while in some European countries steam traction accounts for 52-79 per cent, electric 325 per cent and diesel 5-7 per cent. Existence of wide variety of railway gauges has also rendered the railway working in Yugoslavia difficult and expensive.

MODERNISATION PLANS

The Yugoslav railways are gradually withdrawing the overaged coaching stock and replacing them in increasing numbers with stock provided with necessary amenities and capable of faster runs. The railways have introduced modern coaches wherever possible, withdrawing the old and out dated ones.

In future the railways propose to pay special attention to the construction of wagons of different types with suitable carrying capacity, keeping in view the requirements of international traffic. This move will help the railways to serve the industries better.

New locomotives are proposed to be brought into use and new system of haulage introduced. This will help the railways to run speedier and heavier trains as well as to provide more convenient and cheaper transport. The railways' modernisation plan envisages the gradual introduction of electric traction in place of steam which will be followed by diesel traction wherever economically justified.

The railways' policy regarding the construction of new lines can be outlined as follows: Where the goods and passenger traffic has increased considerably, investments will be made in constructing new lines with better hauling capacity and with modern traffic control equipments; secondly, if the increased traffic demands are on the narrow gauge, conversion of the lines will be made to the normal gauge; and thirdly, to undertake construction of normal gauge railway lines in those areas where it is impossible to introduce any other system of transport.

ROLLING STOCK SUPPLY FROM INDIGENOUS MANUFACTURERS

Moreover, it is of special importance for the development of Yugoslav railways that more and more effort is made to obtain railway coaches from inside the country to meet the traffic needs. In keeping with this policy, orders for all kinds of railway vehicles will henceforward be placed with indigenous manufactures. But in cases of inability of indigenous industry to supply in short time and when the railways cannot wait for them, orders will be placed with foreign firms.

Special attention, will be given in the coming years, to keep in good working order the existing rolling stock and to their maximum utilisation, side by side, with the new stock. Only by so doing can the ever-increasing demands of transport be successfully met.

For meeting the traffic requirements, the Government has sanctioned an investment of 178,000,000,000 dinars (Rs. 281 crores) in the Plan. Out of this

(Continued on page 42)

WOODHEAD MONROE FLUID CUSHION SHOCK ABSORBERS FOR RAILWAY ROLLING STOCK

CONSTRUCTION

A glance at the illustration, Fig. 1 will be sufficient to appreciate the robust construction and generous proportions of this type of shock absorber. Every part has been designed in such a way as to keep stresses well within safe limits, and a special feature is the design of the oil seal, which has proved to be reliable under all climatic conditions.

Referring to Fig. 1 it will be noticed that the top attachment is connected to a piston rod. This is protected by a dirt shield, and a piston is situated at the lower end of the rod. The piston reciprocates in a honed pressure tube. Both the pressure tube and the reserve tube are attached to the mounting, and are sealed at the top by the rod guide. A sturdy compression valve is situated at the lower end of the pressure tube, and a rebound valve is incorporated in the piston. The pressure tube is always full of oil, while the reserve tube contains only sufficient oil to keep the compression valve constantly immersed.

THE OIL SEAL

The rod is lubricated in the rod guide by oil from the pressure tube, which is at a pressure above atmospheric when the shock absorber is operating. Excess lubricant tends to escape from the shock absorber, but is prevented from so doing by the synthetic rubber oil seal. This seal has four wiping

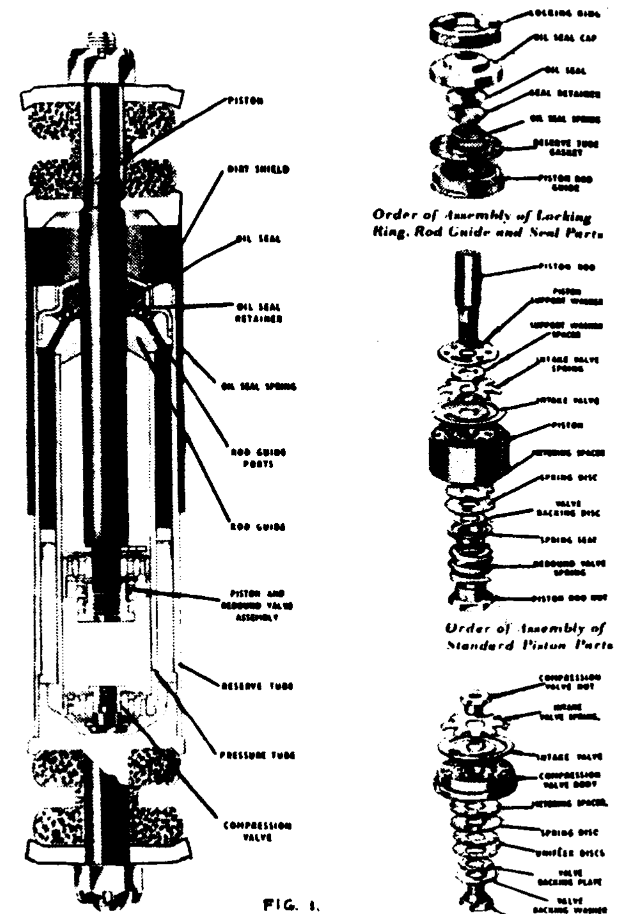


FIG. 1.

Order of Assembly of Locking Ring, Rod Guide and Seal Parts

Order of Assembly of Standard Piston Parts

Order of Assembly of Compression Valve

(Continued from page 41)

allocation about 93,000,000,000 dinars (Rs. 147 crores) have been earmarked for the purchase of railway coaches in Yugoslavia and abroad, about 45,000,000,000 dinars (Rs. 71 crores) for construction of railway lines, stations and other projects and the rest for the construction of the permanent way, bridges, tunnels etc.

It is expected that the railways' modernisation plan would result in increased movement of transport—70,000,000 tons of goods and 212,000,000 passengers by 1961. This will mean a 35 per cent increase in goods and 33 per cent increase in passenger traffic as compared to 1956 figures.

As a result of the investment, it will be possible to provide increased comfort in passenger trains, by introducing 600 well-furnished modern coaches for use by long distance passengers. The railways will be able to meet satisfactorily the nation's transport needs with the purchase of 12,000 new wagons. The reconstruction of nearly 2,500 km (over 1,550 miles) of permanent way of class I and class II railroads will create the necessary condition for greater speed, greater security of transport better utilisation of railway vehicles. It will also be possible to increase capacity by introducing 140 electric and diesel locomotives.

The problems of the Yugoslav railways are massive but the steps taken by the railways to meet them represent a big step.

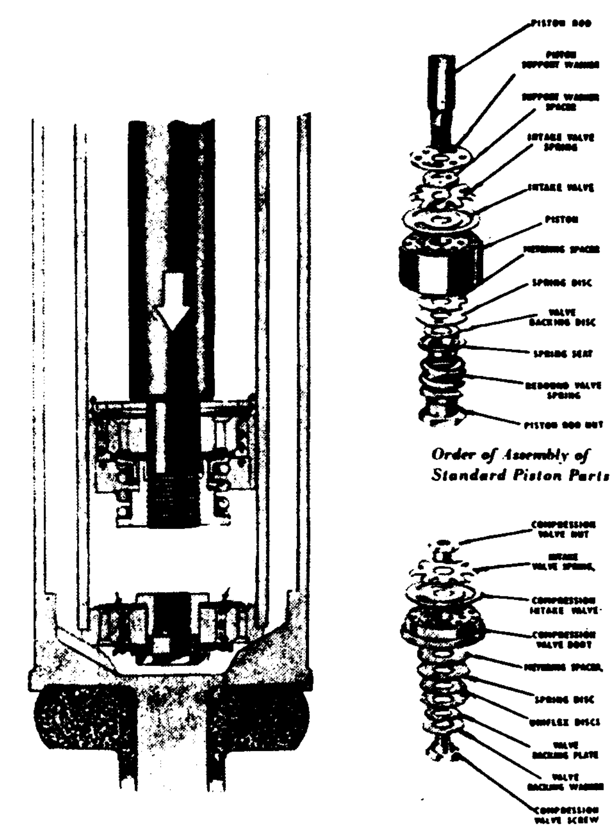
lips to clean the rod as it is withdrawn from the shock absorber. There is a cavity beneath the seal, connected by ports to the reserve tube, and excess lubricant finds its way into this cavity, is relieved of its pressure, and drains back into the reserve tube which is at atmospheric pressure. It will be appreciated therefore that the oil seal is never subjected to oil pressure, its duty being simply to wipe the rod dry. The rod is ground to a smooth surface finish, after which it is given a coating of hard chromium and buffed. This procedure not only produces a mirror-like surface, but prevents corrosion.

Owing to the precision finish of the piston rod, wear on the oil seal is negligible, but it will be noticed that a spring constantly presses against the oil seal retainer, holding the seal tightly against the rod and automatically taking up wear. It is the design of this seal and the surface quality of the piston rod which are chiefly responsible for the long life of the unit.

OPERATION

Compression Stroke. Fig. 2.

As the shock absorber is compressed, the piston rod



Order of Assembly of Standard Piston Parts

Order of Assembly of Compression Valve

FIG 2.

is introduced into the pressure tube, which is full of oil. A quantity of oil, equal to the volume of the piston rod, is, therefore, displaced through the compression valve, into the reserve tube. The compression valve resists the passage of oil, thus offering a resistance to the downward movement of the piston rod, and hence controlling the resistance of the shock absorber on the compression stroke. As the piston descends on this stroke it is necessary to allow oil to pass into the space above the piston, and for this purpose a light 'one-way' valve is situated at the top of the piston, which will open only while the piston is descending.

On the compression stroke it will be noticed that the outer ring of holes in the compression valve is closed to the downward passage of oil by the intake valve. Therefore, all the oil passing downwards through the compression valve follows the course of the arrows, passing down the inner ring of holes into the annular groove beneath them which is normally sealed by the metering spacer and spring disc. If only a very small quantity of oil is to pass it will be able to leak out of the groove by way of the bleed notches in the metering spacer, but when the flow of oil increases (i. e. when the speed of movement rises), pressure is built up in the groove and the metering spacer and a spring disc, hitherto pressed firmly against the base of the valve by the uniflex discs, are deflected downward, so that the oil can escape. The oil pressure at which the discs deflect is controlled by the strength and number of notches in the metering spacer. In certain circumstances it is an advantage to have a build up in resistance at the higher speeds of operation and in this case 'orifice control' (which is velocity conscious) is introduced by restricting the size and number of holes in the compression valve through which the oil must pass. If necessary the outer ring of holes in the piston can be similarly restricted, and it will be appreciated that any pressure of oil caused by this means will act, not only on the cross section area of the piston rod, but upon the whole area of the piston, so that big resistances can be obtained for high operating speeds without an undue increase in oil pressure.

In order to replenish with oil the part of the pressure tube above the piston, the piston incorporates an outer ring of holes through which recuperating oil can only pass as shown by the arrows. It must lift the piston intake valve as it goes, as this valve is normally closed, allowing oil to pass only upwards through these holes.

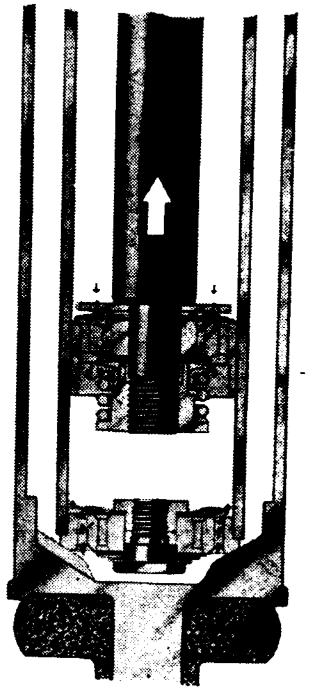
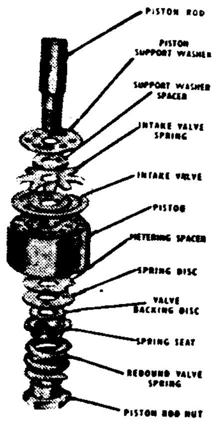
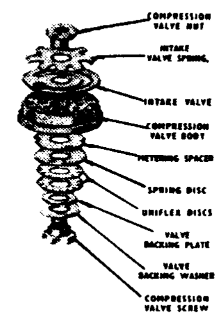


FIG 3.



Order of Assembly of Standard Piston Parts



Order of Assembly of Compression Valve

OPERATION

Rebound Stroke. Fig. 3.

When the shock absorber is extended, the piston rises in the pressure tube, and as the pressure tube is sealed at the top end by the rod guide, oil must flow downwards through the piston. In the piston is the rebound valve, offering a resistance to this flow of oil, and thus causing and controlling the resistance of the shock absorber on the rebound stroke. As the piston rod is being withdrawn from the pressure tube on this stroke, it is necessary to replenish with oil from the reserve tube, and to enable this recuperation to take place a light 'one-way' valve is situated on the top face of the compression valve.

The intake valve in the piston is closed on this stroke by the pressure of oil above it, and the oil is forced down the inner ring of holes in the piston into the groove beneath them. This groove is normally sealed by the metering spacer and spring disc. Small quantities of oil can escape through the notches in the metering spacer, but when the speed of the piston increases, causing more oil to pass through the valve, a pressure is built up in the groove, which at a predetermined amount is sufficient to cause the metering spacer and spring disc to deflect against the coil spring. Oil is therefore allowed to flow as shown by the arrows. As in the case of the compression valve 'bleed' and 'blow-off' characteristics are independent of one another, the former being controlled by the number of notches in the metering spacer and the latter by the strength of the coil spring. As on the compression stroke, velocity conscious orifice control can be introduced when necessary to cause a rapid build-up in resistance at the higher speeds of operation. This is done by restricting the size and number of the holes in the piston through which the oil must pass, although the degree of restriction is critical and must be carefully chosen.

On this stroke, oil is drawn into the pressure tube up the outer ring of holes in the compression valve. The intake valve ensures that oil can only pass upwards through these holes and is normally closed.

ALTERNATIVE PISTON ASSEMBLIES

The foregoing description of the basic valves will be sufficient to enable the illustrations, Fig. 4 to be appreciated. Each assembly constitutes a piston and rebound valve, and each is used for a special purpose in conjunction with the compression valve already described.

Order of Special Assemblies of Piston Parts for 2" Bore Railway Type Shock Absorbers

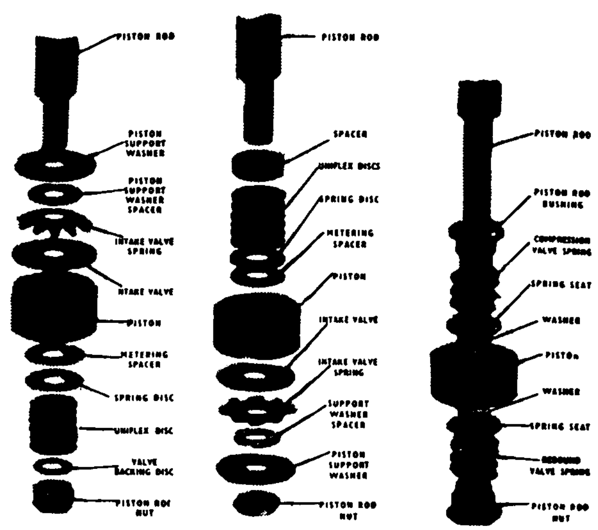


FIG 4

'A' Rebound Disc Type

This arrangement is similar to the conventional rebound valve, except that 'blow-off' is controlled by uniflex discs as in the case of the compression valve.

'B' Compression Disc Type

It will be noticed that the piston and its various parts are similar to 'A' but 'upside down'. This arrangement gives a very high resistance on the compression stroke and negligible resistance on rebound. It will be appreciated that the oil pressure beneath the piston in this case operates on the whole area of the piston, enabling very high resistances with comparatively low pressures.

'C' Cross Drilled Piston

Some applications, particularly when horizontal control is required, demand an equal amount of resistance on each stroke. It can be said that this piston has a conventional rebound valve on each side of it, so that movement is resisted in both directions.

By carefully selecting 'bleed' and 'blow-off' controls on the piston and the compression valve, equal resistance is obtained in both directions, or, alternatively, the unit can be made to have more control on the compression stroke than on the rebound stroke, a characteristic required by certain applications.

APPLICATIONS

By now it will be readily appreciated that there are a number of features which make the Woodhead-Monroe shock absorber suitable for any type of railway work. Perhaps the most important feature is the robustness of construction—it has been full realised that railway work in general gives a hard and trying time to all components, and hence all materials used in construction are of very adequate proportions and the best quality available for the job. Next the versatility of valve loading. Any combination of loading requirements can be provided, by using different valves or different pistons or both, as the case might be.

The most obvious use of shock absorbers is to control the movement of the bolster of any given bogie, both vertically and horizontally. In the past a useful degree of control has been provided by introducing friction—for example in the bearings of the swing links to control lateral movement, and in the laminated springs, once universally used, but now superseded more and more by coil springs. It is true to say that a reasonably good ride can be obtained by using frictional damping, but, apart from being unreliable and difficult to keep within reasonable limits, the basic characteristic is wrong in that the greatest resistance is at the beginning of movement. By comparison hydraulic damping allows an initial movement and gradually builds up resistance to arrest it, so providing a cushioning effect.

When applying shock absorbers to railway work, it is every bit as important to ensure that there is not too much damping, as it is to ensure that there is adequate damping. Thus, to get the best value out of shock absorbers, inherent friction should be cut down to a minimum. If possible, for example, coil springs should be used, but if laminated have to be fitted, then care should be taken that they are adequately and regularly greased.

As well as bolster control however, fitting shock absorbers to control axle box springs has also proved very successful in reducing wheel chatter, and wheel to rail wear etc.

In this connection, designers should bear in mind that the Technical Department of Woodhead-Monroe are at their service, and will be only too happy to examine any proposed shock absorber installation, and recommend suitable shock absorbers. But to do this it is necessary that full information as to loads carried, spring deflections etc., with a bogie arrangement drawing should be sent with the enquiry.

NOTICE

We sincerely regret for the delay in publication of this edition owing to circumstances beyond our control.

EDITOR

High-Production Vertical Boring Mills in Railway Workshops

RETAINING RING ROLLING-IN MACHINE

AMONG the machine tools used in railway workshops, especially those for the overhaul of rolling stock (wheels and axles), the single and double-column vertical boring mills occupy a very important position. According to whether shrunk-on tyres or solid wheels are to be machined, the standard batch-built high-production vertical boring mills are equipped with suitable tooling and clamping fixtures, which can also be fitted later or replaced and which enable these universal machines to be utilized as special-purpose machines. When boring out tyres, for example, an operational cycle must be adopted corresponding to the variety of sizes encountered in these components in repair workshops and approximating as nearly as possible to an automatic cycle.

The electro-magnetic clutches, which are used almost exclusively nowadays in high-production vertical boring mills for the control of the feeds, enable these machines to be equipped with tracer-controlled profiling attachments, which copy turn to a template and which are used especially for machining solid wheels. It is not only the profile of the actual running surface of the wheel which is copy turned in this way, but also in many cases the curve wheel body. The profiling attachment must therefore be fitted to both the railhead and the sidehead.

In the following paragraphs, we should like first of all to show the possibilities of application of universal vertical boring mills, our remarks being based on the assumption that these machines are of a design corresponding to the very latest workshop practices, especially as regards the efficiency of the drive and the simplicity of the centralised control, particularly in relation to feed changes.

Fig. 1 shows a type KEF single-column vertical boring mill, in which the rail elevation has been dispensed with, so as to achieve the maximum rigidity of the machine under the heaviest possible cuts.

When machining solid wheels as shown on an enlarged scale in Fig. 2, the sidehead copy turns the running surface to a template, while the five-station turret on the railhead machines the boss and, also using the profiling attachment, turns the body of the wheel. As the boss of the wheel did not have to be bored on this machine, the wheel was held on a spigot inserted in the bore, but the machine can also be arranged to bore out tyres. For this purpose, the five-station turret on the railhead carries five tools for roughing and finishing the inside diameter of the tyre and for producing the retaining ring groove and the stop. In workshops without special wheel-set lathes, where the running face of tyres has to be profiled as well, the sidehead is utilised with the tracer controlled

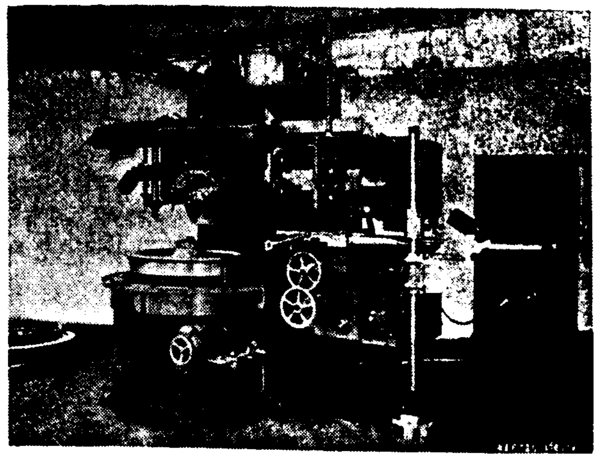


Fig. 1. Type KEF 125 Single-column Vertical Boring Mill for turning tyres and solid wheels.

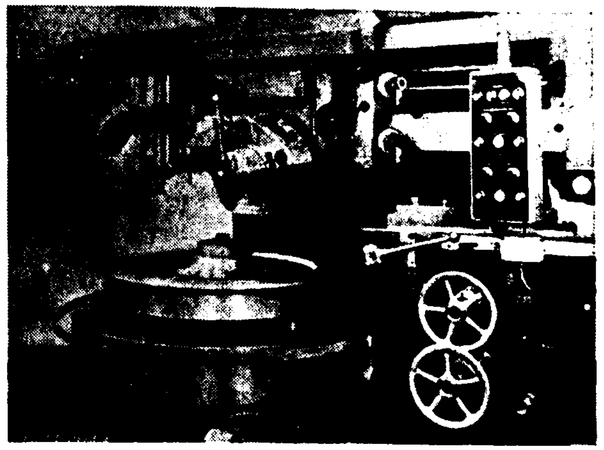


Fig. 2. Solid wheel being copy turned on a KEF 125 Single-column Vertical Boring Mill

profiling attachment as for the solid wheels and the side faces of the tyre are turned at the same time. The running surfaces are turned with button tools as in the wheel-set lathes.

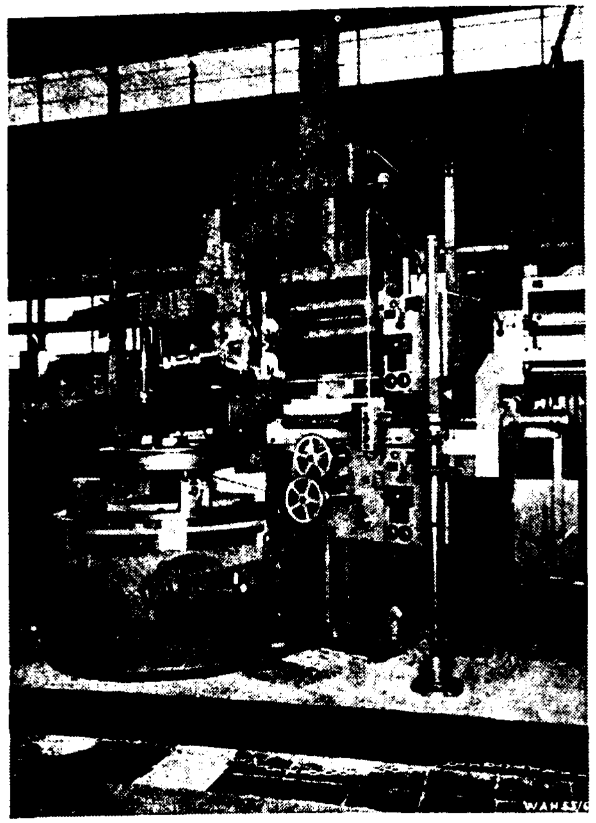


Fig. 3. Type KE 160 Single-column Vertical Boring Mill for solid wheels.

In its standard form, i. e. with elevating cross-rail this machine is intended chiefly for machining solid wheels and is equipped for machining the outside and the bore of the boss. As will be seen from the illustration, the component is held in a power-operated self-centring chuck, which can be placed on the standard table and can be supplied for operation by compressed air or oil.

The KZF double-column vertical boring mill brings a very great increase in production in the machining of solid wheels as shown in Fig. 4, the sidehead being used for profiling the running surface as in the previous cases, while the remaining turning operations, including turning the body of the wheel to a template, are divided up between the two railheads operating simultaneously. For this purpose, the railheads are provided with large faces with tee slots to take the heavy toolholders necessary for this operation. The indexing of the turret is thus eliminated. The production of the machine is increased still further by the simultaneous utilisation of several tools. These machines can also be equipped for machining tyres. Hydraulic or pneumatic chucks are preferable for clamping the components. The standard double-column vertical boring mills, type KZ, with elevating cross-rail can also be used for this work in a manner exactly similar to the single-column machines.

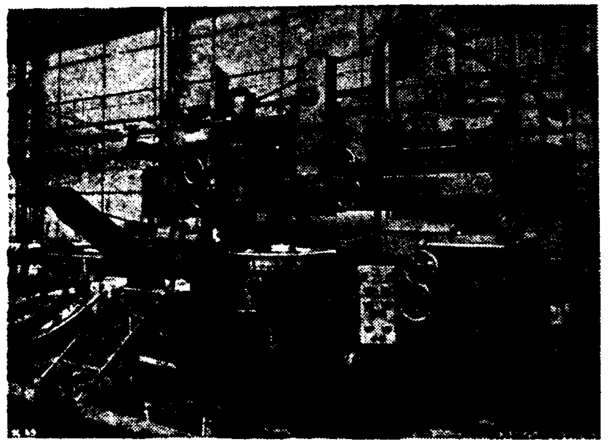


Fig. 4. Double-column Vertical Boring Mill for solid wheels.

If large batches of tyres of the same dimensions are to be produced, as is usually the case with high production in the steel works, a special automatic tyre lathe is used. The two heads on the fixed cross rail, intended for boring on the right hand side and grooving on the left hand side, work automatically to an electro-magnetically controlled cycle. After centring, the component is automatically clamped either mechanically as in Fig. 5, or in a power chuck. Included in the operational cycle is a speed

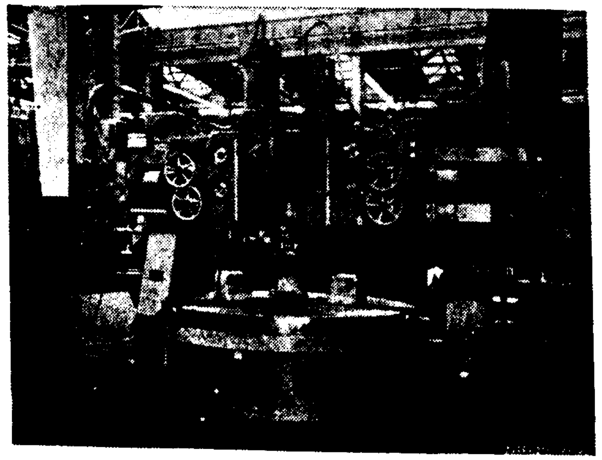


Fig. 5. Type RRK Automatic Tyre Lathe with mechanical work clamping fixture.

Fig. 5-a. A battery of RRK Automatic Tyre Lathes with air chucks.

Fig. 6. Type XW Retaining Ring rolling-in Machine.

change before the finishing operation commences, the table being brought up to the higher speed automatically. Further, a measuring device with a special fine measuring unit ensures that the pre-determined diameter is accurately adhered to. Gauges are used for setting the tools.

As the automatic functions can be cut out, these machines are very often used in railway repair workshops. When the tyres are sorted out and grouped in batches of the same size, a special tyre lathe reduces the machining time as compared to a universal machine, even when the automatic functions are cut out.

In all the above cases, a swivelling-arm crane is used alongside the machine to expedite insertion and removal of the components.

Retaining ring rolling-in machine Type XW.

This rolling-in machine is for beading-in retaining rings in railway wheels. The frame holding the two rolls is in the form of a casting. The shaft for the upper roller rotates in fixed bearings, the adjustment being effected hydraulically through the medium of the lower roller. The upper roller is conical and its centre line is at an angle to the plane of the wheel. The angle of inclination and the taper of the cone are so calculated that the contact surfaces of the tyre ring and the conical roller roll over each other correctly and without slip, this producing the best results. A special device is provided to compensate for the pressure differences caused by the varying heights of the unmachined tyres. The roller frame is connected to a base plate, which supports the holding blocks for the wheel or the wheel and axle assembly.

Finally, we should like to mention that the machining of cylinders and pistons can also be performed highly successfully on the single-column vertical boring mills, type EK and KE, described above. For this purpose, heads with square rams are used in place of the standard heads with five-station turrets. For the production of piston rings from tubular blanks, special parting-off tools for use in the sidehead have been developed.

The machines described above are from the production programme of Messrs. Schiess A. G., Dusseldorf, Germany.

STILL UNDER EXAMINATION

Shri Shah Nawaz Khan, Deputy Minister of Railways, told Shri Jhulan Sinha during Question Time in the Lok Sabha that the recommendation of the Reviewing Committee of Railway Accidents Enquiry Committee that "Judicial enquiries instead of enquiries by Government inspectorates should be held into major railway accident" was still under examination.

At present, the views of the Ministry of Communications on the matter were being awaited.

He said it had been finally decided that the Railway Inspectorate would continue to be under the Ministry of Transport and Communications.

C.T.C.—a Means of Improving the Competitive Power of Railways

I BOBERG, LM ERICSSONS SIGNALAKTIEBOLAG, STOCKHOLM

(Reprint from Ericsson Review)

The C.T.C. (Centralized Traffic Control) system based on relays alone, without any mechanical selections, is described in this article, which also presents some points of view on the use of the C.T.C. system and the developments it has undergone upto the present time.

GENERAL

THE term C. T. C. (Centralized Traffic Control) originated in America, but is now generally accepted everywhere. It is defined by the Association of American Railroads as "a term applied to a system of railroad operation by means of which the movement of trains over routes and through blocks on a designated section of track or tracks is directed by signals controlled from a designated point without requiring the use of train orders and without the superiority of trains."

The advantages of C. T. C. on a railroad system will be best appreciated by comparing the conditions where C. T. C. does not exist. It must be assumed, however, that there are local safety arrangements—interlocking plants at the stations and automatic blocks on the lines—since they are an essential factor in the use of C. T. C. Their purpose is to ensure the safety of railroad operation, which implies that a signal cannot be set to "Go" unless the route is free and the points are locked. The installation of C. T. C. neither adds to nor detracts from this primary safety condition.

All the normal operations of a station's local interlocking plant are performed by the station master—or his assistant—who thereby passes a message to the train crew. The station master also issues communications in the form of written orders and timetables. If, however, as the situation is in Sweden, the train movements of an entire traffic region are under centralized supervision, the station master must contact the traffic dispatcher by telephone in any emergency such as delays, putting in an extra train etc. On the receipt of the station master's message, and from the graphic timetables and other information at his disposal, the dispatcher must assess the situation and decide what action is to be taken. He communicates his decisions to the station masters at the stations concerned, who put them into effect by the operation of the interlocking plants and by written orders to the train crews on specially prepared forms.

This elaborate procedure may result in serious traffic delays. A station master may be unable to get through to the dispatcher at an early stage—the station master has other jobs to attend to as well, or the dispatcher may be engaged on another call. While the dispatcher is deciding what action to take, the situation may have changed to such an extent that his decision is in fact not the best one. Even when the dispatcher has arrived at a decision, he may have difficulty in getting into contact with the station masters. The station masters must then issue written orders, which involves extra delay. Thus even if there are no misunderstandings and no wrong action is taken, much time may be lost by ringing the trainmaster into the picture, and his action *may* prove to be inappropriate.

Under a C. T. C. system the C. T. C. office receives complete, immediate and continuous information regarding positions and categories of trains and, as far as is required, the states of points and signals. The dispatcher, whose place is taken to be in the C. T. C. office, is thus constantly in touch with the up-to-the-minute traffic situation and can plan the necessary action in good time. The dispatcher's decisions can be carried into immediate effect without being passed through subordinates. Apart from the direct saving of time in the receipt of information and carrying out orders, C. T. C. enables the dispatcher to make better decisions, resulting in an additional saving of time.

The time saving afforded by C. T. C. implies fewer and shorter stops for trains and, consequently, greater average speeds, furthermore a greater traffic capacity on existing tracks. Thus when the track capacity is rather low, the installation of C. T. C. may avoid the considerable cost of laying a new track. The fact that, with C. T. C., the dispatcher obtains continuous information and can therefore make rapid decisions regarding the movement of traffic, leads to greater flexibility—for instance, express trains can be given superiority in the assurance that they will run to time without needing to delay other trains to any great extent.

The result of C. T. C. is that part of the station crew's job is transferred to the dispatcher. Admittedly this may put such a burden of work on the dispatcher that he must have an assistant, but this small expense is insignificant compared with the savings involved in reducing the station crews. The saving in personnel is thus an important argument for the installation of C. T. C.

The C. T. C. office can exercise a periodical or continuous check that train drivers obey the signals. With any luck, too, broken rails may be discovered in advance.

DEVELOPMENTS

The first experiments with C. T. C. were conducted in the USA at the end of the 1920s, but it was some time in the 1930s that the system became of practical importance. It was at that time, too, that LM Ericssons Signalaktiebolag developed its first C. T. C. system.

Knowing the many advantages of C. T. C., it may well be asked why no systems were installed in Europe until the last few years. The reason must be, of course, that developments were held up firstly by the war and then by the post-war restrictions on capital investment. It is not impossible, moreover, that the comparative prosperity of many European railways after the war removed some of the incentive for progressive measures. In the last few years, however, a few European plants have come into being.

C. T. C. SYSTEM

During this long period of waiting for the acceptance of C. T. C. in Europe, a new C. T. C. system based on the use of relays alone without any mechanical selectors was developed. A brief description of this system follows (fig. 1).

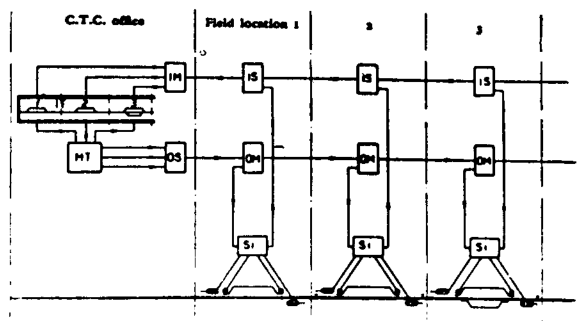


Fig. 1. Block lay out of C.T.C. system.

The controlled track system is reproduced in miniature on an indicating panel IT in the C.T.C. office. The control of points and signals is exercised from the operating panel MT in the control room, the information passing through the control transmitter OS in the control room and control receiver OM at the field location to the local signal installation Si, which executes the order. Changes of conditions in the signal installation are transmitted to the indicating panel via indication transmitter IS and indication receiver IM.

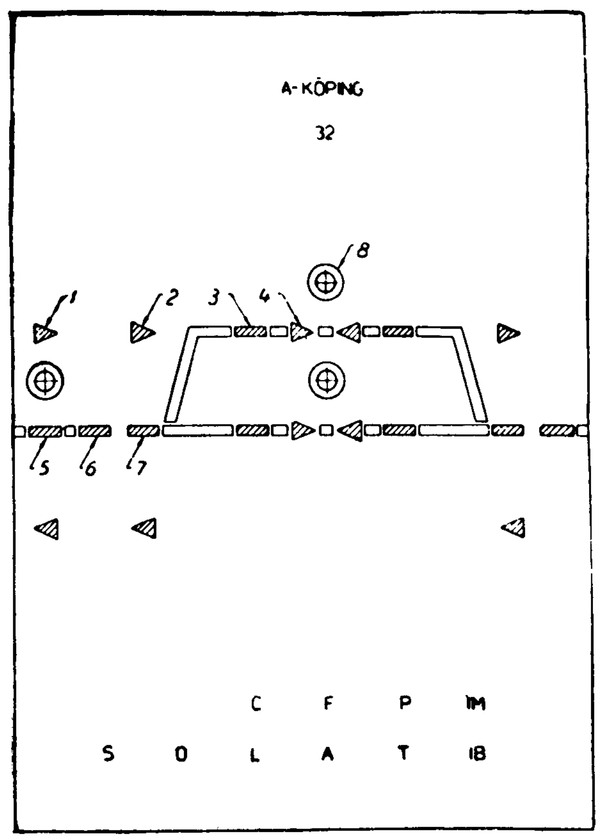


Fig. 2. Section of C.T.C. indicating panel designed for a station on the Ange Bracke line, Swedish State Railways.

Lamp 1 indicates the direction of movement at the block between stations 31 and 32, lamps 2 and 3 indicate the route from the line into the siding, and lamps 5, 6, 7 and 4 the position and possibly the category of the train. Lamp 4 also indicates the direction. Letters C, F, P etc. are normally unlit, but light up to indicate certain operating conditions such as centralized control, local control etc. When a plug is placed in jack 8, routing orders affecting the siding cannot be transmitted.

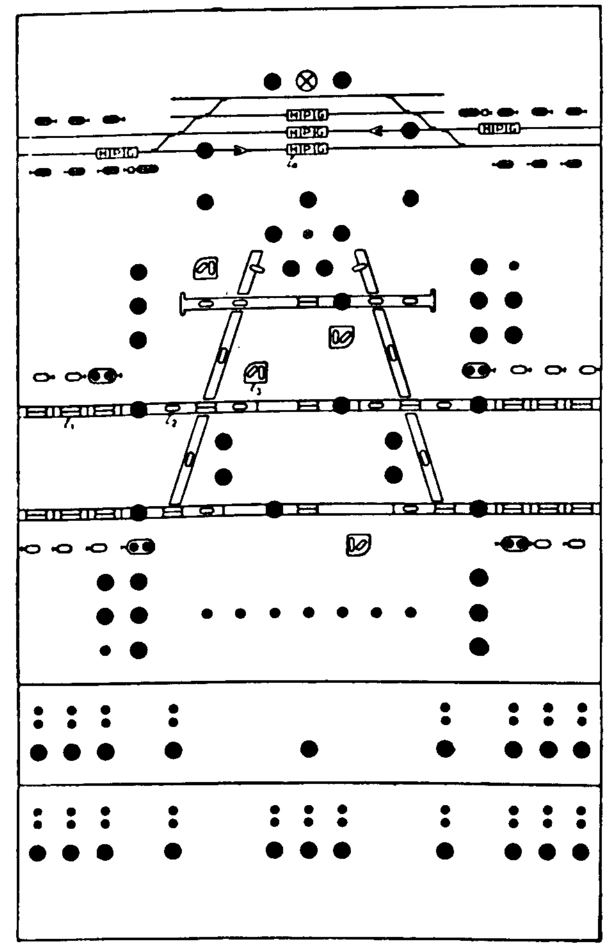


Fig. 3. Proposal for section of control panel for the Danish State Railways C.T.C. plant Nyborg—Tommerup

The dark circles are control buttons, and those with crosses are indicating lamps. There are also indicating lamps of type 1 for train positions, 2 for state of points and 3 for state of signals. The letters H, P and G light up to indicate the category of train—express, passenger or goods.

Local Signal Plant

As was mentioned in the introduction, a C. T. C. system depends upon the existence or installation of local safety arrangements—interlocking plants and automatic blocks. These local plants must be of the relay interlocking type, that is to say that all lockings and interlockings must be effected by relays. The various plants can have their own local control apparatus from which, in an emergency, signals and points can be operated within the station area. Local control apparatus is not essential, however.

C. T. C. Office

The C. T. C. office must be equipped with a panel for indicating train positions etc. and apparatus for operating signals etc.

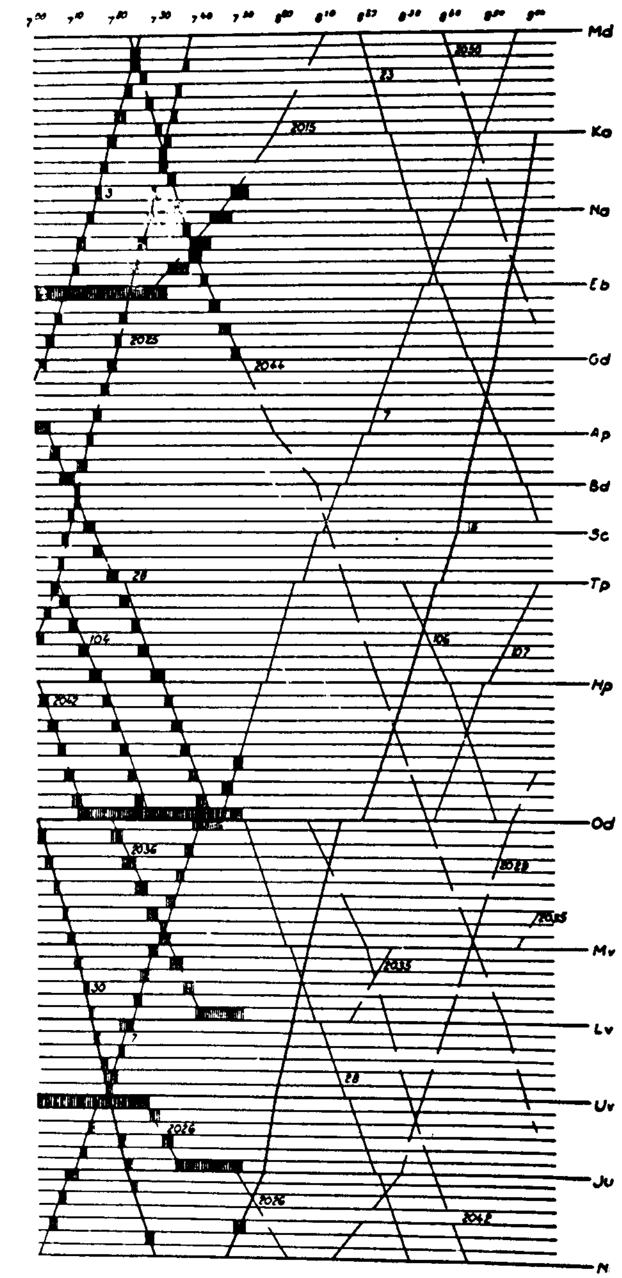


Fig. 4. If the graphic timetable for the C.T.C. section is readyprinted on the traingraph chart, an immediate visual control of how trains are following the timetable can be obtained from the marks recorded on the traingraph

In the illustration the traingraph has recorded movements up to 7-50 a.m. The directions of the trains are marked in different colours.

The indicating panel—the track diagram—is a schematic representation (see figs. 2 and 3), in miniature of the track system to be supervised from the control room. Lamps of various colours and shapes on the track diagram show the positions and category of trains and, as far as is required, the states of points and signals, locked routes, train directions etc. The category of train is shown, for example, by lamps lettered S, P and G—express, passenger or goods train—or by a common lamp which flashes different codes. The track diagram is made up of units, each of which represents one station. Thus any unit can be easily altered and extended without requiring to change other parts of the diagram.

Another operation performed in the control room is the recording of train times. The traingraph is equipped with hammers, operated by relays, which indicate the passage of trains over certain points on the line. The paper has space for making notes both before and after stamping. The traingraph may have 100 hammers and more, train passages can thus be recorded at a large number of points along the line, resulting in a graphic chart of train movements. If the graphic timetable is printed on the paper in advance, a continuous and automatic control is obtained of whether trains are following the time table (fig. 4).

In the conventional type of C. T. C. offices the control cabinet is often combined with the track diagram (fig. 3), which is thus fitted with the necessary control buttons and levers. A control apparatus consisting of a small keyset (fig. 5) is now supplied. A keyset of this kind has the advantage that the dispatcher can sit in one position (fig. 6) from which he has a good visual control of the traffic situation

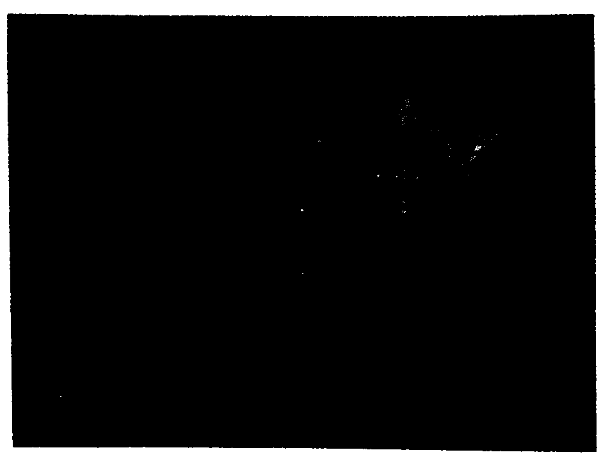


Fig. 5. The control panel or keyset in C.T.C. system is made for operation with the left hand.

The panel shown here was made for the Swedish State Railways C.T.C. plant Ange—Bracke. It has eight numbered control buttons, buttons A and S for cancellation and transmission of orders respectively, and buttons S, P, G and O for marking up the categories of train on the indicating panel. (O signifies that no category of train is to be indicated)

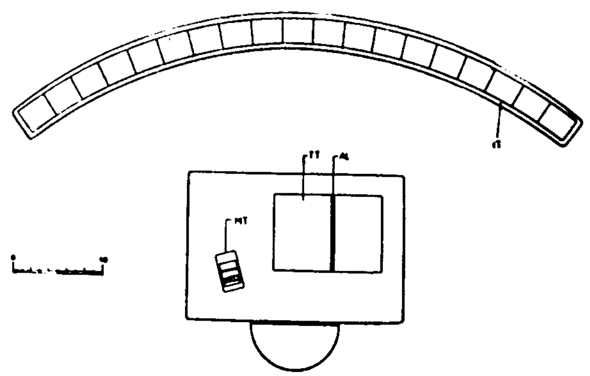


Fig. 6. Indicating panel IT in a C.T.C. office

should preferably be semi-circular to give the C.T.C. operator a good view of the whole panel from his desk. At the left of the control desk is the small control panel MT, and at the right the traingraph with its impact ruler AL. The ruler is fitted with a large number of hammers, and the paper moves continuously from right to left.

within the entire track system under his supervision. He gets a less good view if he stands close to the track diagram, which he should do when the keys are on the diagram.

Exchange of Information

The exchange of information between C. T. C. office and the local interlocking plants requires a number of relay equipments and pairs of line wires. The control room equipment consists principally of a control transmitter and an indication receiver, and every field location has a control receiver and an indication transmitter. The number of pairs of line wires along the line depends on the traffic density and on the number of indications at every station. The system caters for the use of only one pair of line wires for indications and controls, but the use of two or perhaps more pairs of line wires may be advisable or necessary. Cables or bare wires may be employed.

The capacity of the basic system for sending controls is 36 stations and 36 controls per station; one control may cover the establishing of an entire train route. For indications the capacity is 49 stations and 49 indications per station. The reason why the indication capacity has been made greater than the control capacity is that more indications than controls are usually required per station.

Information is transmitted in the form of groups of D. C. impulses. Four groups of six impulses each are used for controls, one impulse in each group being negative and the last impulse in each group being a long one. The first group of impulses selects a group of stations, and the second a station

within the group. The third group of impulses selects a group of controls, and the fourth a control within the group. Thus one control requires twenty-four impulses. Using the keyset the four groups of impulses are obtained by keying a four-digit number. When operation is carried out on the track diagram, an operation is translated into four groups of impulses. A check is made in the case of every control that short impulses are short and not long, that every sixth impulse is long and not short, and that there is one—and only one—negative impulse in every group. This check ensures that there is exceedingly small likelihood of a control being so distorted under transmission to a field location that it gives rise to faulty execution. If a field location does find, however, that a control is distorted it replies by lighting a fault signal lamp in the C. T. C. room. If the impulsing is correct on the other hand, but the control cannot be executed for local reasons, the field location replies by lighting another lamp in the C. T. C. room. The advantage is thereby gained that the train director is immediately advised—i. e. without awaiting an indication—whether a control is impossible to carry out.

For sending indications the sending station transmits two groups of impulses of seven impulses each. The first group of impulses identifies a group of stations, and the second a particular station. In each group of impulses there is only one negative impulse, and the last impulse is a long one. The different indications are divided into seven groups with seven functions in each group. During indication sending, which starts automatically as soon as a change occurs in any function at the station, all devices in the groups in which a change has taken place are indicated successively, but not in the other groups. An indication sending thus does not call for more impulses than are required to record the change, by which the advantage is gained that the line wires are not engaged on sending indications for longer than is necessary. Every time an indication is transmitted a check is made, as regards the identification of the station, that short impulses are short and not long, that every seventh impulse is long and not short, and that there is one—and only one—negative impulse in every group. As regards the actual indication a check is made simply that short impulses are short and not long and that every seventh impulse is long and not short.

The relay equipment is made up in units of as small a number of types as possible. The advantage of this is that the stock of spare units can be kept to a minimum.

Examples of Control and Indication Operations

Fig. 2 shows part of the track diagram in a C. T. C. room, comprising station No. 32 and a half section of line westwards and eastwards. It is assumed that a train is coming in from the west (from the left in the figure) and is to be taken into the siding. The dispatcher orders the route to be cleared for entry into the siding by keying number 3213 on the keyset. The information is sent direct to the track diagram, on which lamps 2 and 3 start to flash green and white respectively as a reminder to the dispatcher that the control has been transmitted but not executed. As soon as the line wires—or any of the line wires—to the field locations are free, the control is transmitted to station No. 32. If the control can be carried out, it is executed by the local interlocking plant. As soon as the control has been put into effect, an indication is sent to the C. T. C. room and passed on to the track diagram where the flashing light from lamps 2 and 3 is replaced by a steady green and white light respectively.

The movement of the train along the line operates relays in the local interlocking plants. Information of the train's movement is sent to the C. T. C. room and forwarded to the track diagram, on which the positions along the line are marked by red lamps. Thus in the case illustrated lamps 5, 6, 7 and 4 light up successively in red, and the latter lamp, by its shape, also shows the direction of the train. If the category of train is indicated by flashes, quick flashes may be used to show the position of an express train, rather slower flashes a passenger train and still slower a goods train. The marking up of new or changed information of the track diagram is done by pressing button S (express), P (passenger) or G (goods) on the keyset in the C. T. C. room. All indications of train categories are arranged within the C. T. C. room and are not dependent on special impulses from the field locations. The traingraph stamps the passage of every train past given points on the line.

FUTURE DEVELOPMENTS

The railways, like all other public and private enterprises, are successively modernizing their systems in order to operate on a more efficient and economical basis. It would seem inevitable, therefore, that they must make use of the advantages offered by C.T.C. to a growing degree. Indeed it is hoped that C.T.C. will prove a valuable means of aiding the railways in their efforts to maintain and increase their competitive power.

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INTRODUCING TO ENGINEERS

We have great pleasure in introducing this new feature from this edition with a view to establish closer contacts between railway engineers and top-executives in the engineering trade and industry.—EDITOR

MR. R. EVRALL is the present Managing Director of Messrs. Alfred Herbert (India) Private Ltd., Calcutta who succeeded Mr. E. D. Mitchell in July last year.

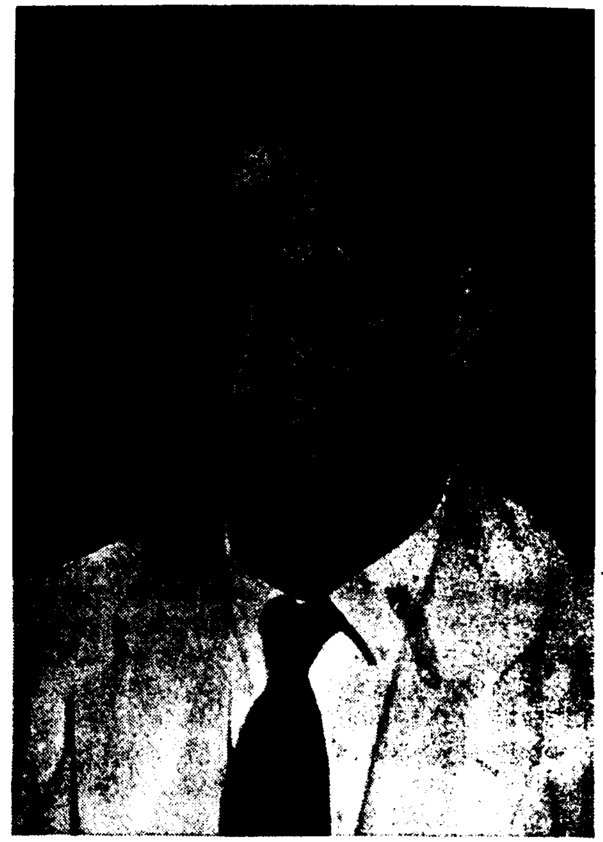
Tall, handsome Evrall received his early education at King Edward VI School, Nuneaton and joined Messrs. Alfred Herbert Ltd., Coventry as early as 1926 as an apprentice. During five years of apprenticeship at Coventry, he served in various departments of the Works, and Sales Engineering Section of the Drawing Office which dealt with the design of special machines and tooling equipment for users in all parts of the world.

Mr. Evrall is a shrewd and intelligent man. During his apprenticeship and immediately following the training period, he studied at the Coventry Technical College and equipped himself with fund of technical knowledge.

Mr. Evrall joined the Indian Company as Technical Sales Assistant early in 1936 and he has spent the whole of his business life with the Herbert Organisation. In the latter part of 1940 and the early part of 1941 Mr. Evrall was deputed to America on the Indian Company's business and whilst returning from States, he was taken as prisoner of War.

Soon after release, Evrall re-joined the Indian Company in 1946 where upon he was made a Director and subsequently Assistant General Manager.

As a keen sportsman, he has pleasing manners and with his ready wit and humour he has proved an ideal salesman in the true sense of the term.



Mr. R. EVRALL

We are sure under the able guidance and stewardship of Mr. Evrall the Company will expand its activities in India especially in the field of machine-tool trade. We wish Mr. Evrall and members of his family all success and prosperity throughout.

ADVANCED PERMANENT WAY SCHOOL AT POONA—RAILWAY BOARD DECISION

The Railway Board has decided to set up an Advanced Permanent Way Training School at Poona and the Central Railway has been authorised to make the necessary arrangements.

The school is being set up to provide advanced training in the maintenance and construction of railway track to engineers and senior inspectors of the Indian railways and also engineering officers and inspectors of other countries in the E.C.A.F.E. region.

The training is expected to lead to greater safety, efficiency and economy and result in high level track maintenance, which is becoming very essential with the fast speed and increasing density of traffic on the Indian railways in the future.

An instructional film on the proper maintenance of railway track is also under production, and when completed it will be used widely for training purposes.

(1)	(2)	(1)	(2)