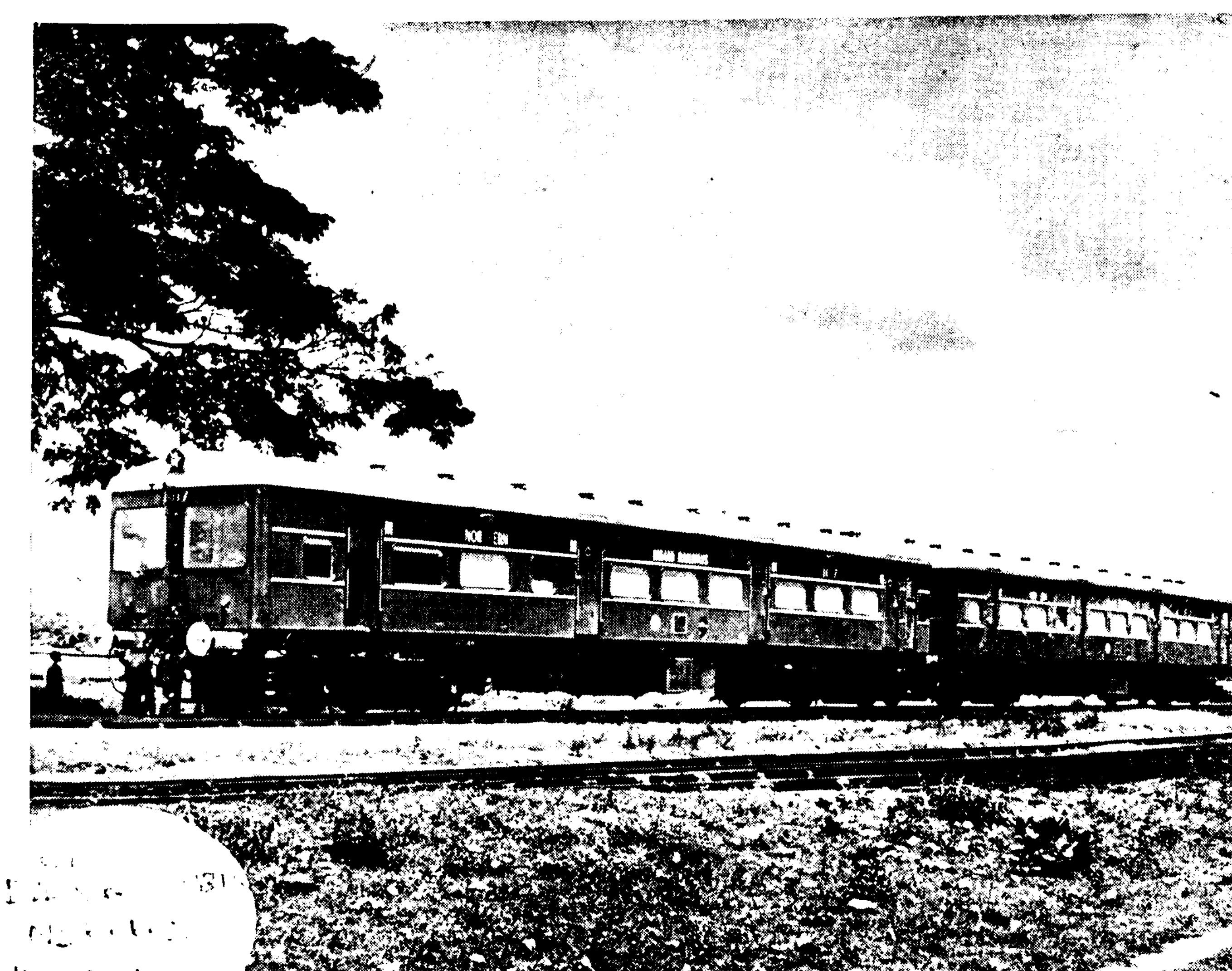
THE INDIAN RAILWAY ENGINEER



THE INDIAN RAILWAY ENGINEER

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RAILWAY ACCIDENTS AND THE PUBLIC

THE confidence of the Public in any National or State enterprise is indeed a pearl of great price and for the organisation concerned to thrive and progress and serve the public in a fitting manner, this treasure must be cared for and preserved under any circumstances and at all costs.

Our Railways are the biggest single national asset of the country in which are invested more than 1000 crores of public money, and consequently the working of the railways is watched with great interest even by the man in the street. It therefore behoves the Railways more than any other public organisation to enjoy the confidence of the public now and always. Railway transport is the very life blood of the nation and the nation has a right to see that that blood is kept pure and in every way fit to do its onerous work.

Railway Accidents major or minor have tendency to shake public confidence, and the greater their frequency the more the likelihood of that confidence being shaken badly.

Although the public would like to be taken into confidence by railway authorities in honestly and fearlessly explaining the causes of accidents, it is not concerned with excuses to mitigate those causes. What the public demands and rightly so is that as far as is humanly possible there should be no accidents at all and if that is too tall a proposition they should be so rare that they could be excused. The public is convinced that all accidents except those which are the result of an act of God are avoidable and hence it demands that all precautions should be taken well in advance to avoid them. It does not reflect great credit to railway working to be wise after the event which may have caused a serious railway disaster and the loss of a number of innocent lives when with care and foresight that misfortune could have been avoided.

A grave responsibility therefore rests with all railway personnel from the highest to the lowest connected with the safe running of our trains and it cannot be said that they are not adequately compensated to shoulder that responsibility within their respective spheres of duty.

It must however be borne in mind that the possibility of accidents varies in the ratio of the square of the number of train crossings and hence the greater the number of trains on the line and the oftener they have to cross each other at stations and sidings the more frequent is the likelihood of an accident.

Whatever else may be said there is no doubt that there are more trains today on the same lines than there were, ever before. What with the greater intensity of train working to carry a much heavier volume of traffic than 20 to 30 years ago the proneness to accident has increased immensely.

Further with the tightening of statistical reports on accidents even the most minor ones in yards and sidings, the increase of accidents may be really more apparent than real.

Undoubtedly the intensive ferretting of accidents by newspaper reporters and giving them undue publicity by banner headlines today may be throwing too much limelight on the accident aspect of Railway working. In the old days only main line accidents received publicity and that only if their consequences led to a heavy death roll. Nevertheless accidents are accidents and the less we have of them the happier will the public be.

Unlike foreign countries especially those of Europe and North America who are constantly hampered in the running of their trains by bad visibility resulting from frequent fogs, heavy mists and continuous rains throughout the year, India enjoys excellent visibility except may be for short periods during the monsoon season. Hence the chances of accidents on this score alone should be much less here than there, but such is not the case.

Against acts of God who sends us torrential rains, making our rivers break their bounds, washing away tracks, heavily erroding bridge piers and even crumpling bridge structures there is little we can do. But on the other hand with the advance of the meteorological science timely information is frequently available to take advance precautions. Very frequent patrolling by more staff, with shorter beats, telephone communication with stations or signal cabins, detonation signals and flares to warn drivers of impending dangers are within the realms of practical possibility and should be resorted to irrespective of costs, because otherwise a single train disaster in its consequences of loss in locomotives, carriages, wagons, passengers, railway personnel and damage to goods and track may far outweigh the extra cost entailed in precautionary measures.

Accidents on Railways are of many kinds and due to many causes but if finally boiled down they could be contained in three main categories.

(a) Accidents due to failure of the human element.

(b) Accidents due to failure of material.

(c) Accidents due to sabotage and other causes.

It is a well known fact that since the World War II there has been a tremendous dilution of railway labour. Owing to the policy of feeding the war machine many people are today in railway service who have no right to be there at all. Staff who were taken to nail ammunition boxes are today designated carpenters, those who stencilled numbers and address on those boxes are today painters, and so it is in all departments. This staff did not receive any training, with the result their foundation was faulty. According to Railway rules and the pressure exerted by Unions seniority in service is the criterion for promotion and it is this type of labour which is now holding key positions connected with the safe working of railways.

Undoubtedly the labour concerned is receiving training and the railways today have more refresher courses for all categories of labour than they ever had before. To have training and refresher courses is one thing and to profit by them is quite another. Where the foundations are sound profit will undoubtedly be derived from training and refresher courses but when the foundations are defective refresher courses might make confusion worse confounded.

Another great defect in the general run of railway personnel today is lack of responsibility. It is not unusual today to find drivers, firemen, cabin men and other key men leaving their posts of duty according to the clock terminating their duty period, irrespective of whether a reliver has taken over or not. It also happens in workshops that men leave their machines running to have a cup of tea away from their place of work or to have a chat and irreparable damage is done either to the work or to the machine. These attitudes show a poor sense of responsibility. Supervisors dare not speak to their men for fear of bodily violence nor complain to higher authorities from whom they are not likely to receive the necessary support. Lack of responsibility stems from a psychological cause and that is lack of discipline and that is born of lack of respect for superiors, lack of fear of punishment and very little love for work. The root cause is very deep and could hardly be discussed except at great length in relation to prevailing conditions It may however be said that a low standard of responsibility is one of the prime causes of accidents due to failure of the human element.

The second cause of accidents is failure of material.

On railways in general where such high prominence is given to statistics, workmanship in the repairs of rolling stock often suffers. Usually targets for the out-turn of rolling stock after overhaul are laid down and are adhered to like the laws of Medes and Persians. A drop in out-turn is considered so serious an offence that workshop people often have to resort to skimped work and poor inspection to maintain the out-turn. The result of this is a heavier burden on the sheds of maintenance and here the time is so short with the turn rounds that at least some of the rolling stock leaves the shed in a defective condition. This type of stock constitutes the potential source of accidents, major or minor. Axle boxes and bearings defectively oiled or greased run hot en route. Improperly tightened gudgeon pins, split pins, cotters and other fastenings often work loose and come off and result in derailment or something more serious.

A more liberal stock of spare parts at Sheds, more time to do the work better and a tightened inspection would remove this source of danger.

With regard to deliberate tampering with the track or rolling stock to derail it at an out of the way position for looting the contents little can be done except a greater degree of vigilance and patrolling.

The Railways have reviewed and are reviewing accidents over a number of years in order to arrive at common factors and have come to the conclusion that in 1941–42, 41.8% of the accidents were due to the failure of the human element, 19.8% due to failure of rolling stock or track, sabotage 11.2% and fires 10.5%. They have also compared these figures with those available from the U. K. and the U. S. A. but unfortunately this type of analysis has not been made available to the public.

It is known that Safety Organisations have now been introduced on the railways and the duty of the staff concerned is to study accidents in the past and introduce such remedial measures which will prevent their recurrence in the future. This is a step in the right direction and it is hoped that better results will be available for the future and that accidents will be minimised to an appreciable degree.

The Design and Manufacture of Light-Weight Coaches

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

(Continued from I.R.E., July 1958, Vol. 6 No. 1)

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

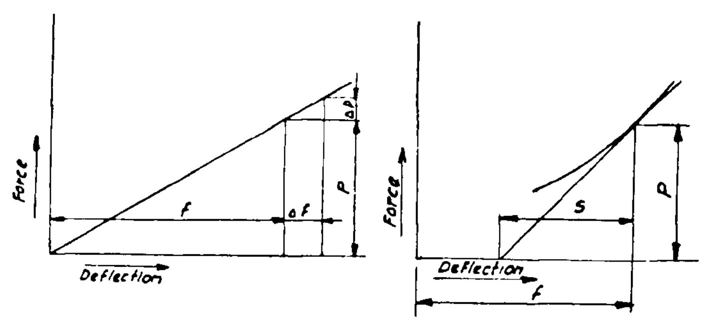


Fig. 13

by $c = P/f$. In accordance with Figure 13, a small additional deflection Δf encountered when running over an irregularity means an additional force $\Delta P = \Delta f . c$. The load P carried by the spring corresponds to a mass $m = P/g$ and this is accelerated at the rate $a = \Delta P/m$, that is to say, for a constant value of Δf, 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

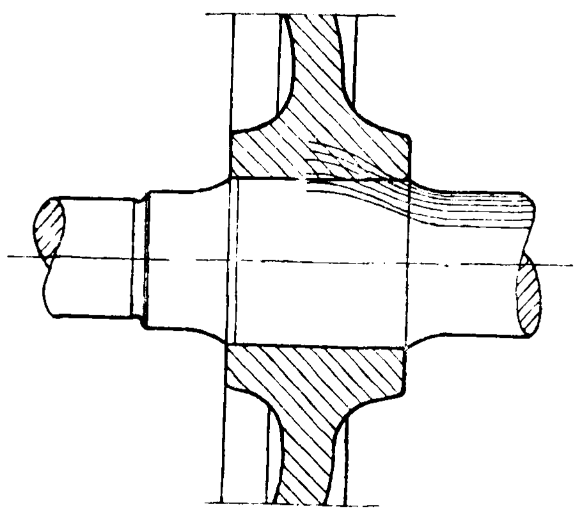


Fig. 14

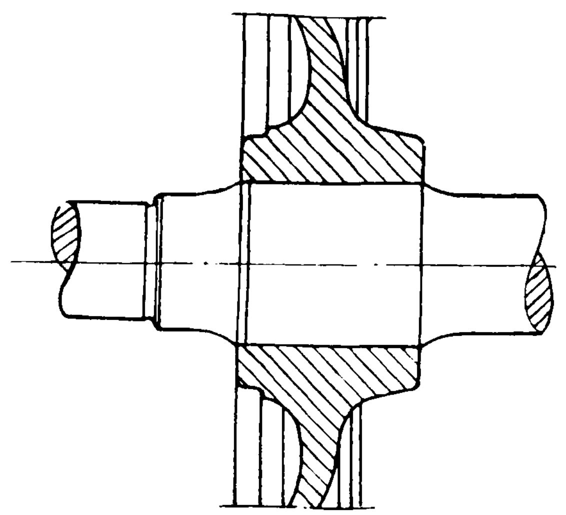


Fig. 15

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.

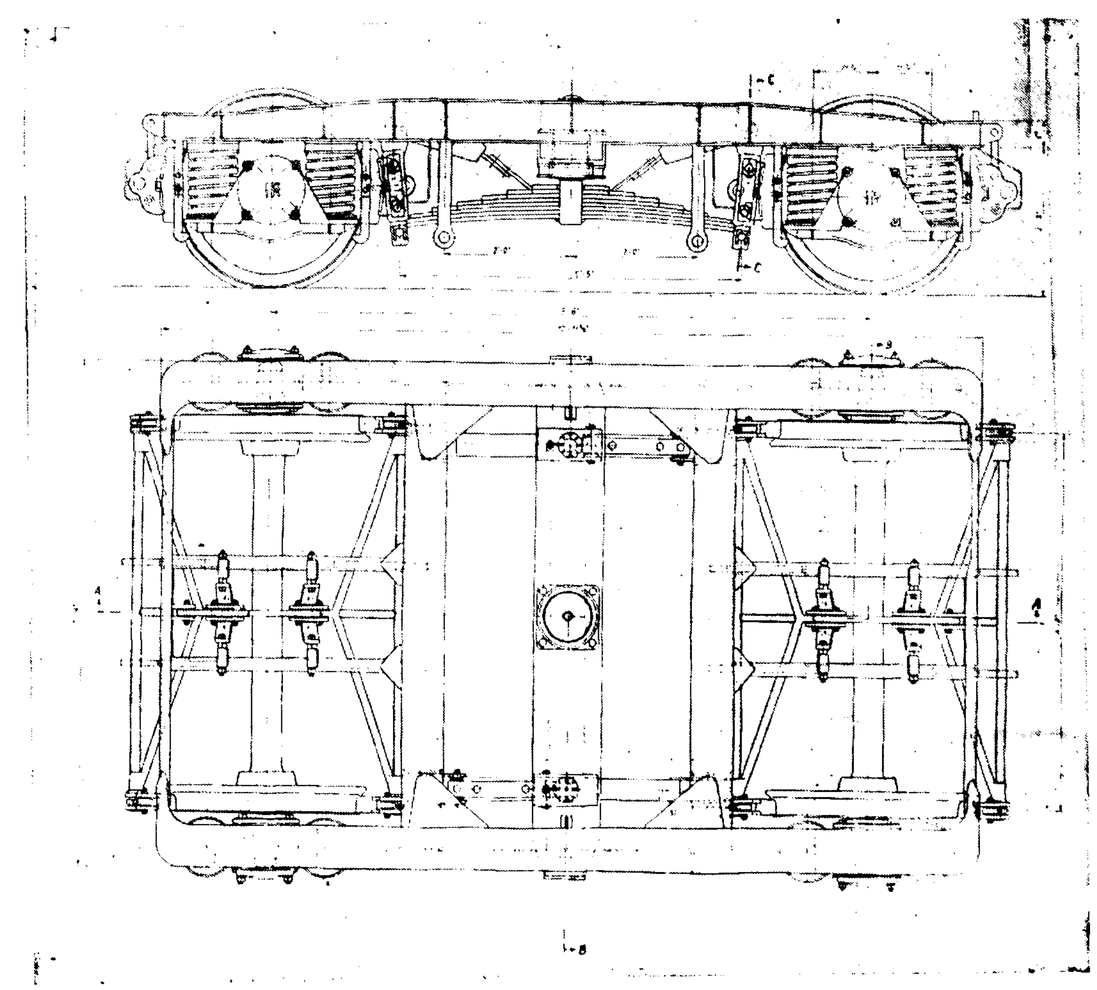


Fig. 16

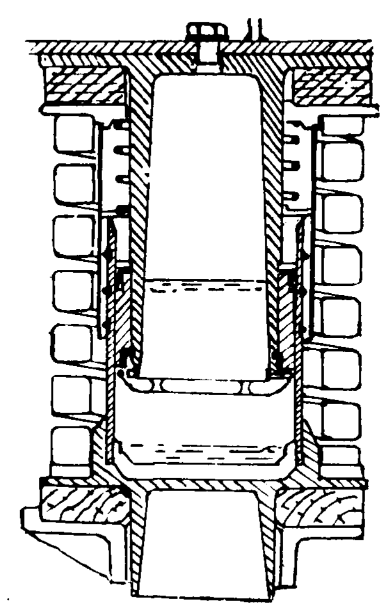


Fig. 17
Cross Section of Damper.

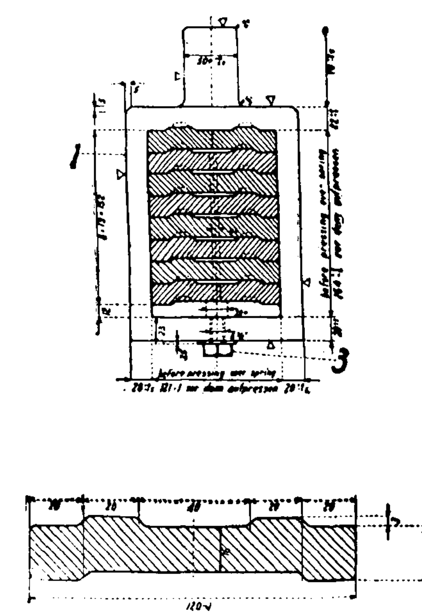


Fig. 18

(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 $4\frac{1}{2}$ 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.

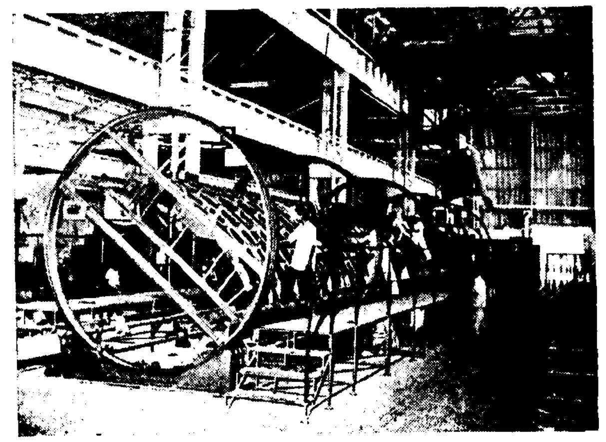


Fig. 19. Roof jig.

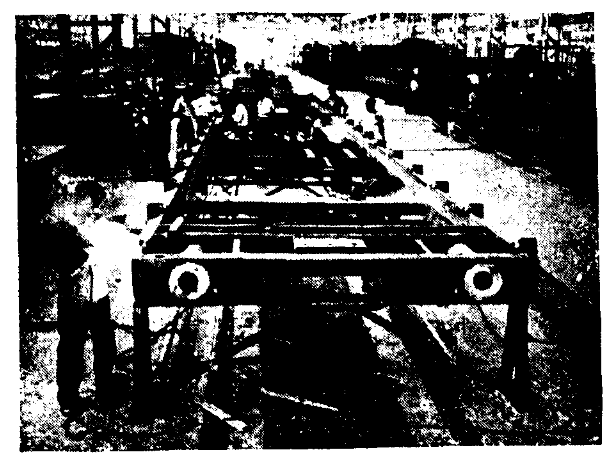


Fig. 20. Underframe jig.

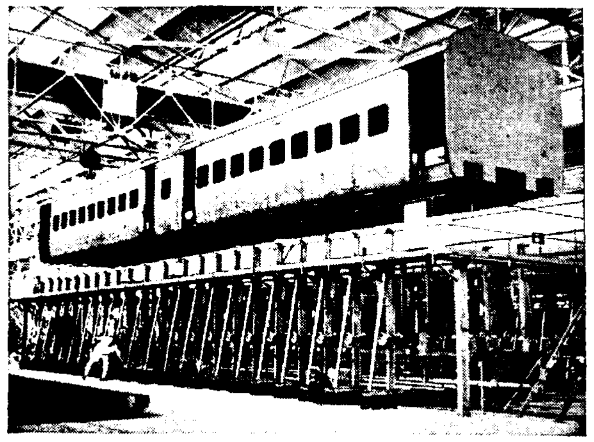


Fig. 21. Main Assembly jig.

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)

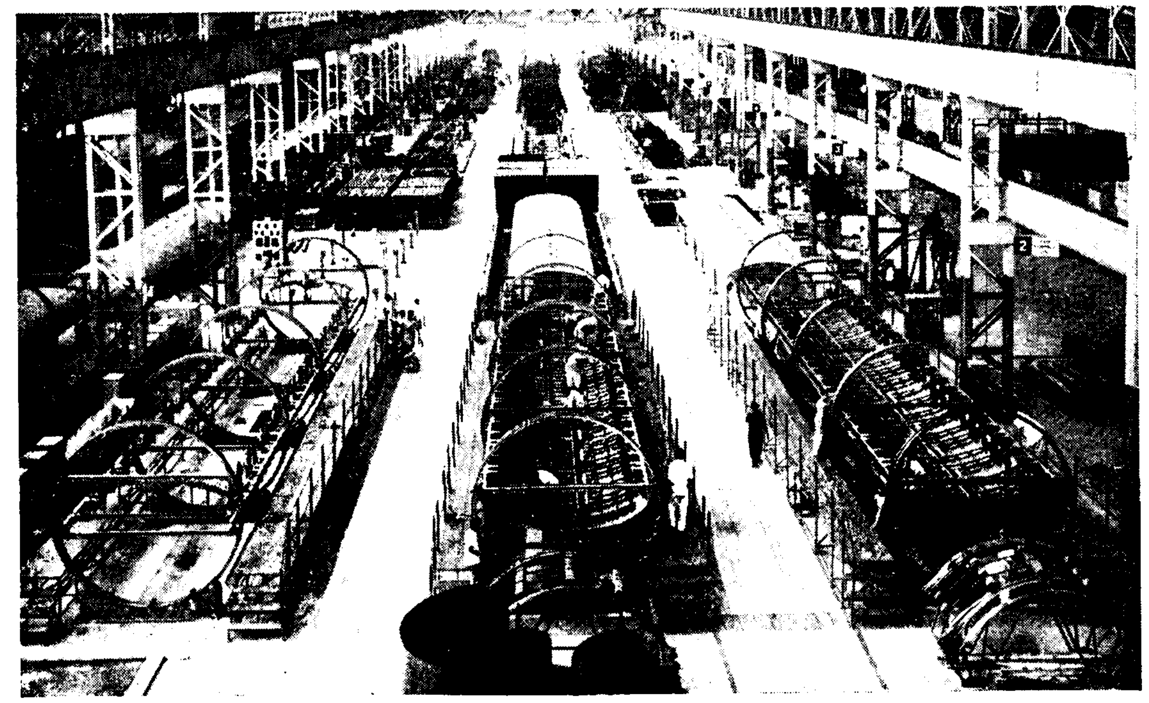


Fig.23. Main Assembly Shop as it is now (Feb. 1957)

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

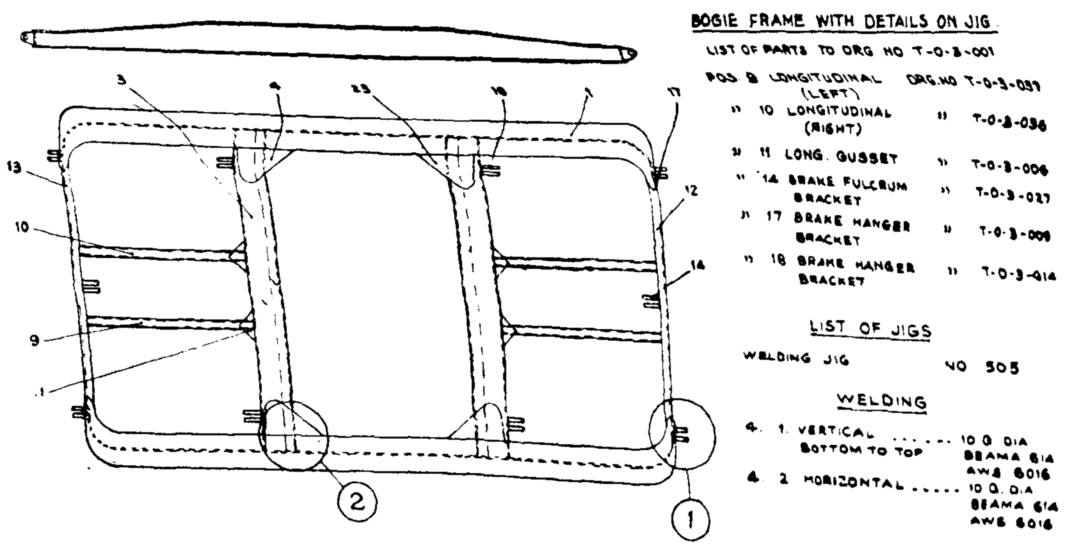


Fig. 24

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 wil arrow marks.

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

(*d*) The specification of the electrodes is given two standards, *viz.*, BEAMA (The Brit Electrical and Allied Manufacturi Association) and AWS (The Ameri Welding Society).

MALLEABLE CAST IRON PIPE FITTINGS

An Indian Standard Drafted

The Indian Standards Institution has issued a draft Indian Standard Specification for Malleable Cast Iron Pipe Fittings Doc: SMDC 9 (68) which prescribes the types and dimensions (centre-to-face and "face to face" dimensions and their tolerances) for malleable cast iron pipe fittings suitable for screwing to pipe threads specified in IS : 554–1955. The Dimensions specified are essential for inter-changeability.

Out of a range of types and sizes of fittings of more than 2000 items, which had been standardized i various countries of the world, the Internatio Organization for Standardization, (ISO), has, with t agreement of the participating countries, chosen 6 malleable cast iron fittings, which are necessary f general use and which are being manufactured in ma production. With a view to assisting the indust in India to fall in line with the practice followed i other countries of the world, this standard has be based on the Draft Recommendation of the ISO.

THE ALCO 251-B DIESEL ENGINE

THE hundred 1800 HP main line diesel electric locomotives that ALCO Products, Incorporated, of Schenectady, New York, U. S. A., is delivering to the Indian Railways are powered by the Model 251—B four stroke cycle turbosupercharged 12 cylinder diesel engine of ALCO's own design and manufacture.

Before proceeding to give particulars about this engine, it is interesting to review its history and background.

ALCO Products, Incorporated, formerly the American Locomotive Company, purchased the works of McIntosh and Seymour, Incorporated, of Auburn, New York, U. S. A. in 1929. McIntosh and Seymour had been one of the earliest builders of diesel engines in the United States and their production stretched as far back as 1915.

From this very early date to the late thirties, McIntosh and Seymour and ALCO built a considerable number of engines, most of which were of very large size for stationary and marine purposes.

In between, quicker running, lighter weight engines were being built and developed for some shunting locomotives fabricated for American railroads.

In the late thirties, ALCO put on the market a 12—1/2 × 13" engine which is still built, and which has powered several thousand shunting and branch line locomotives in the United States and abroad. This engine, even if its design, dimensions and weight no longer reflect the state of the art, still enjoys a considerable reputation for ruggedness and dependability. Its supercharged version developing 1000 BHP at 740 RPM was first built in 1940.

While the 12—1/2 × 13" line was being developed, ALCO started building a number of engines of 9—1/2 × 10—1/2". An eight cylinder engine of these dimensions, built in 1935 and developing 600 HP at 1000 RPM, can be considered the fore-runner of the 251—B Diesel Engine.

The trend towards dieselization was becoming more apparent in American railroads and the locomotive industry quite naturally borrowed the standard mass production techniques of the automotive and other fields.

At that time, ALCO was building steam locomotives far larger and more powerful than any built before, but in spite of this success, they continued in their quest for a light-weight diesel engine.

In 1943, a 9 × 10—1/2", two cylinder prototype was run in the experimental laboratory in Schenectady. Experimentation continued during the war years and, as soon as manufacturers were free to resume their normal production, ALCO put in the market the Model 244 engine, 9 × 10—1/2" carrying its rated load at 1000 RPM.

When the 244 engine yielded its place to the 251, it was being built in two versions. One of 12 cylinders developing 1700 BHP and one of 16 cylinders developing 2350 BHP.

As can be seen, the 251 engine has a very long history and each of its features has been studied in one or many of the preceding models, stretching as far back as the original McIntosh and Seymour engines.

The 251—B engine has the following basic dimensions and characteristics :

Cycle—4 Stroke—Turbosupercharged

Stroke—10-1/2", Bore—9"

Rated Load—162.5 BHP per cylinder

Speed—1000 RPM

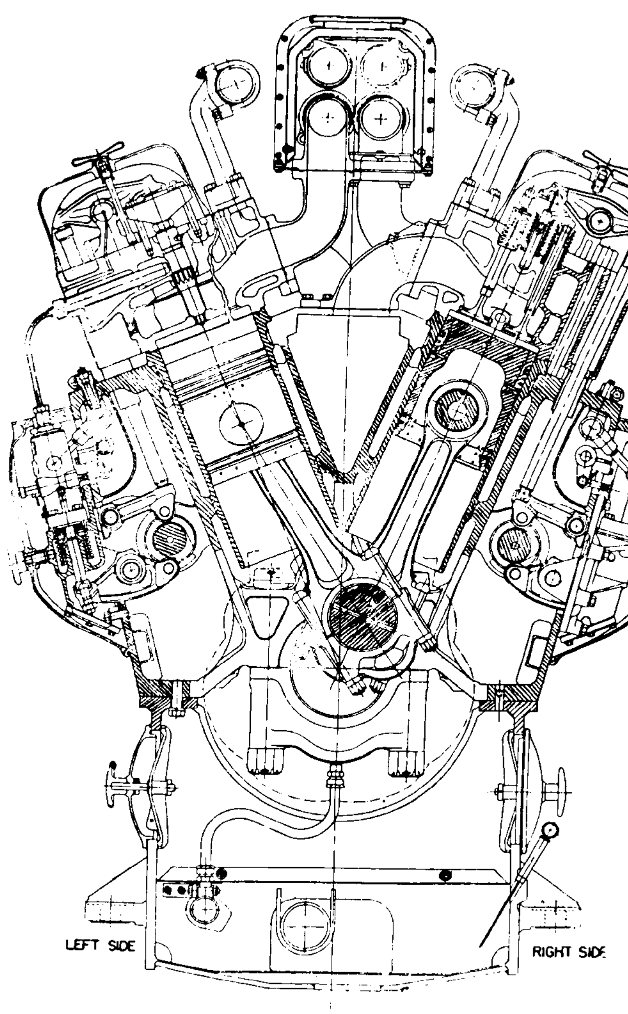
Mean Piston Speed—1750 fpm

B. M. E. P.—193.5 psi.

The engine is built in 6, 12 and 16 cylinder versions, developing respectively 975, 1950 and 2500 BHP.

The 12 cylinder engine powers the Indian locomotives. Its dry weight is 32,650 lbs., complete, and its length is 157.62", thus being extremely compact and light engine for its power class.

The main structural member of the engine is the main frame or block of welded-steel construction, stress relieved. The main-bearing saddles are drop forged. The crankshaft is carried by seven underslung bearings of which the center carries the two thrust collars.



CROSS SECTION THRU VEE 251 ENGINE
LOOKING FROM GENERATOR END

Fig. I. Cross section of the ALCO Model 251 Vee-type diesel engine

The engine base is also of welded-steel construction and carries the four engine mounting pads, the lubricating oil and cooling water pumps, and supports the after-cooler and turbosupercharger.

Figure I shows a cross section of a V Type Engine. It can be seen that the block is very deep and that the sides and top deck form a continuous structure. This results in very high rigidity and, by insuring the proper positioning of the remaining elements of the engine, contributes to their longer life.

The crankshaft is a single piece, hardened steel forging. The camshafts, one per bank, consist of three sections each. Each section contains the air, fuel, and exhaust cams for two cylinders. The bearing and cam surfaces of the camshafts are induction hardened for longer life.

The main and connecting-rod bearings are of a hard-bronze lead alloy. Grooveless construction is used for the top half of the connecting-rod bearings to insure uninterrupted oil film and thus better support the loads. The ALCO engine is of the wet-block type. Cast iron liners, with porous chromium plating are used.

The cylinder heads are of cast iron, with hard valve inserts for longer life. There are four valves, two intake and two exhaust, with hard-steel heads.

Following ALCO's long time practice, the drop-forged, steel-connecting rods are drilled to provide an oil passage from the crank shaft to the piston pin and piston for lubrication and cooling purposes.

The pistons are of aluminum alloy and made in three pieces. A piston body receives a ring carrier. The body and carrier have milled passages to provide for oil circulation for cooling purposes.

There are three compression and two oil rings. The top compression ring is carried in a nickel alloy insert to minimize wear.

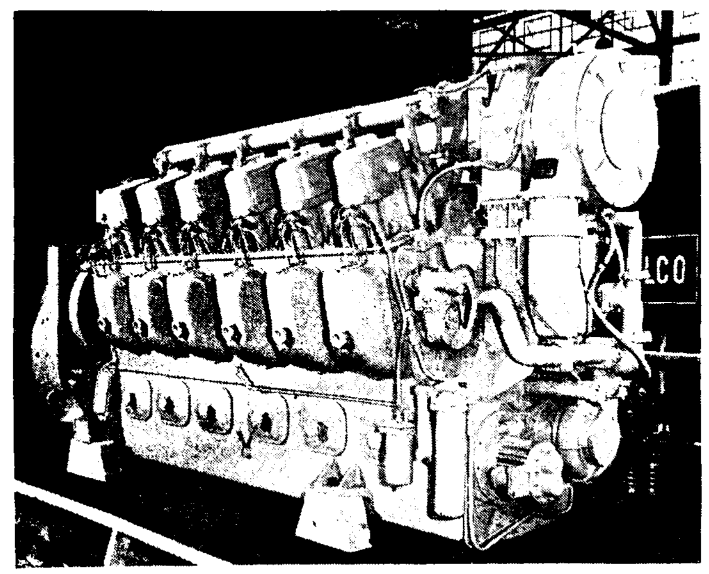
The engine is provided with a gear-type, lubricating-oil pump driven from the crank shaft, and providing pressure lubrication to all the working parts.

A centrifugal pump also driven from the crankshaft, is used to insure water circulation.

As said before, all the working parts are pressure lubricated. Oil returning to the engine from the filter is led through a main header from which branches go to each main bearing. The crankshaft is drilled so that oil is allowed to flow to the connecting-rod bearings for lubrication. In the 251 engine, the center main position does not have to supply oil to any connecting-rod bearing. The adjoining connecting rods receive lubricating oil from No. 3 and No. 5 main bearings. This results in a far thicker oil film at the No. 4 main bearing.

The lubricating oil from the connecting-rod bearings is led through the drill passage in the connecting rod to the gudgeon pin, which is of the floating type. Passages drilled in the pin lead the oil to the pistons. The oil falls back to the crankcase from the pistons through a drain hole drilled in the under side of each piston.

The ALCO 251 engine uses individual fuel pumps,



The 12-cylinder ALCO Model 251 Vee-type diesel engine. This 1800-hp. power plant provides prime power for the ALCO " World" locomotive.

of the Bosch type. These pumps have special features of ALCO design, the most important of which is a snubber valve which minimizes high pressure line vibrations and thus results in longer life of the high pressure line and the injectors.

The high pressure line enters the cylinder heads from the side and reaches the injector by means of passages cored in the head.

As mentioned before, one of the most important features of the ALCO engine is the after cooler. The air, after leaving the turbosupercharger, is led through a fin-tube type heat exchanger and is cooled by water from the engine-cooling system. In this manner, the air entering the cylinders does so at a far lower temperature than that resulting from its compression at the turbosupercharger, therefore, a denser air charge is available for better scavenging, for cooling of the combustion chamber, and for more efficient combustion of the fuel.

A nickel alloy cast-iron manifold is used. Four branches, each of them taking three cylinders, lead the exhaust gases to a turbosupercharger designed and built by ALCO. This turbosupercharger is a very simple machine with inside sleeve bearings and of high overall efficiency.

WATER COOLERS AT RAILWAY STATIONS

Water coolers to provide cool drinking water to passengers are proposed to be provided at 48 more railway stations in different parts of the country during the current financial year.

Last year, such coolers were provided at 34 stations. The stations at whic water coolers are now being provided are :

Eastern Railway: Burdwan, Kiul and Jhajha; Northern Railway: Shahjahanpur, Hardoi, Khaksar, Hardwar, Dehra Dun, Etawah, Shikohabad, Hapur, Hathras Jn., Mainpuri, Churu, Moha, Tehsil, Delhi, Kishanganj, Jind Kurukshetra, Saharanpur, Ambala Cantt. and Sonepat.

North-Eastern Railway: Farrukhabad; North-East Frontier Railway: Amingaon, Gauhati, Pandu, Alipurdaur Jn., Bongaigaon, Lumdig, Dibrugarh, Siliguri Jn. and Tinsukia.

Southern Railway: Bezwada, Nellore, Tenali, Gudiwada, Adoni, Dharmavaram, Dronachallam, Bagalkot, Gadag, Mayavaram, Dindigul, Tinnevelly Jn., Cannanore, Calicut, Olavakkot Jn., Arsikere and Hindupur.

* * *

RS. 5 CRORE OUTLAY PROVIDED FOR TELECOMMUNICATIONS AND SIGNALLING

An outlay of slightly over Rs. 5 crores has been provided for the improvement of signalling and telecommunications on the Indian Railways during the current financial year.

Among the important new works to be started will be the provision of the modern route relay interlocking of the latest control switch or push button pattern at the Howrah terminal yard on the Eastern Railway. The project is likely to cost Rs. 25 lakhs.

It is proposed to introduce a " very high frequency " multi-channel communication scheme on the South-Eastern Railway. Centralised traffic control system, the most modern form of railway signalling which is widely in use in the U.S.A. and other Western countries, will be introduced on the Kathihar-Baranni section of the North-East Frontier Railway. This would help considerably in enhancing line capacity on this section.

Several schemes for improving signalling on the Southern Railway have also been included in the current year's programme.

Diesel Developments on the Southern Railway

12 Australian B. G. cars in traffic, 12 more expected for the Northern Railway

By I. B. Macfarlane

Service Engineer, Colombo (Railcar Project) Plan.

TWELVE broad gauge diesel railcars, supplied by Australia under the Colombo Plan, have been in traffic since April 30 working local services in the Vijayawada division of the Southern Railway.

The railcars were designed and built by the Australian Contractors, The Commonwealth Engineering Company of Granville, New South Wales. This firm has factories near Sydney, Brisbane, Melbourne and Perth and is the largest rolling stock manufacturer in Australia. "Comeng", as the company is known, specialises in railway work and has supplied to Australian Railways enough diesel-hydraulic shunting locomotives, railcars, stainless steel and other passenger coaches, goods wagons and "special" vehicles such as 200 ton hot-metal cars to form, in all, a "train" over 45 miles long. Rolling stock has been exported to India, Malaya and New Zealand, and the company has other export orders for Cambodia and South Africa in hand.

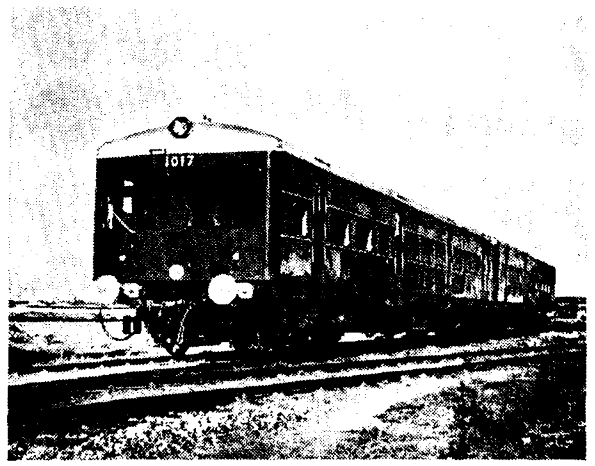
The contract for the 24 Indian railcars was signed in mid-1955. The design work was done by the drawing offices in Sydney and Brisbane.

Each completed railcar weighs 47 tons tare, and is carried on two four-wheel bogies.

82 Third-Class passengers are carried on wooden seats in 3 large compartments. Two toilets are provided. The number of standing passengers is limited purely by space available, unlike other railcars where passenger capacity is limited by engine power.

There are two driving cabs - full car width at A end, and half-width at B end. Both are identical as regards controls, the only difference being that the A end cab contains an observer's seat, the electrical locker, and the lights and fans push-button control panel.

The body is an all-steel integral unit with full strength underframe and heavy end collision posts.



Two Comeng Rail Cars for the Northern Railway.

I. R. S. buffing and draw-gear is fitted. Bogie centres are 48′ 6″, bogie wheel base 9 ft., and length over buffers 73 ft.

The car is panelled in masonite with plymetal partitions. Red and cream linoleum tiles are laid on the floor.

The exterior finish is Tuscan red with a 1½″ cream band above and below the windows, roof silver, underframe black, and cow-catchers red for the Southern Railway, and blue for the Northern.

Interior colours are chocolate brown up to the waist rail, cream up to roof rail and white ceilings. Luggage rack and seat timbers are Malayan red marante clear-varnished to preserve the natural grain and colour. Except for the seats, this colour scheme is identical with that of the New South Wales Railways' Sydney electric trains—another link between India and Australia!

The cars are numbered 1001 to 1024 and coded "YZZT".

There are two completely independent sets of power equipment supplied by British United Traction Limited

(B. U. T.). The centre of each is a normally-aspirated four-stroke Leyland horizontal 6-cylinder 15.2 litre diesel engine, developing 200 H. P. at 1800 r. p. m. These engines have $5\frac{1}{2}'' \times 6\frac{1}{2}''$ cylinders with wet liners, cast-iron cylinder block and aluminium alloy pistons. The fuel injunction equipment comprises a C. A. V. pump and Leyland injectors.

Induction air for each engine is drawn at roof height from inside the end passenger saloons and passes downwards through an air chute to the oil bath air cleaner underframe-mounted beside the engine.

A four-cylinder air-operated throttle motor is connected to the C. A. V. all-speed governor giving "idle" plus four selected engine speed maxima (900, 1300, 1700 and 2000 r. p. m.). Each engine is provided with automatic shut down and driver warning in the event of low engine lube oil pressure or over-heating.

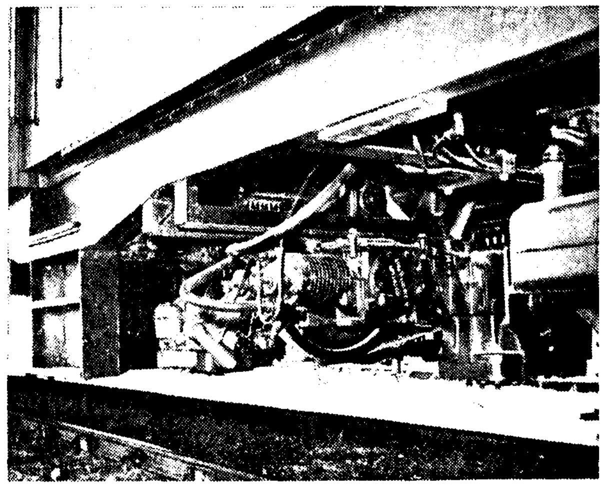
The drive is via a fluid flywheel, to absorb starting and gear change slip and rail shocks, thereby protecting the engine and transmission, a freewheel to allow the engine to idle or stop if it shuts down automatically when the railcar is running at speed, and a four-speed epicyclic gearbox to the reversing final drive unit mounted on the inner axle of each bogie.

The radiators are mounted under the floor at the side of the car; each is driven from the free end of the engine via a right-angle drive gearbox and two shafts, that from the engine to the 90° drive box having Layrub flexible couplings. The transverse fan-drive shaft has universal joints. A 24-volt Stone's 'XR' type dynamo is vee-belt driven from a pulley on the input (engine) side of the 90° drive gearbox.

Two Westinghouse 32 HU compressors are provided, each being driven by four vee-belts from the input side of the four speed gearbox. Induction air for these is from the engine air cleaner nearby.

The four-speed gearbox, supplied by the Self Change Gear Co., Coventry, England, is air-operated. There are three sun-and-planet gear trains each with external band brakes. To select 1st, 2nd or 3rd gears the respective brake band is tightened by a piston pushrod and rocker arrangement. Top gear is obtained by engaging a direct-drive multiplate clutch, operated by three peripheral pistons.

The final drive has two transverse-axis constant mesh bevel gears driven by the input pinion. Forwards or reverse motion is selected by meshing a



View showing (left to right) Leyland 200 H. P. engine with fluid flywheel, Air compressor, and four speed S.C.G. Gearbox.

dog clutch, splined to the shaft of the final reduction pinion, with one of these bevel wheels. The dog-clutch is pushed into mesh by an air-operated selector fork. Detector switches indicate that the reverser has meshed correctly. A locking pin is provided to isolate the final drive in neutral gear. The whole unit is centrally carried on the axle; a torque reaction arm is attached to the bogie frame through resilient rubber mountings.

Control of engine speed, gear changing, forwards and reverse motion, service braking, sanding and compressor synchronisation is electro-pneumatic via 28 wires of a 30 core train line cable and Westinghouse E. P. valves. Safety interlocking is effected by Siemens pressure switches, which close the engine throttles when a service brake application is made, disconnect the gearbox (thereby allowing the engines to be revived up to compress air) after an emergency brake application, and prevent the train being driven off unless there is enough air in the emergency brake pipe to stop it.

Two additional pressure switches unload all air compressors simultaneously at 100 lb. main reservoir pressure and suppress a "deadman" emergency brake application if the service brakes are applied.

Should any reverser not be meshed correctly, its safety E. P. valve will de-energise, thereby applying the emergency brake.

The 24-volt electric system, comprising generators, regulators, lights and fans, was supplied by J. Stone & Company. All equipment is to Indian Railway Standards. Full white and blue night lights are

provided, plus a fixed fan for each bay of four or six seats.

All the electrical control equipment – fuses, switch-gear, relays, voltage regulators etc., is concentrated within the electrical locker in the "A" end driver's cab, leaving only the two generators, the E. P. valves (in special two dust-free boxes), the E. P. brake master controller and the two engine starting control boxes on the underframe.

The railcar is fitted with the 3-pipe Comeng-Westinghouse air brake system. There are two entirely independent air brake systems, the electro-pneumatic or service brake, and the emergency brake. Both are controlled from the one driver's brake valve.

The three pipes are:

(a) Main reservoir pipe, to equalise the delivery pressure of all the compressors;

(b) Straight air pipe, for the service brake, and

(c) Emergency pipe for the fully automatic Westinghouse emergency brake.

The electro-pneumatic brake (E. P. brake) has the following features:

1. Very rapid brake application, simultaneously on all cars throughout train.
2. Graduated application and release by self-lapping brake valve.
3. The brake is self-maintaining for any reasonable leakage.

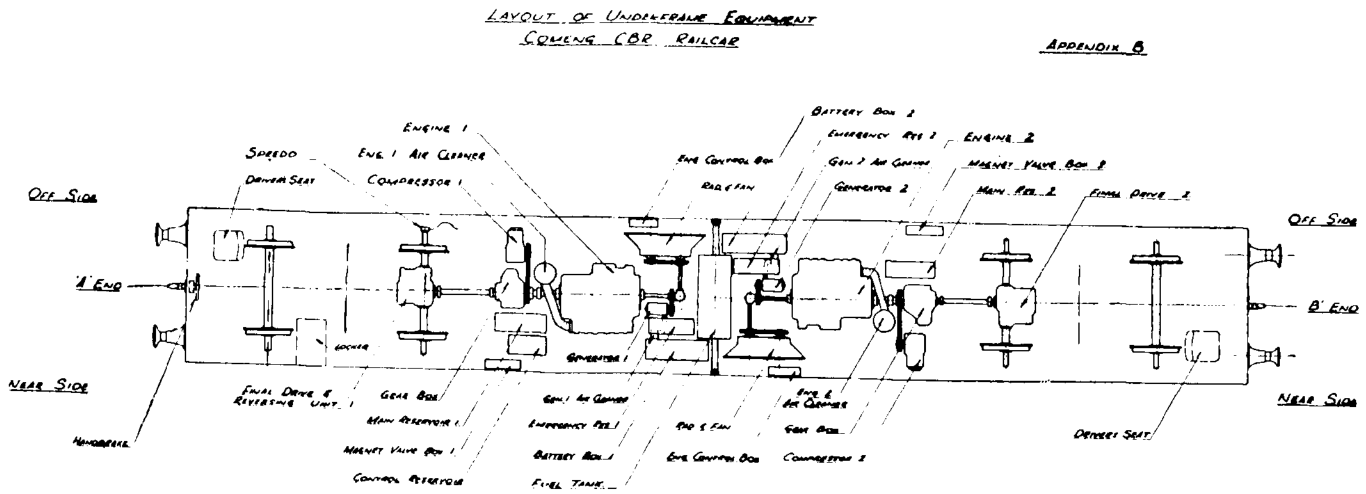
Basically the E. P. brake is a straight air brake on which are superimposed electrically-operated admission and release valves in every car, c. f. control of application and release from the front car only of a straight vacuum or Westinghouse system.

The principle of the system is as follows:

The driver's brake valve handle in the leading car is moved to a position between "release" and "full service" corresponding to the degree of braking effort required. This valve will establish a pre-set pressure on one side of the E. P. master controller's diaphragm, closing a set of "brake" contacts. Thus the master controller serves to convert the pressure into a 24 V. electrical signal, feeding a "brake" train line which energises "brake" magnet valves on all cars. When energised, these feed main reservoir air to the straight air pipe, which is connected to the opposite side of the master controller's diaphragm. Thus when the straight air pressure equals that set by the brake valve, the "brake" contacts open, and the "brake" magnet valves de-energise.

The straight air pipe is really a pilot pipe for a relay valve which admits main reservoir air to the brake cylinders, thereby exactly duplicating the pilot pipe pressure.

To release the brake, the valve handle is moved towards the "release" position, thereby causing the greater straight air pipe pressure to move the master controller diaphragm and close a set of "release" contacts, feeding a "release" or "exhaust" train line and energising the "exhaust" magnet valve on each car.



Arrangement of underfloor Power and Control equipment on Comeng Broad Gauge Rail Cars for Indian Railways.

Thus the straight air pipe pressure will be lowered and the relay valves will seal off the main reservoir pipe and exhaust the air from the brake cylinders, thereby releasing the brakes.

It will, therefore, be seen that the secret of the rapid operation lies in—

(a) reducing the volume of air required to pass through the driver's brake valve to a very small value.

(b) Simultaneous admission or release of straight air on every car.

(c) Supplying the main volume of braking air required for each car—i. e. for the brake cylinders—from reservoirs on that car itself.

Should the electrical system fail, the train may be worked on direct straight air service braking, by isolating the master controller, and charging the straight air pipe directly from the driver's brake valve. The self-lapping feature is retained and the only effect is that the system is slower in action than E. P. control.

If a pipe bursts the E. P. brake will become inoperative—it is not automatic. Safety is preserved however, by the Westinghouse Emergency brake.

The emergency brake is a simpler form of the standard Westinghouse single-pipe air brake on which triple valves give graduated application and release.

Since the E. P. brake gives the desired partial applications, the emergency brake is of the full-apply or fully-release type. No graduated application is possible. When running the emergency pipe and the emergency reservoirs (two per railcar) are charged to between 60 and 75 lbs. pressure. The brake is applied by venting the train pipe to the atmosphere, causing the air stored in each emergency reservoir to kick its emergency valve over and thus connect the reservoir direct to the brake cylinders. When the pipe pressure is restored the emergency valve will connect the pipe to the reservoir, thus recharging it, and vent the brake cylinders to atmosphere, thus releasing the brake.

The emergency brake may be applied by moving the driver's brake valve handle to the "emergency" position, by pulling the communication chain, by the train parting, by the deadman system or by a failure of a reverser to mesh correctly.

The 6″ dia. long-travel brake cylinders, eliminating the need for slack adjusters, are carried on the bogie frame—one cylinder is provided for each wheel. The brake linkage has the minimum number of pivot points. The steel pivot pins and lever bushes are all case-hardened to minimise wear and the need for maintenance. I. R. S. cast-iron brake locks are provided.

The bogies are of the 4-wheel coil spring swing link-bolster, equalised type with hydraulic shock absorbers.

The coach body rests on the bolster through a vibration-damping rubber pad built into the centre plate assembly. The bolster in turn is supported on the spring plank by two double concentric coil springs. The spring plank is hung from the bogie-frame transoms by four forged swing links; thus half the weight of the car body is transferred to the centre two transverse members of the bogie frame.

Each side of the bogie frame bears onto a forged steel equaliser beam through a double concentric coil spring adjacent to each axlebox, the equaliser beams in turn resting on the top of the axleboxes.

Rubber-bushed stabilizer bars connect the bolster to the spring plank and eliminate transverse oscillations; two anchor rods connect the bolster to the bogie frame, one on each side, thus taking traction and braking forces and obviating the need for sliding faces. Transverse movement of the car body is limited by rubber snubber blocks attached to each end of the bolster.

S. K. F. roller bearing axleboxes are provided.

The driver's controls comprise a throttle controller, (idle plus four speeds) gear-change controller interlocked with a forwards/reverse key and a Westinghouse W2E self-lapping brake valve with detachable handle. Three deadman controls are provided—the throttle lever knob, a foot treadle, and a "press" switch in the doorway, used for shunting. One of these must be held depressed to cancel a "deadman" emergency brake application. There is approximately 9 seconds delay to allow the driver to change his position. When a 20 lb. service brake application is made, a pressure switch suppresses the "deadman" emergency brake application, thus

permitting the driver to leave his cab when the train is halted, in a station. Should the service brake leak off below about 15 lbs. pressure (which is highly unlikely) the emergency brake will apply.

Auxiliary controls comprise horn button, wind screen wiper cock (both pneumatic) sand button (E. P. control) and the usual switches for headlights, buffer lights, fan, cab lights, instrument lights etc.

Components were manufactured in the Sydney and Brisbane factories and then shipped to Bassendean, near Perth in Western Australia, for final erection and fitting engines and transmission equipment.

The all-steel integral bodies were built in six major sub-assemblies—underframe, two sides, two ends, roof. Each of these was assembled flat in jigs. Final assembly was done in a complete bodyframe jig. Readers may be interested to know that all erection was carried out using only a single 5-ton capacity gantry crane over each bay. The most difficult sub-assembly to handle was not the railcar shell but the complete bogie.

Approximately 130 men were employed on erection, fitting of power and electrical equipment, painting and interior finishing. A skilled fitter is paid approximately £15/-Australian per 40-hour, 5-day week, plus overtime at time-and-a-half, and double time at weekends. This works out around Rs. 600/- per month.

The railcars were hauled 17 miles to the wharf at Fremantle by a steam locomotive, being temporarily mounted on West Australian Government Railways 3′ 6″ gauge bogies with towbar couplings. Since the W. A. G. R. structure gauge is only 8′ 6″ wide, these 70 feet, 10′ 6″ wide I. R. S. dimension cars presented quite an out-of-gauge load, travelling on top of instead of beside all station platforms. The cars were handled in four trains of six without mishap. Shipment to Madras was by the m. v. "Belkarin" for the Southern Railway cars and s. s. "Christen Smith" for the Northern Railway, the coaches being both loaded and unloaded by the ship's heavy-lift derricks.

The first 12 railcars (for the Southern) were unloaded at the East Quay in Madras Harbour on January 1st and 2nd this year (See "Indian Railway Engineer" for January 1958). They were first fuelled by the Burmah-Shell Installation in Royapuram yard, (put in to refuel the diesel-electric generator cars on the air-conditioned Deluxe Janata rakes operating between Madras and New Delhi), and were then towed by a steam locomotive to Perambur Carriage Works in two special trains.

Whilst the cars were at Perambur Works it was necessary to fit underframe air hoses, cowcatchers, exhaust pipes, roof ventilators and horns, all of which had been removed for the sea voyage.

Before shipment the bodywork was specially protected by a plastic skin, sprayed on as a liquid. This envelope is removed simply by tearing off in sheets. Just how simple was soon obvious; most of it was "removed free of charge" by curious sightseers both when the railcars were on the wharf and when they were shunted into the workshops for the first time.

Whilst at Perambur all the railcars were given a full lubrication service covering all power unit items. The engines were then started and the power equipment, control system, lights, fans etc., all tested in turn.

On receipt of the Safety Certificate permitting operation over main lines, every railcar was given a shake-down trial run from Perambur Works out to Arkonam Junction and back, a round trip of some 79 miles. Four test trains, each comprising three cars were run thereby checking operation of each railcar under multiple unit control.

These trials established that the railcars' acceleration is only slightly below that of a suburban electric train operating on similar gradients.

After these shake-down tests various minor adjustments were made. All pneumatic piping was checked for leakage with soft soap and water, the few small leaks thus detected were rectified.

During trial runs, the dust cloud raised by the passage of the railcars was undesirably high, due to the aerodynamic properties of the sheet-steel cowcatchers. The cowcatchers were therefore modified by cutting suitable slots and holes to reduce the volume of air disturbed by the passage of the train. Subsequent tests showed the dust level to be equal to, if not below, that of a steam train travelling at the same speed.

In subsent airbrake tests an emergency application at 70 lbs. train pipe pressure brought a 4-car set travelling at 75 m. p. h. to a dead stand in just over half a mile. This brake performance is thus considerably better than that of a normal vacuum-braked train; the use of composition brake blocks would improve it even more. The maximum speed attained during trials was 76 miles per hour on straight level track. In service, however, speeds will not exceed 55 miles per hour.

It was decided by the Southern Railway to operate all twelve railcars on local services in the densely populated coastal Andhra Pradesh region, extending 33 miles north and 58 miles south of Samalkot Junction, 391 miles north of Madras on the Madras-Calcutta main line. Services were to commence at Cocanada (or Kakinada), the terminus of a 9½ mile branch line from Samalkot. The passenger traffic in this area is the densest on the Southern Railway. The Cocanada line had seen railcars before: six 110 h. p. diesel-electric cars with Armstrong-Saurer vertical transverse-mounted engines were purchased by the former Madras & Southern Mahratta Railway in 1937. These cars were withdrawn from service some three years ago. Four of them may still be seen standing in the yard at Pattabiram, near Madras, awaiting either reconditioning or condemnation. Since a small railcar shed with simple facilities existed at Cocanada Port it was decided to base the new Australian cars there also.

On April 30th the diesel services were inaugurated at Cocanada by Sri M. S. Murty, Divisional Superintendent, Vijayawada, Southern Railway, in a pleasant informal ceremony at Cocanada Port Station. Some two hundred guests comprising civic officials and the leading citizens of Cocanada were present. After short speeches by Sri Murty, Sri Krishnaswami, the D. M. E. of Vijayawada Division, and Mr. I. B. Macfarlane, the Australian Engineer from the Commonwealth Engineering Company, the guests were taken to Samalkot and back in a specially-decorated three-car set.

Following the inauguration ceremony the railcars took up four regular return trips daily from Cocanada to Samalkot Junction. Whilst the drivers and maintenance staff gain confidence and experience operating the new railcars, the diesel services are restricted to the Samalkot Junction—Cocanada branch line. It is expected that by mid-August services will be railcar operated from Samalkot Junction northwards to Tuni, and south to Rajahmundry and Tadepalligudem.

Plans are in hand to fit six I. C. F coaches with air brakes and electric jumper cables, and marshal the railcars into 3-car power-trailer-power units. This will increase the usefulness of the power cars and reduce overcrowding. Each of the proposed units will weigh 131 tons, seat 240 Third-Class passengers and have a gross horsepower of 800.

Speed is restricted to 30 m. p. h. on the Cocanada branch because of poor track, and 50 m. p. h. on the main line.

The railcars have proved very satisfactory in service. At the date of writing, some cars have run over 4000 miles; no power unit failure has occurred. Following signs of slight distortion on two cars, all four-speed gearbox suspension brackets have been strengthened. Some trouble has also been experienced due to the ingress of dust into the driver's throttle and gearbox controllers, but this too has been completely cured by fitting plastic dust bags over the contacts concerned. No railcar has failed on the run nor has any car failed to report for duty on time, at the commencing point of its trip. Nor has any diesel train dropped time that could be booked against a failure of railcar equipment. In some 700 trips with rather complex new equipment and freshly trained staff this is an excellent and enviable record.

Running maintenance, light repairs and lubrication servicing are done in the running shed at Cocanada. This has a single road with examination pit, long enough for one car. Equipment provided in a small workshop attached to the shed comprises fitters bench, a small lathe, air compressor and a good stock of hand tools.

Intermediate overhauls (60,000 engine mile intervals) will be done at Cocanada. These comprise removal of cylinder heads, de-carbonising valve grind, check of cylinder liners, pistons and piston rings, change of injection pump, inspection report on all equipment, repairs to transmission as required by the report, and removal and cleaning of radiators.

Periodical overhauls (120,000 miles) will be done at Perambur and cover complete engine stripping and overhaul.

Servicing work on these cars has proved particularly easy since all items requiring attention are easily accessible and there is plenty of room to spare around the underframe.

The Caltex Oil Co., has installed seven fuel oil storage tanks with a total capacity of 21,000 gallons together with an automotive-type bowser for fuelling the railcars. Unfortunately the diesels must share their home with steam locomotives, which gives rise to highly undesirable ash, smoke, local dust etc., around the railcar area. It is to be hoped that a small diesel locomotive will eventually be obtained to work goods trains and passenger trains conveying through Cocanada coaches detached from Nos. 4 and 3 Madras-Howrah and Howrah-Madras Mails at Samalkot Junction. When a diesel shunter is provided steam will be completely eliminated from the Cocanada branch.

The twelve railcars destined for the Northern Railway are expected to be unloaded at Madras in August and driven the 1361 miles up to New Delhi under their own power—believed to be the longest diesel railcar trip ever run in the Commonwealth and probably the World.

The Commonwealth Engineering Co.'s Railcar Engineer Mr. S. E. Dick, supervised the initial commissioning and trials. After his departure for Malaya in March, his assistant Mr. I. B. Macfarlane acted as service engineer in charge of Southern Railway cars. Mr. J. Connell, Superintendent of the Bassendean factory will arrive on the s. s. "Christen Smith" with the second shipment. Both he and Mr. Macfarlane will assist the Northern Railway to commission their cars.

A special diesel school was set up at Perambur by Mr. W. F. Bolton, Service Manager of B. U. T., to train the Southern Railway Staff on the power equipment. Mr. Dick also gave lectures on Westinghouse Air brakes. At the time of writing, the nucleus of the Northern Railway's diesel staff is being instructed at Perambur, Madras, on power equipment, air brakes, and control system.

The Riding Comfort of Railroad Passenger Cars

By W. E. Burdick
Mem. ASME, Engineer of Tests
General Steel Castings Corporation, Granite City, Ill.

MANY factors affect the riding comfort of railroad passenger cars, including truck design and maintenance, track repair and alignment, and car-body construction.

The modern passenger truck illustrated in Fig. 1 is the outgrowth of the first cast-steel passenger trucks with integral pedestals made by Commonwealth Steel Company in 1904, and which came into general use by 1920. Roller bearings introduced in 1927, the unit clasp brake in 1929, and off-tread brakes in 1938 have contributed much to riding comfort.

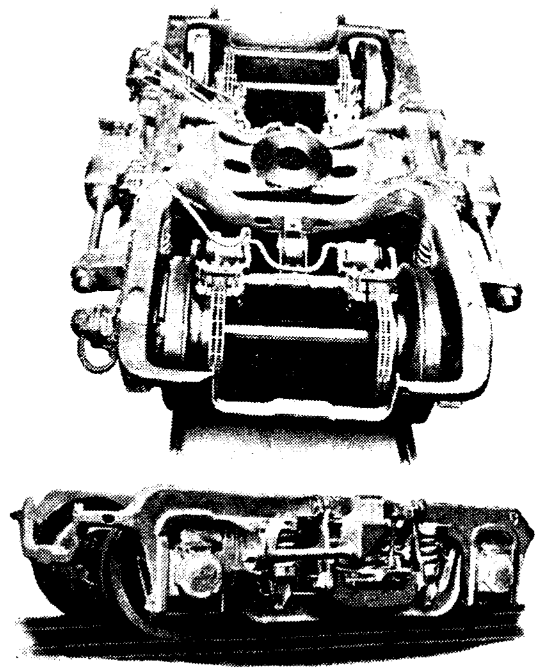


Fig. 1. Modern four-wheel passenger truck: off-tread brake shown, tread brake also provided.

The figure shows off-tread brakes. Either tread or off-tread brakes are provided. Similar features with the addition of a pair of wheels are found in the six-wheel type, for heavier cars. The author has found little difference in the riding comfort between the four and six-wheel trucks. Features of the modern truck are:

1. A one-piece frame with lined, integral pedestals to insure wheel alignment, and ruggedness to minimize maintenance.
2. Roller-bearing boxes, a "must" for smooth high-speed operation, without "hot boxes."
3. High-speed brakes with wheel-slip control to insure a smooth, minimum-stopping distance.
4. Rubber-cushioned draft anchors for easy transmission of longitudinal forces from the wheels to the car body.
5. Equalizer coil springs to cushion rail impacts. Equalizers keep weight on both boxes in case of spring breakage, preventing derailments from this source.
6. Shock absorbers across the bolster springs preventing resonant build-up.
7. Fabric damping pads at springs, equaliser feet, and swing hangers to reduce transmission of noise and high-frequency vibrations.
8. Bolster suspension outside the truck frame for ready inspection and fast renewal of defective parts.
9. Swing hangers in combination with the shear deflection of bolster springs to produce soft lateral action.
10. The central bearing to prevent shimmy.
11. Resilient coil springs supporting the bolster on a wide spring base providing roll stability.

The lean of cars on curves affects riding comfort (1) and involves the clearances between cars on passing track. The union Pacific conducted tests to show the comparison in lean between a dome car with outside-swing-hanger trucks and a prewar sleeper with inside-swing-hanger trucks (2) It was found that the two cars at 6 in. unbalanced elevation for static and dynamic tests compared as follows:

	Static lean inward, in.	Dynamic lean outward, in.
Dome car — outside swing hanger trucks	6.60	7.20
1941 sleeper — inside swing hanger trucks	9.60	12.30

Note from the foregoing that the transverse displacement for the outside-hanger truck for static lean was 3 in. less than that of the inside-hanger truck and for the dynamic lean, 5 in.

MAINTENANCE

A poorly maintained truck will soon drive away traffic. The modern truck is designed for easy maintenance, but no piece of machinery can run indefinitely without attention.

The truck components are gauged to insure that, when assembled, parts will function properly without binding or fouling. The one-piece cast-steel truck frame maintains its alignment indefinitely, excepting for wreck or abuse, and it is only necessary for the maintainer to renew worn parts to restore it to its original true condition.

OTHER FACTORS AFFECTING RIDING QUALITY

To insure that the four corners of a car have equal spring deflections it is necessary to know the actual weight carried by each spring. The weight of each end of the car may be obtained with a conventional track scale. The weight of each side of the car may be obtained by means of three-point support weighing, where one end of the car is supported on a ball and socket with the weight distribution of the opposite end determined by electronic load cells (3). Both ends are similarly weighed, and by rolling the car through known angles, the location of the center of gravity longitudinally, transversely, and vertically may be readily determined. The over-turning speed on curves can be determined when the vertical location of the center of gravity is known. Proper brake application and slack control, negotiating curves with regard to speed restrictions, starting and stopping, and control of trains through changes in profile can contribute substantially to the riding quality.

Cylindrical-tread wheels have less tendency to hunt, and thus impart less lateral motion to the truck than do tapered wheels. The only difficulty is that they do not stay cylindrical long; after a few thousand miles they become worn so that the beneficial contour is lost.

Riding conditions affected by wheel unbalance and eccentricity were investigated by the AAR(4), who found that:

"The detrimental effect of wheel unbalance on the riding of the test car was inconsequential when the total unbalance per wheel was below 2 lb. at rim radius. The investigation of the effect of wheel machining shows that the limiting condition of wheel unbalance can be met by the semi-finish machining of wheels.

"Wheel-tread eccentricity (up to 0.035 in.) had no important effect on the riding of the test car."

The quality of track affects the ride. Correlation between track conditions and riding qualities has been established by a number of railroads by operating a ride recorder over their lines, pin-pointing rough spots for attention of the track department.

The coil springs themselves may set up annoying vibrations such as hum and rattle. Hum is of the order of 50 cps. and, when excessive, causes a

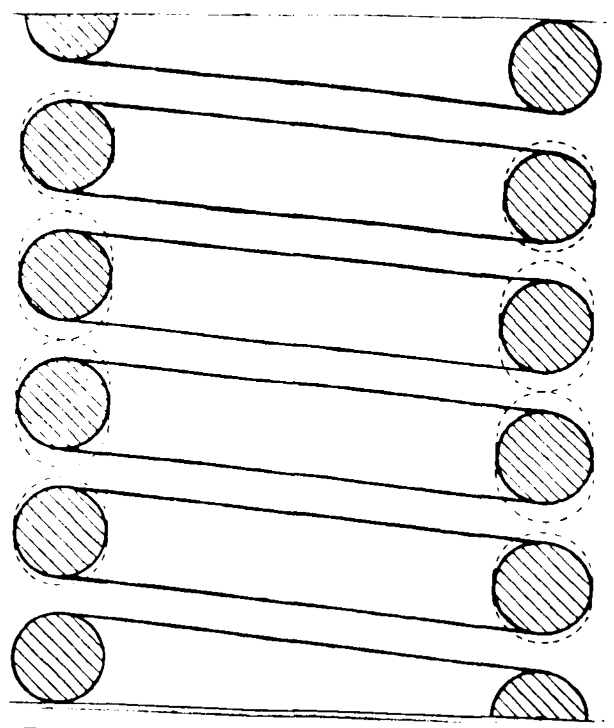


Fig. 2. Mode of vibration producing spring hum.

rumbling sound within the car. Investigations show that this hum is caused by surge of the spring, which is a relative vibration of the middle coils with respect to the end coils, Fig. 2. Insulation against transmission of this vibration to the car body has been partially successful. Rattle of springs can become very disturbing. This appears to be caused by nested coils impinging on each other. The solution of this problem is to increase the diametral clearance between coils, and center them with each other.

Noise is often mistaken for rough riding, and proper noise insulation throughout the truck and car structure can do much to increase passenger comfort, particularly on sleeping cars.

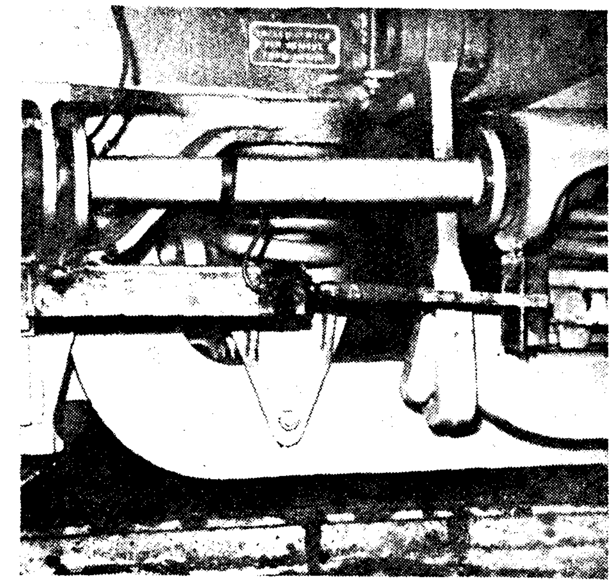
Noise and vibration annoying to passengers can originate in the end-draft connections and diaphragms, and are often mistaken for truck noises. Maintenance here is required and much progress has been made in insulating these points with fabric damping pads. Rubber draft gears and "tightlock" couplers have helped to keep down "slack."

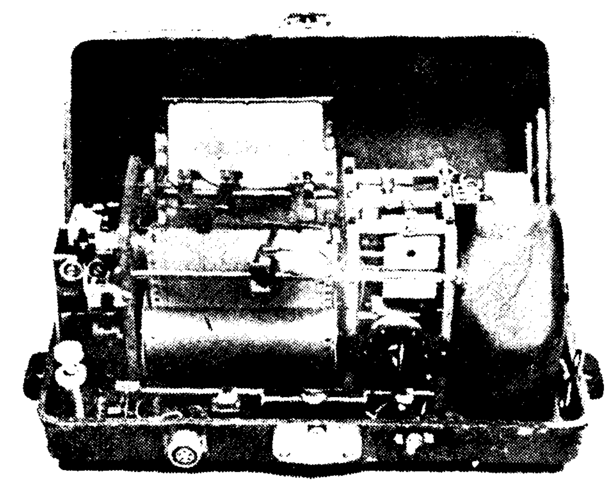
TESTING TECHNIQUES AND OBSERVATIONS

Instruments for recording riding qualities were available before World War II, but not generally used on railroad passenger cars.

The Three-Way Ride Recorder was developed by engineers associated with the University of Illinois and since the war has come into general use. The instrument records vertical, longitudinal, and lateral car body accelerations, and within its frequency response reproduces the impressed accelerations with fair accuracy. Mileposts or other information may be coded on a chart by means of a marker. The chart is clock-driven at 6 in. per min. so that the distance between milepost marks, in seconds, may be used to establish operating speeds.

When more detail is desired, electric accelerometers are used. Motion indicators can be readily constructed from spring-steel strips with a strain gauge. These strips are clamped to one truck member and driven by an adjacent member. Relative motions between the two produce signals, which are calibrated and recorded on an oscillograph.





There are a number of accelerometers of the "impact-counting" type in use. These instruments totalize the disturbances reaching certain preset intensities and are useful in an over-all evaluation of the riding qualities of a car. They do not locate points of disturbance.

A test program carried out on a "problem car" will illustrate the testing technique. This car, a bedroom-lounge, was reported for rough riding. It was equipped with inside-hanger trucks with the following characteristics: (a) conventional center plates, (b) roll stabilizers, (c) restricted lateral journal roller bearings, (d) bolster coil springs with 3⅞ in. static travel. Changes were made to this truck, one at a time, as follows: (a) central bearings replaced center plates, (b) spring planks replaced roll stabilizers, (c) free lateral boxes applied on new wheel-axle assemblies, (d) static travel of bolster springs was increased from 3¾ in. to 6¾ in., (e) lateral shock absorbers were added.

The ride recorder was used to check the riding quality of the car and to provide statistical data for grading the ride. Runs were taken over about 12 miles of mainline track at practically the same speed and the car was in the same consist position. Since the test extended over a 2-year period, wheel changeouts were inevitable, but most of the data was based on low wheel mileage with 1 : 20 treads. No check was made of wheel unbalance. Duplicate runs, when made, showed consistent results. The quality of the ride is numerically established by summating the excursions of the recording styli by lines crossed, and obtaining the average per mile. Based on our riding experiences we have established a grading of riding comfort. Fig. 4 shows a bar diagram of the ride values obtained by each change made to this car, from which it is noted that the riding qualities improved from poor to excellent.

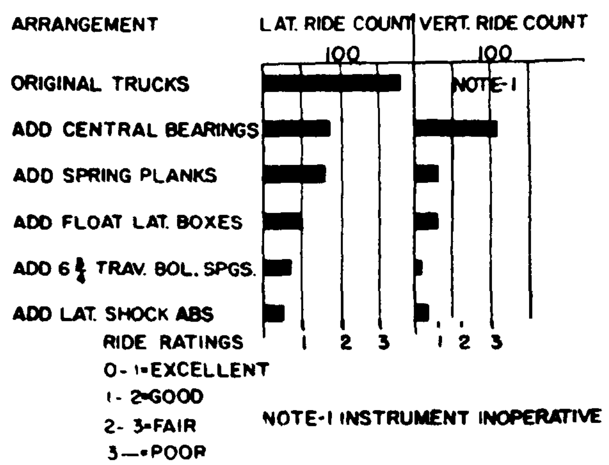


Fig. 4. Bar diagram of riding-quality improvements obtained with each change made to the car.

A serious ride complaint is shimmy, which is a lateral vibration in the range of 3 to 4 cps. (5). It usually develops at speeds above 60 to 65 mph. and is ordinarily associated with a slight tread wear. When double flanging is observed, it is often caused by shimmy. By retarding truck swiveling on tangent track this mode of vibration can be checked. The central bearing rotates against a friction pad and thus suppresses shimmy. Fig 5 shows an oscillogram of the effect of a central-bearing application on a car which had a severe shimmy. Practically, all of the then-known panaceas had been tried, unsuccessfully, to correct this condition. The oscillograms on the left show, top to bottom, the motion of the truck

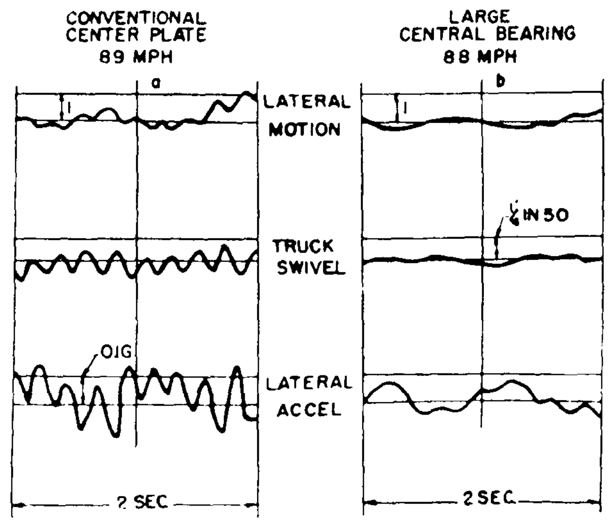


Fig. 5. Oscillograms of the effect of central bearing application to a car: (a) car shimmy, before application; (b) after application of central bearings.

laterally, the truck swivel, and the lateral acceleration of the car body. The frequency is about 4 cps., and all traces are in phase. The records on the right side show the effects of the central bearing on the same car, with the same wheels, at the same track location and speed. With swivel-control, shimmy has disappeared.

This oscillographic equipment is satisfactory for measurement of events in the riding range of frequencies. For higher frequencies in the sonic range, in fact from 20 cps. upward, vibration measurements can be made on equipment that will measure vibration amlitude, and analyze the resultant waves. A tape recorder can be used to preserve these vibration patterns for later play-back. With these instruments annoying vibrations can be traced to their source and corrective measures taken.

The eccentric oscillator can be used to trace the source of vibrations of 6 cps. and upward. By this means one vibration in the order of 10 cps. was pinned down to a car structure as shown in Fig. 6. The oscillator was placed on the end of a car and when tuned to 10 cps., a severe car vibration was excited. Investigation disclosed two nodal points, over the inside edge of each truck from which the vibration pattern was found to be as shown. Accelerometer readings taken with the car in motion showed components of this frequency affecting riding qualities.

With the exception of shimmy, the most annoying lateral vibration in a car is due to yaw; that is,

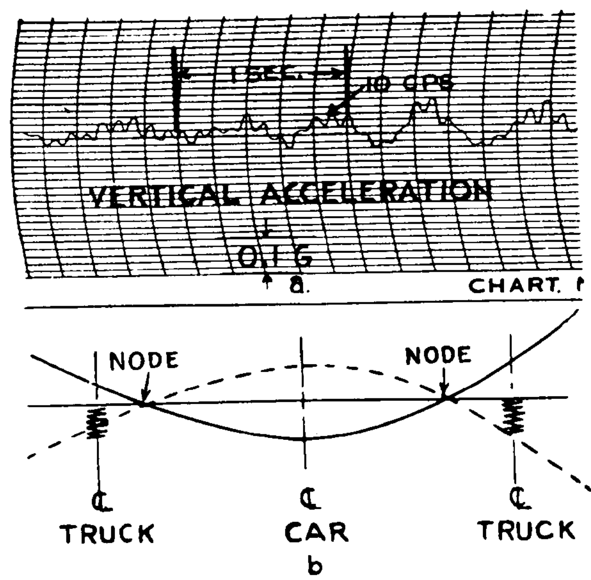


FIG. 6

(a) Oscillogram showing presence of 10-cps. vibration; (b) mode of vibration producing this frequency.

when the front of the car travels to the left, the rear travels to the right. This is a natural mode of vibration, and can be easily excited with the car at rest by a man using a crowbar. As the car travels along the track the natural hunting of the wheels will seek out this mode, and can cause an almost continuous vibration to be sustained. The vibration will tend to be restrained by adjacent cars, so it is usually the most severe at the rear of the train. This motion is not particularly a function of truck design, since modification of swing-hanger length or angularity, spring stiffness or location, and other similar modifications will merely shift the natural frequency a slight amount.

Any means by which the hunting of the wheels can be checked, or kept from disturbing the truck, will improve this yawing motion.

If it were possible to place the trucks on percussion centers of the car, the coupling of the truck actions by the mass of the car would cease to exist, and each truck would respond only to its own track irregularities.

POSSIBILITIES IN FUTURE INVESTIGATIONS

The only logical approach to a completely satisfactory answer to the riding problem of passenger cars, appears to be in a concerted research program.

The problem is not only the truck manufacturers; it is equally the responsibility of the car builders, and the railroads as well. The very nature of the physical laws involved requires that the location of the trucks be established to suit the mass and radius of gyration of the cars. The railroad's collective responsibility is that they are selling $ ¾-billion worth of passenger transportation a year (6). In contrast to this volume of business, with some notable exceptions, little is spent in research into the most important commodity—the customer's comfort.

The research should be directed to one objective—the determination of the effect of all factors affecting riding comfort. A few of the items of investigation which the author suggests are:

1. To determine the radius of gyration about the three axes of the car by experimental means.
2. To restrict the effect of wheel hunting.
3. To determine the minimal track conditions for riding comfort.
4. To develop an oscillator which will vibrate the car in all of its critical modes, including the low frequencies associated with riding.

The economics of the new light-weight "dream" trains is now under study and experience will determine their future. Regardless of their final design, to be successful the new trains must be comfortable.

ACKNOWLEDGMENTS

The author is indebted to the many railroads for permitting tests to be carried out on their equipment. The suggestions by the personnel of the author's company are acknowledged with gratitude.

BIBLIOGRAPHY

1. "Passenger Comfort on Curved Track," Association of American Railroads AREA Bulletin No. 516, June-July, 1954.
2. "How Dome Cars Acts in Curves," by D. S. Neuhart and W. C. Krautheim, *Railway Age*, March 19, 1956, pp. 66—68.
3. "Passenger Car Center of Gravity—How to Determine It and Why," *Railway Locomotives and Cars*, March, 1956, pp. 66—68.
4. "Effect of Wheel unbalance Eccentricity, Tread Contour and Track Gauge on Riding Quality of Railway Passenger Cars," Association of American Railroads, First Progress Report, April 4, 1950.
5. "Dynamics of 'Shimmy' in Passenger Car Trucks," by S. G. Guins, ASME Paper No. 50—SA-21.
6. Address by E. G. Budd, Jr., Proceedings of Interim Business Meeting of the American Association of Passenger Traffic Officers, New York, N. Y., 1957, pp. 18—21.

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USE OF WAITING ROOMS BY WOMEN

Women passengers travelling third class are in future to be allowed to use waiting rooms which are at present meant exclusively for those travelling in higher classes.

According to a directive issued by the Railway Board, at stations which have only one waiting room for female passengers, third class female passengers will be allowed to share it with passengers travelling first and second. At stations where two waiting rooms are provided for ladies travelling by first and second classes respectively, the latter will be thrown open to third class female passengers also.

At places where the former inter class waiting rooms were converted for other use after the abolition of inter class, wherever possible, these will now be reopened for the use of third class female passengers.

The SCAMMELL "SCARAB" Mechanical Horse

By A. C. Bhattacharya, A. M. I. P. E.

WHEELS signify movement with economy of effort—a phrase which suggests modern mechanical handling and transport—the strong arms of any big undertaking.

Rationalisation is the order of the day. In an epoch where, by rationalisation, the efficiency of all undertakings is being increased and manpower to the largest extent superseded by machine work, the transportation problem, by necessity, calls for a solution under new aspects. Specially in undertakings where bulk materials have to be handled as for instance in railways for collection and delivery services, a solution of this kind becomes pressing.

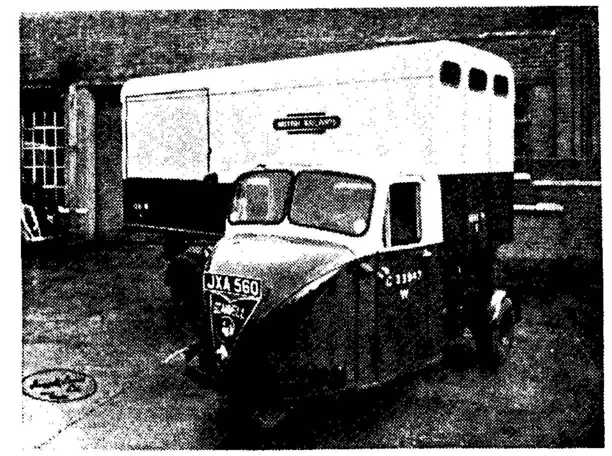
In workshops also, be it of the railways or others, where it is a question of more production per man, method in movement is vital. Goods and materials must pass through the workshops smoothly with ease and minimum time so that maximum manpower is freed for productivity.

Since its inception in 1933, the Scammell Mechanical Horse, which was designed in the first place to do the job of the draft horse on railway collection and delivery services and to do it quicker and with greater economy, has established an excellent reputation for all round efficiency and economy in this field of movement. With its extreme manœuvreability, versatility, and interchangeability of trailers, the Scammell "Scarab" which is a development of the original Scammell Mechanical Horse, provides a swift distributive service unequalled by any other form of road transport.

Specially designed for long service on short-haul work, the 'Scarab' Mechanical Horse vehicles with their instantly and automatically coupled semi-trailers are doing outstanding jobs in railways, government departments, municipalities and loading transport operators throughout the world.

OUTSTANDING ADVANTAGES

Amongst the outstanding advantages of the Scammell system are the instantly and automatically coupled trailer/tractor combinations. The interchangeability and instantaneous coupling gear as well as the ingenious turntable device fitted to the trailers, permit operators to run a series of trailers in an efficient shuttle service, usually on a ratio of 3 trailers to each mechanical horse. The operator, therefore, is getting the use of the equivalent of three lorries at the running cost of one, resulting thereby in a considerable saving in time, labour and overhead charges.



'Scarab' Mechanical Horse with box body semi-trailer in extensive use with the British Railways.

Not only is the coupling and uncoupling, and the connecting of the brake gear, carried out automatically but it may be effected with the two units at an angle or on uneven ground. It is due to this articulation that the motive unit and its trailer can turn in less than its own length and can manœuvre into positions unaccessable to any other type of vehicle, with the utmost ease. That the steering is effected by the single front wheel, which is provided with a castor action, also plays a vital part in the amazing manœuvreability, as it enables the motive unit to turn at a right angle in either direction. With a 15-foot trailer, the 'Scarab' can turn round in 19 feet, an asset which is used to full advantage in threading in and out of heavy traffic.

A shuttle service permits one trailer to be en-route while one trailer is being unloaded and the other loaded. Consequently there is no waiting time which occurs when operating the normal lorry system. The motive unit, that costs the most, is thus kept usefully employed for the maximum working time, thereby reducing overhead expenditure and eliminating drivers' standing by time whilst loading and unloading.

COUPLING GEAR

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

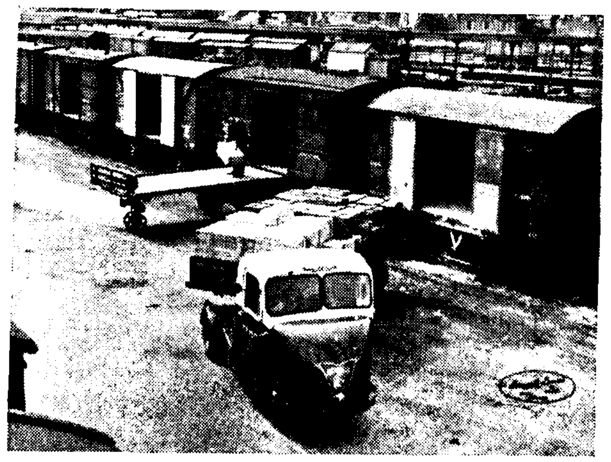
The engine, clutch, gear box and driving axle of Scarab tractor are built on unit construction principle. In 3-ton model, the engine develops 34 H. P. at 3,200 r. p. m., whereas in 6-ton model, the horse power developed by the engine is 45 H. P. at 3,200 r. p. m. For 6-ton model Scarab, Perkins P4 Diesel Engine may be fitted alternatively. These units are purpose-built to specification with capacities ranging between 3 and 150 tons.

The petrol tank has a capacity of 14 gallons and a mechanical pump is fitted on the engine. The gear box has four forward and one reverse speed and all ratios except reverse and first are engaged by dogs. The back axle is of double reduction fully floating type.

BRAKES

Application of brakes on driving axle is by means of foot pedal and the action is one of mechanical. Brakes on trailer axle are by means of a vacuum servo on the tractor. Balance between tractor and trailer brakes is assured by the use of a large diameter control valve. A vacuum reservoir is provided. Trailer handbrake applies brakes on trailer by means of a slipper and bell crank lever on coupling gear.

The cab is of all steel construction. Pressed steel fabricated sidemembers of channel section are down



3-ton "Scarab" and 15' flat platform semi-trailer with slatted headboard leaving the railway siding with loaded goods. Another such semi-trailer backed into position for loading materials is also seen in the picture.

swept in the middle to give low floor height in the cab. Except for the front intermediate which is channel, all cross members are tabular and bolted in position. The front suspension is by coil spring totally enclosed and immersed in oil. Spring movement is damped hydraulically.

The steering is of skew gear type with enclosed steering shaft and 16" steering wheel having a ratio of 12.5 : 1. Hand starter is provided in addition to electric starter.

ELECTRICAL EQUIPMENT

The electrical equipment comprises a 12-volt starter and 75 amp. hr. battery. Other accessories are an electric windscreen wiper, horn, one headlight, two rubbolite sidelamps, two rubbolite tail lamps and lucas coil ignition with engine governor and built-in suppression.

The range of trailers includes tanks, tippers, drop frame trailer, pole trailers, etc.

The many outstanding features of Scarab Mechanical Horses are being fully exploited by the British Railways with a fleet of over 17,000 of these horses and approximately 35,000 semi-trailers. Many hundreds are also being used successfully by the railways of Ceylon, East Africa, Malaya, Ligeria, Sierra Leone, Rio de Janeiro, etc.

In India, hundreds of these units have been purchased by the municipal authorities who have found them highly successful and economical. Tests carried out by them go to show that the Scammell Scarab and Trailer cost on an average per ton mile six annas and six pies as compared with ordinary tractor and trailer at eleven annas and six pies per ton mile. Durability and minimum maintenance cost are the other attractive features which are making these units so popular.

An old saying has it that *look after your minutes and the hours will take care of themselves.* With Scarab Mechanical Horses every minute is an operating minute and 60 operating minutes in every hour with almost no idle time.

ACKNOWLEDGMENTS

The author wishes to make acknowledgments to Messrs. Scammell Lorries Ltd., Watford, Herts, U.K. for supplying the photographs for illustration purposes.

RAILWAYS TO INTRODUCE EIGHT-WHEELER WAGONS ?

A move is afoot, according to a newspaper report, to introduce eight-wheeler goods wagons on the Indian Railways in an effort to increase track capacity.

Foreign countries with long distances like United States, Canada, USSR and China have already switched over to eight-wheeler wagons, which carry more than twice that of the conventional four-wheelers existing on Indian Railways.

CENTRE-BUFFER COUPLER

To speed up operation and avoiding collisions the introduction of Centre Buffer Coupler, which is already in use in Russia, China, the USA and other countries, is being considered. The advantage of this coupler is that it is automatic and wagons when shunted—against each other link up automatically. The centre buffer coupler can also stand greater strain, facilitating the haulage of heavier and longer freight trains.

Other improvements thought of, include the installation of the electrical hump for the process of breaking up and remarshalling and mechanical loading.

* * *

INCREASING SCOPE OF RUBBER RAIL PADS

The Annual Report of the Natural Rubber Development Board, just published, highlights the laying of rubber rail pads " in very large numbers " carried out in various parts of the Commonwealth during 1957.

The Report continues : " In South Africa, following a successful trial, 400,000 rubber pads were ordered for use with concrete sleepers. In Australia, New South Wales Railways are using regular supplies of pads and intend gradually to introduce these to the majority of the track which they control, whilst the Queensland Railways are to commence experiments with rubber pads in connection with their electrification scheme. Following close liaison with New Zealand Railways there seems every prospect of large-scale use in that country."

In the more general engineering field the Board's policy has been " to stimulate new developments in conjunction with the British Rubber Producers' Research Association and to issue basic information to engineers on established uses where natural rubber is pre-eminent."

* * *

LOCO COMPONENT WORKS NEAR BANARAS

The Indian Railway Locomotive Components Works at Manduadih, near Banaras, is being constructed at a cost of nearly Rs. 4.8 crores. Located on 350 acres of land including a staff colony near Manduadih, an important railway transhipment yard on the North-Eastern Railway, the workshop will be constructed entirely by Indian engineers. It will employ about 2,500 persons when in full production.

The workshop will manufacture parts for both Broad and Metre gauge locomotives. A training centre with the first batch of 80 trainees is expected to begin functioning within the next few months, and teaching staff for it is now being recruited. A major portion of the land required for the project has already been acquired.

Laval Sleepers for Railroad Construction

RAILROAD traffic today is of primary economic and industrial importance throughout the world but by the same token requires increased speeds, loads and density of traffic. The possibilities for further increases largely depend on the quality of the track which is a determinant factor in the safety of operation and of the comfort of the passengers.

Until recently, further developments in railroading encountered serious limitations in the design of the present-day track construction. Although the characteristics of the ideal track have long since been defined in detail, they seemed in practice incompatible with each other. Railroad track should present all of the following main characteristics:

1. It should be stable = The stability of track essentially depends on its weight per linear meter and of the seating and bedding in the ballast.

2. It should safely permit the use of welded rails = Safety is greatly increased, particularly in curves, by any improvement in stability.

3. It should permit insulation of the rails in a positive and simple manner = Automation of traffic and utilization of automatic block signals are not possible unless the rails can be insulated perfectly.

4. It should require only minimum maintenance = Maintenance is a heavy item in operating charges. The greater the stability of the track and the longer the life of its components, the greater the reduction in maintenance costs.

5. It should be easy to install = Track installation should be possible rapidly and permit the utilization of more lightly constructed base-courses and of short radii of curvature together with a minimum of always costly ballast. Track components should lend themselves to simple and standard methods of manufacture.

The standard track with wooden cross ties gives good results but is rather light which results in considerable maintenance work and does not make it possible to appreciably exceed present-day speeds and loads. Concrete cross ties are heavier and give greater stability to the track but have the disadvantage that they are difficult to insulate and therefore cannot be used on track equipped with automatic block signalling.

The French National Railways (SNCF) have solved these problems by departing from tradition and reconsidering the construction of railroad track on the basis of modern requirements and materials. Their solution has been baptized the "LAVAL Sleeper Track" and consists of a continuous file of broad slabs supporting the rail which rests on rubber sole plates. The rails are held at the proper distance by a separate bracing member between two successive sleepers. This design provides the following main advantages:

1. *Greater Stability* = The weight of the track is 600 kg. per meter compared to 200 kg. for wooden and 400 kg. for concrete cross ties. The seating surface is twice that obtained with cross ties. The bedding is provided by four continuous sidefaces (the longitudinal clearance between sleepers is only 20 cm.)

2. *Greater Safety* = The exceptional stability of the track makes it possible to use welded rail sections with a length of 2,400 meters in conjunction with Laval sleepers, although the standard length in France for such sections on cross ties is only 800 meters.

3. *Simple and Positive Insulation* = It is only necessary to insulate the separate braces which is done by interposing a plastic shield between the rail flange and the brace ends.

4. *Great Savings in Maintenance Costs* = The greater distribution of load through the broad sleeper places less strain on the track and keeps it remarkably long in position. The sleeper is monolithic and affords a greater surface for wider distribution of load so that it should have a very long useful life. Although no practical data are as yet available, the latter should be double that of a cross tie to judge from experiences with reinforced concrete.

5. *Savings in Construction Costs* = Installation of the track presents no special technical difficulties. The distribution of load permits basecourses to be constructed more lightly. The high weight of the track and the double bedding in the ballast makes it possible to use shorter radii of curvature, particularly for welded rails. The minimum radii of welded track curves in France are presently 800 meters when laid on wooden cross ties, 700 meters on concrete cross ties and 500 meters on Laval sleepers. The amount of ballast required is reduced by 30 to 50% from that necessary for cross ties. The track components are adapted to simple and standard methods of manufacture.

Laval sleeper track consequently seems to be the solution corresponding to the existing problems. However, since the design constitutes a radical departure from standard methods, the French National Railways (SNCF) have carefully tested it on different types of lines before definitely adopting it and proceeding with large-scale installation. The Laval sleeper has been practically tested over a period of ten years and about 60 miles of track have been laid with it. The period of experimentation is now terminated and large contracts are being negotiated for equipping the most heavily travelled and fastest lines of the French railroad system with the new sleepers.

Very recently, installation has been begun on the Paries-Le Mans line which carries trains at a speed of 140 kilometers per hour and daily loads of close to 50,000 tons. Laval sleepers are also being utilized on the Paris-Basel, Paris-Toulouse, Paris-Granville and other lines.

Second Railway Bridge on Yamuna

The field work of the final location survey of Ghaziabad-Tughlakabad rail link via second Yamuna bridge had been completed and the Northern Railway Administration are just finalising the report and estimate. It is, therefore, too early to say anything about the location of the bridge, details of other works and the estimated cost of the bridge.

This was stated by Shri S. V. Ramaswamy, Deputy Minister of Railways, in a written reply to a question by Shri Ram Krishnan, Sardar Iqbal Singh, Shri Bibhuti Mishra and Shri D. C. Sharma in the Lok Sabha.

The Manufacture of Parkson Plain and Universal Millers, Sunderland Gear Planers, Dividing-Heads, Gear Testers and Vises

(Continued from IRE / July 1958 - Vol.6 No.1)

[II]

ABMTM MEMBERSHIP

TOWARDS the end of the war, when thoughts were turning to post-war manufacturing problems and the possible conditions of trade, J. Parkinson & Son accepted an invitation into membership with Associated British Machine Tool Makers Ltd. and Ernest Parkinson later became chairman for the period 1925-27. In joining this newly-formed selling organisation they undertook to concentrate upon the design and manufacture of plain and universal milling machines, Sunderland gear planers and gear testers—a policy of specialisation which has been adhered to continuously now for 40 years.

In 1923 Ernest Parkinson took into partnership his two sons Edward and Harry and in 1949 the firm was reconstituted as a private company under its present title J. Parkinson & Son (Shipley) Ltd. The change to specialisation resulted in a steady development in the design and manufacture of millers, gear planers and testers, though during the 1939-45 war the Company's energies were devoted almost entirely to milling machines. Ernest Parkinson took a very active part in the control and direction of the business he had done so much to develop, up to a few days before his death in 1953 when almost 84 years of age.

RECENT DEVELOPMENTS

In 1954 the Company's shares were acquired by Croft's Engineers (Holdings) Ltd., the well-known power transmission engineers, and Mr Norris Butterworth joined the board of directors, with Edward and Harry Parkinson acting as joint managing directors. Under the new board, and with the active interest of Sir Arthur Croft chairman of the parent company, building extensions and alterations, begun late in 1954, progressed up till early in 1957. The principal items involved in these changes were :

1. Erection of three new fitting bays, all 200 ft. long, one 35 ft. wide and two 27 ft. wide, each served by a 10-ton overhead crane and equipped with trunking system for power supply.

2. Erection of light machine shop (area 8,000 sq. ft.) to concentrate under one roof facilities for making Sunderland gear cutters ; also a new heat-treatment shop.

3. Erection of three new bays, each 33 ft. wide × 146 ft. long, for layout of pattern shop, pattern stores and a special equipment fitting shop.

4. Demolition of absolete property partly used for pattern storage. Building and equipping of mechanised bay for foundry (approx. 8,000 sq. ft.) on this site ; also modernising foundry facilities for changing, washing and shower baths.

5. Demolition of tall brick chimney near centre of works, demolition of walls, and re-roofing to enlarge the vise department.

6. Installation of new boiler for space-heating additional shops, and conversion of heating system to steam-heated electric unit heaters.

7. Re-organisation of general machine shop layout, eliminating absolete machines and power transmission arrangements, extending busbar system and installing new machine tools.

8. Connect up to additional Grid power supply, increase transformer capacity and install new mains switchboard.

The carrying out of this heavy program virtually involved the re-wiring of the whole works for both light and power, and necessitated the moving and re-siting of hundreds of machines. Although outside contractors undertook the building and certain other items, the alterations and extensions imposed considerable extra work and strain upon both management and men. Thanks to loyal co-operation on the part of all concerned, the various moves were accomplished with a minimum of disturbance to normal production.

Retirement benefit pension schemes introduced for works personnel and staff are now well established; also every encouragement is given to investors in the National Savings movement.

Established many years ago, a works Sick Benefit Club, operated by its own elected committee, continues to be a sound and valuable part of the Company's welfare activities.

Minor injuries sustained during working hours are dealt with by a full-time qualified attendant in the First Aid room; also the Works Medical Officer holds private consultations at regular twice-weekly visits.

The Canteen, recently enlarged and redecorated, has a main dining room and separate rooms for foremen and other staff.

The employment and training of apprentices is dealt with on a regular basis and every encouragement is given for attendance at courses run by local technical colleges.

PRODUCTION PLANNING AND CONTROL

In arranging the production program of each component the production engineer and planning engineer are jointly responsible for the sequencing of operations, methods of production, choice of tools, jigs, gauges and other equipment, and they also decide how and where each job shall be done.

When determining the processing of any part the planning engineer first makes out a rough sequence of the operations, selecting standard tools, gauges and equipment where available, writing out in detail the operations step by step. From this sheet the first batch of work is processed through the shops and any amendments or additions are made as the work progresses. Where necessary an Operation and Tool Setting Layout is drawn up to help machine operators in setting up their machines. It will be noted from this sheet that each tool is shown diagrammatically in its correct position. This method of layout is readily completed by clerical assistants once the planning engineer has supplied the essential data. Working on tracing form No. 2A the planning engineer only needs to enter the elements of operation giving the feeds, speeds and numbers of cuts, and then he indicates by code numbers on the right-hand side of the sheet which tools he requires at each station.

A Standard Tool Chart is provided showing all the possible tools that may be used on the conventional combination turret lathe. By placing the stencil on this chart a clerk can trace the outline of each tool in its appropriate position by its code number and ultimately build up a pictorial diagram of tooling to give a visual presentation of the set-up also. This is specially helpful in the case of semi-skilled machine operators and eases the supervision required on the work. It will be appreciated that the time per piece can easily be calculated from the feeds, speeds, number of cuts and other data given.

A similar procedure to the above is adopted for some of the fitting operations.

The basis of production control is a forward program for each major product. This, recorded on graphdex sections, shows delivery promises, batch quantities and the progress of all batches, and indicates the program requirements for a considerable period ahead. Progress against each batch is shown under the headings of date of issue, castings, machining, pre-fitting and final assembly.

Delivery dates are clearly shown on the forward program so that any enquiries regarding delivery can be dealt with immediately from these charts. Details are ordered by production control from a parts list which is arranged in the form of units and sub-units, for example :

No. INA Milling Machine.

Unit 1—Column.

Sub-units—A. B. C. D. E.

A list of standard detail parts is kept of each subunit. Bought-out parts are ordered to standard schedules from the forward program. For each manufacturing batch a production schedule giving the order of priority is first issued to the foundry, so that the foundry staff can record progress.

For machined parts planning sheets and job time cards are issued in line with the machine production program, clearly indicating when the issue of all sub-units must take place. The object is to co-relate the movements of all parts, to facilitate the starting of sub-assemblies and final assembly on pre-determined days and to proceed without delay to the completed machine.

PROGRESS

When the manufacture of a batch of machines or special equipment has been authorised, the drawing office issue :

1. Full set of lists of parts (printed in black and white).
2. For finished parts stores ; list of parts.
3. For pattern shop ; list of c. i., phos. bze., al. parts and forgings.
4. For castings stores ; list of c. i., phos. bze., mall. iron, c. steel, al. parts and forgings.
5. For finished parts stores list of (quantity) component parts.

All the foregoing lists when issued indicate the quantity required under each reference number. The drawing office also issue a complete set of detail drawings relating to each batch part, the blueprints bearing the order or batch number and the quantities required.

All the above lists together with a set of job card. (copied from Ormig masters for each operation on every part) are sent to the progress engineer who then passes on a cast-iron list to the pattern shop and foundry. This list, marked up to indicate priority and the number of castings required in the machine shop, enables the pattern to be issued to the foundry with the required number marked on it.

Each job card shows the number of the batch, the material from which the part is made; also the operation and instructions how to proceed with the job. Different coloured cards are used for each machine and to distinguish replace or repair parts, shop work and other jobs not covered by batches. Progress office copy the operations of each part on the list of parts opposite the reference number. The job cards are then sorted and the first operation card is put with the detail drawing of that part.

The priority of batches and any other work is determined by the production planning engineer who, works in close liaison with the progress engineer.

The first operation card and drawing for cast-iron, aluminium, phosphor-bronze or forging are sent to the castings stores. The first card and drawing for bars to be sawn off go to the bar stores, while the first card and drawing of all other parts are sent to the foremen of the departments in which the first operations will be done.

Meanwhile the castings stores clerk having received the castings from the foundry, issues the first card and drawing and the required number of castings to the machine in the department where the first operation will be completed, and hands the card and drawing to the foreman of that department.

The foreman passes on the card and drawing to the operative who is to do the first operation.

When the operative has completed his previous job he takes the first operation card of the new job to the progress office to clock off the previous job card and clock on the first card of the new job.

The progress office clerk then removes a section of the job card which shows the batch, drawing and reference number of the job, looks out the appropriate list of parts and the reference number, and stamps the date in the top half of the space provided to the next operation. This denotes to the progress engineer that work on the job has been begun.

When the operation has been completed the workman clocks off the card at the progress office where the card is stamped with the date in the bottom half of the space provided next to the operation. This denotes to the progress engineer that the first operation has been completed and the card for the next operation is issued to one of the materials collectors in the progress section.

The collector, having the card of the first operation, takes the parts from the operative to the inspection department where, after approval of the parts, the card is signed by the inspector and handed in to the cost office for costing purposes. The collector then picks up the job card for the second operation and takes this card, drawing and material to the department where the next operation will be done.

If a part is rejected by inspection department the card and drawing are returned to progress office, who then issue a replace card stamped to indicate the number of the department which was responsible for the rejection.

If the remaining quantity of parts passed by inspection of the above part are not urgently needed the parts will be stored on a replace shelf in the progress department until the replace part is made, when the whole set of that reference will proceed to the next operation. This routine procedure has been adopted to avoid the expensive alternative of putting a single part through the whole sequence of operations by itself. No operative is allowed to clock off one job card without clocking on to another. When the last operation of a batch has been completed, the last card (which indicates next operation stores) is sent to the progress office and a separate card showing the number required and number received is issued to accompany the finished parts to stores.

The card is then stamped "Received in Stores" and on it is entered the number of parts for that reference received ; the stores list of parts is also marked up to show that the parts have been received. The whole batch remain in the stores until instructions are issued for passing the parts to the assembly department for erection.

Parts made in *quantity batches* may be from 36 to 300 in a batch, the most useful quantities being 60 and multiples of 60, as these numbers lend themselves readily to calculations involving hourly rates and performances. Quantity batches are set in motion in a similar manner to ordinary batches.

In the finished parts stores a set of record cards is kept of all quantity parts. On these cards are entered the number of parts sent out to each batch and the minimum stocks allowable.

(To be continued)

Bombay Regional Railway Equipment Advisory Committee Meets

The fifth periodical meeting of the Bombay Regional Railway Equipment Advisory Committee was held on 3rd September, 1958 at the Headquarters Office of the Central Railway under the chairmanship of Shri B. Arora, General Manager. This Committee was formed last year for t e purpose of recommending development of new capacity and utilization of spare capacity for the manufacture of Railway stores and thereby attain self-sufficiency in Railway equipment.

The third and fourth reports of the Standing Sub-Committee in regard to utilisation of idle capacity were discussed. Details of procedure for placement of orders on such firms were also finalised. Accordingly, machining capacity with firms at Secunderabad is expected to be utilised for final finishing of certain interlocking fittings produced in the Railway Workshops at Mettuguda.

Development of new capacity to manufacture Line Clear Token instrument, Grease Guns for soft and hard grease and a dozen key items for Electrical Signalling items constituted the other important items of discussion. The Director of Signals and Tele-Communication would be visiting Bombay shortly and he would be available for consultation, examination of drawings and specifications and other matters with firms who are interested in the manufacture of these items. In the second week of October, samples of the Electrical Signalling items would be exhibited at Byculla in the Central Railway's Signal Workshop for the benefit of manufacturers of electrical apparatus who could undertake development of Signal items.

* * *

SUPPLY OF ELECTRIC TRAINS TO INDIA

Shri Shah Nawaz Khan, Deputy Minister for Railways, replied in the affirmative to a question by Sardar Iqbal Singh in the Lok Sabha whether an agreement had been signed between India and a Switzerland firm for the supply of electric trains to India.

The Deputy Minister in a written reply said that a contract was placed with the Swiss Industrial Co., Newhausen, Rhine Falls, Switzerland, for 16 three-coach units and 1 spare motor coach. In all 17 motor and 32 trailer electric multiple unit coaches (Broad Gauge) were ordered at a cost of £ 1,190,117. The contract amount included spares and drawings. The delivery was completed by November 1957.

Factors Affecting the Coal Consumption in Locomotives

By

Sunil Chandra Banerjee. G. I. Mech. E. (Lond.), A. M. I. E. (India)

COAL consumption is a primary factor in the Railway Finance and during these hard days this important point should be examined very carefully for efficient and economic working of the Railways. Although the suburban services of the principal railway stations of our country are electrified, steam locomotives have prospects for many times to come. In tackling the problems arising out of the coal consumption, the following points should be carefully noted.

(1) *Superheating for suburban locomotives* :— Superheating of locomotives means an additional expenditure on superheating accessories and the cost of maintenance; but there is 3% coal superiority over the saturated locomotives, and this represents a saving of about Rs. 1000/- only per locomotive per annum. In case of the suburban services, however, for a locomotive of 60 miles a day the average mileage is about 21900 miles requiring a coal consumption of 905 tons @ Rs. 28/- per ton totalling Rs. 25340/- per locomotive. The average coal consumption per vehicle mile is 4.19 lbs. with an average load of 12.1 vehicles per train. Saving due to superheating is 3% over the saturated locomotives. There again, the question of maintenance of the superheating comes in (which is about Rs. 400/- per year) and the superheated locomotives must save at least 40 tons of coal per year over the saturated locomotives in order to have economic use of the superheating accessories.

(2) *Effect and mileage* :—The above account appears to be a guiding factor in determining the coal bill. It can easily be ascertained from the above that the minimum daily mileage of a superheated locomotive should be about 130 for the economic use of the superheaters. Anything less will show a loss and anything more a profit of 2.15% over the expenses on coal of a similar use of saturated locomotives. It is, therefore, apparent that in the services requiring higher coal consumption per vehicle mile, correspondingly less mileage will produce similar financial savings for equal percentage saving of fuel.

(3) *Effect of speed* :—It has been found by actual trial in a saturated locomotive that the coal consumption with a load 20% less than the average is 82.6 lbs. between a speed range of 35 m. p. h. and 45 m. p. h.; while same locomotive with the same load was found to consume 94.2 lbs. of coal between a speed range of 25 m. p. h. and 35 m. p. h.

In actual practice the locomotives of fast services are usually put in slow ones after the attainment of certain mileages. It is, therefore, probable that engines in equally good condition could haul existing heavy gross load on the slow service for less fuel than the existing comparatively light gross loads on the fast service. The increased speed schedule is an expensive proposition; and it should always be determined whether the revenue earned from the proposed increased speed traffic will be economic for the increased cost of running trains on such schedule.

(4) *Effect of Tare* :—The weight of the locomotive has a direct effect on the adhesion, friction and efficiency. By comparing the performances of two locomotives of 2—6—4 and 4—4—2 types a difference of 12% was obtained in favour of the 4—4—2 type. The 2—6—4 locomotive costs the administration a matter of 13.67% or about Rs. 2800/- as represented in coal more than the 4—4—2 type for performing the same work annually. Some economy can be obtained by superheating the 2—6—4 type locomotive, but the easiest way to economy is the reduction of weight of the locomotive. The 2—6—4 locomotive is designed for suburban services and a reduction in weight will be helpful.

The modern tendency is not to increase the load, but to increase the speed and frequency. The load should not exceed 12 vehicles.

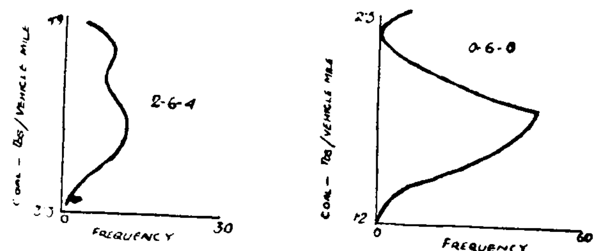


FIG. 1

It is always economic to design the suburban locomotives specially for this purpose. These locomotives should have long cranks with comparatively shorter dia. of the coupled wheels for more mechanical advantage. The boiler should not be too heavy but the steam raising power should be high. The tender should not be too large, and the locomotives should preferably be superheated to have a high steam value.

(5) *Effect of load:*—The load hauled by a locomotive has a very important effect on the coal consumption. As such, unproductive train-loads should be minimised. Although economy can be obtained by superheating the locomotives, superheating is not very productive for light loads. For a 0—6—0 loco, every effort should be made to increase the train load upto a minimum of 60 in order to obtain the reduced haulage charges. The load for a passenger loco is more or less constant but the goods loco requires correction. The superheater loco demands a correction of the records to a standard basis, say 50 vehicles.

For load of 38

coal consumption / vehicle mile = 1.95 lbs.

For load of 54

coal consumption / vehicle mile = 1.70 „

The procedure is this :—

Multiply the actual readings by the normal results for 50 vehicles and divide by the normal results as shown in the curve for each of the loads requiring correction. In the above cases we get,

For 38 vehicles $\frac{1.95\times1.70}{2.075}=1.60$ lbs. / vehicle mile corrected to 50 vehicles basis.

For 54 vehicles $\frac{1.70\times1.70}{1.65}=1.75$ lbs. / vehicle mile corrected to 50 vehicles basis.

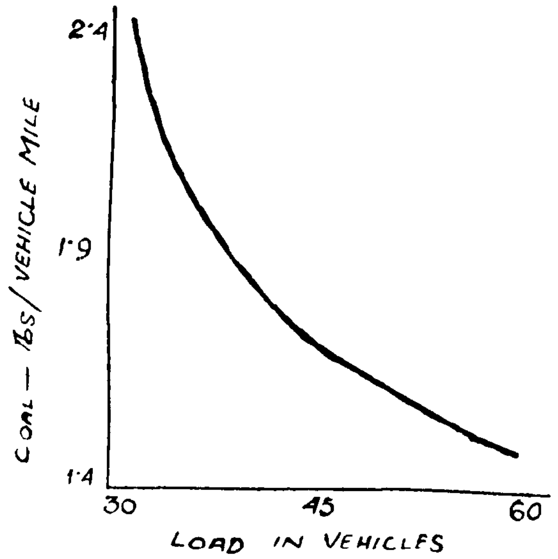


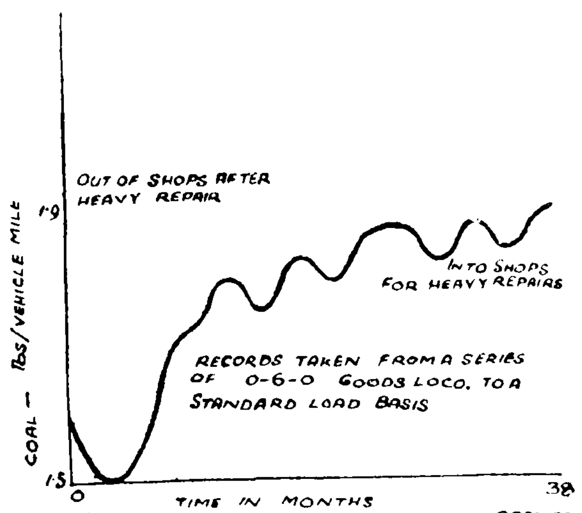
FIG. 2

(6) *Effect of superheating goods locomotives:*—The steam consumption in Goods locomotives is very high ; as such, a high specific volume by superheating the steam is very helpful. With average loads economy amounts to 12% on coal consumption as compared with saturated locomotive performance. This amounts to about Rs. 4000/-in fuel per year for each locomotive in question taking a daily mileage of 80 for this calculations.

(7) *Fuel economy in different services:*—By figuring out the comparative results for the passenger, suburban and Goods links we may have some idea of the general trend of facts. Assuming a constant cost of maintenance, fuel per ton mile and percentage fuel savings for each of these services for convenience, the factors most seriously affecting comparison will be average loads, average fuel consumption and average fuel consumption per vehicle mile.

	Passenger	Suburban	Goods
Gross load in vehicles	29	22	56
Coal consumption lbs/vehicle mile	2.7	4.1	1.9
Relative financial value of equal percentage fuel savings	1.00	1.15	1.36

(8) *Effect of Acceleration and draught on coal consumption:*—High rates of acceleration are a commercial necessity. High draught, high rate of combustion and low equivalent evaporation are concomitant. Spark losses within limits can be controlled and the simplest method of reducing these losses is by using coal in good physical condition. There must be specially selected coal for the suburban services as there is for the express locomotives. The draught should be uniform. Large smoke box and fire box volume will damp out heavy fluctuations in draught; but large grate are a will assist in reducing the rate of combustion per square foot of grate area.



COAL CONSUMPTION BETWEEN HEAVY REPAIRS
FIG. 3

As shown in fig. 3 these striking results have a very prominent and direct influence upon locomotive performance particularly where poor facilities are provided for maintenance. This deterioration which can be very rapid and cumulative unless checked by proper attention, is a source of possible heavy loss which merits the most unremitting vigilence on the part of those concerned with its prevention.

(Continued on page 46)

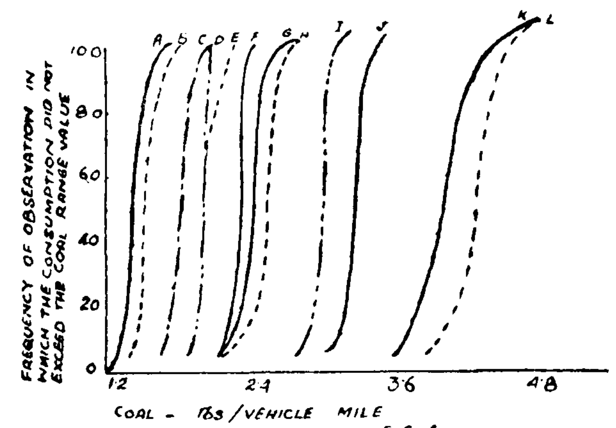


FIG. 4

A—Goods 0—6—0 superheated
B—Goods 0—6—0 saturated
C—Express 4—4—0 superheated
D—Express 4—6—0 saturated
E—Express 4—4—2 saturated
F—Fast passenger 4—6—0 saturated
G—Fast Passenger 0—6—0 superheated
H—Fast Passenger 4—4—2 saturated
I—Tank 4—4—2 saturated
J—Tank 2—6—4 saturated
K—Tank 2—6—4 saturated
L—Tank 2—6—4 saturated

It can be seen from fig. 4 that the main object to be kept in view is not only the lowering of the means, but the general flattening of the curve to a minimum.

(9) *Incidence of expenditure in running sheds:*—The whole expenditure in a running shed can be divided in the following heads—

(a)	Fuel	—49.52%
(b)	Staff—	
	(i) running	—21.88%
	(ii) shed	— 7.78%
(c)	Supertendence & Office	— 4.96%
(d)	Maintenance and spares for locomotives	— 4. 9%
(e)	Oil and other consumable stores	— 3.74%
(f)	Water	— 2.78%
(g)	Machineries	— 1.04%
(h)	Miscellaneous	— 3. 4%

POWER FOR RAILWAY SIGNALLING

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

NEARLY 120 years ago the first electrical device was introduced to railway signalling and communications. This was the Cooke & Wheatstone telegraph accepted by the Great Western Railway for use between West Drayton and Paddington after having been rejected by other railway companies. Its success led to the development of various electro-magnetic devices for train signalling instruments and indicators. This apparatus had no power problems for the various coils only needed a few milliamperes for their operation and the current was supplied by some form of primary battery.

The actual operation of points and signals by electrical power started in about the early twenties. Before this they were worked by compressed air, electrically controlled though there were a few instances of hydraulic operation. The use of compressed air for railway brakes and signals was introduced by George Westinghouse. By 1890 he had been successful in the installation of air brakes on railway trains and he decided to use a similar method for working railway points and signals. The first electro-pneumatic power signal installation in Great Britain is at Granary Junction, Great Eastern Railway, opened in 1899. This was followed by extensive installations on the newer tube lines and the District Railway from 1905 to 1907.

Power installations are understood to be those where all points and signals are operated by either the all electric method (points driven by electric point machines) or electro-pneumatically. In the early electro-pneumatic installations the magnets on the point valves were d. c. working on 12 Volts. This power was supplied from secondary batteries in the signal cabin on trickle charge through resistance from d. c. mains. In course of time a. c. supply displaced d. c. on account of the ease with which the voltage could be stepped up and down by means of transformers. The conversion of electro-pneumatic point operation from d. c. to a. c. meant that the point valves had to be fitted with coils suitable for operation on 110V a. c. which was the standard operating voltage for a. c. signalling. The alternating current coil and iron system had never been entirely satisfactory and in the case of the point magnets there was chattering of the operating parts which meant frequent changing for shop overhaul. The increasing use of metal rectifiers in all industries led to the inclusion of one of these in each point valve permitting d. c. operation of the valve magnet from a line operating voltage of 110V a. c. The power and distribution arrangements for present day signalling systems embodies the best features of the various methods that have been used in the past.

TYPES OF INSTALLATIONS

Power supply arrangements for signalling installations vary with the quantity of electrical apparatus that has to be operated. Although there are many types of installations they can generally be gathered into four classes (a) a mechanical signal box with a few track circuits and signal arm and light indicators etc. (b) an installation of the same type but with complete track circuiting and more electrical instruments and apparatus (c) an electro-mechanical scheme where some of the points are manually worked from the mechanical frame while others are worked electrically. Signals are colour light or electrically operated semaphores and (d) a complete power scheme where all points and signals are electrically operated and controlled from a power signal frame or relay interlocking panel.

With (a) the power requirements are usually satisfied with primary cells each track circuit having its own feed from a primary battery or batteries with other functions worked from similar sources. (b) in this type of installation the signal cabin battery might be of the secondary type trickle charged through a metal rectifier transformer unit. In this case the various functions in the signal cabin would be fed from a common bus bar. The track circuits could be fed from primary batteries and types are available which can feed a track circuit for a year or more before exhaustion. Alternatively a lead acid cell can be used on trickle charge but this method entails capital expenditure on a supply cable through the track circuited area and also the cost of transformer/rectifier charging units.

(c) implies complete track circuiting with all main running signals of the multi-aspect or searchlight type. Where points are worked by all electric point machines they may be d. c. or a. c. though generally the former method of operation is used. The normal operating voltage for multi-aspect colour light signals in 110V a. c. and this is transformed down to the signal lamp voltage of about 12 Volts by lamp transformers in the signal head. If the track circuits are powered by primary cells it may not be necessary to run a signal supply cable throughout the area but only to certain locations for point detection circuits etc. The transformer arrangements at the signal cabin will depend on the kind of power available.

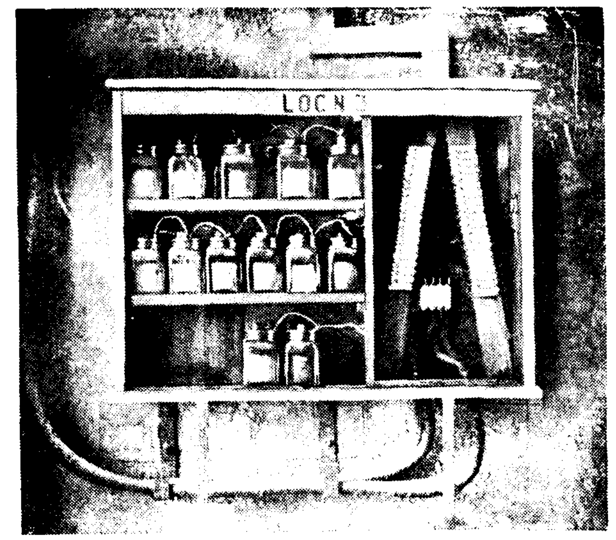
(d) comprises a complete power signalling scheme with all apparatus, track circuits, points and signals energised from a main source of electrical supply. The transformer, switching and other arrangements varies with the size of the installation.

POWER FOR ISOLATED PLACES

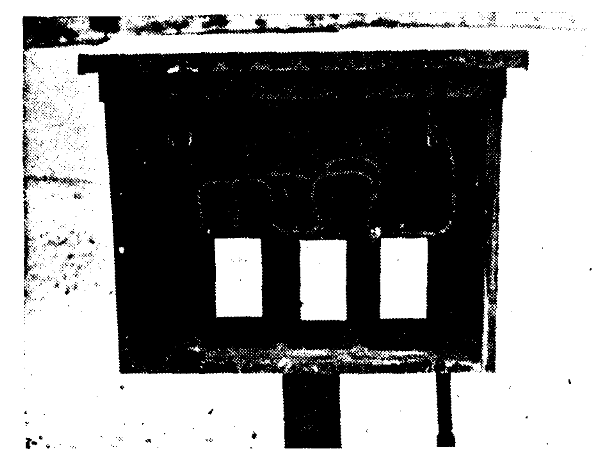
The majority of railway stations in the United Kingdom have an electrical supply or are close to one. The problem of providing electrical power for signalling is greater in up country districts overseas and principally in Commonwealth countries. Generally, in remote parts, single line railway is used with crossing stations spaced according to traffic density or local conditions.

Electrical signalling is often used at these crossing stations and its adoption in overseas countries is increasing. These installations vary from electrical operation of signals to complete track circuiting in station limits with power working of signals and points. Several well known methods of generating power are available for working these installations but the use of primary batteries is still very popular. Several types have been developed to meet the needs of railway signalling and are very suitable for feeding track circuits, signal machines, relay circuits, etc.

The electric signal machine is designed to operate a signal arm from 0 to 45 degrees in the lower quadrant or as a three position signal in the upper quadrant with aspects at 0, 45 and 90 degrees. The arm spindle



Armoured signal cable termination and group of No. 1 Leclanche cells fitted with AD conversion units outside station building. Western Railway, India.



Track Circuit "B" Feed
(Close up view of Battery)
Three cells A. D. 618A connected in parallel.

(Continued from page 45)

It is to be noted that locomotives over due for overhauling should be put off the service and must be repaired without delay; because such locomotives will increase the fuel bill and cost of maintenance. Trial results should be kept in record in order to get the correct information of performances and necessary remedies for defects.

Modern locomotive engineers are in the favour of using low grade coal. As such, pacific boilers with wide fire-boxes additional combustion chambers and improved draught apparatuses are designed. These locomotives require careful cleaning of the boilers and good maintenances of the engine portions. The steam being raised from low grade coal the locomotive requires high thermal and mechanical efficiencies. The shed staff should be carefully trained for cleaning the smoke-box and tubes, in order to minimise the fuel bill.

is worked by an electric motor and gear train and contacts working in conjuction with the motor are arranged to cut it out when the arm has attained the position. A hold off slot retains the arm as long as required the lever or switch controlling the signal is "at clear" or a train passes the signal and replaces it to danger through track circuit occupancy. The average current required by the motor to wind off the arm is about 2 Amperes for about 10 seconds and the holding current 18 to 20 milliamperes. The voltage required varies but for battery operation it is between 10 and 12 Volts. Primary batteries are available with capacities of 1000 Watt Hours and upwards which are very suitable for this type of work.

If searchlight signals are preferred to semaphores there is no difficulty in working them from primary batteries. A special design of lens and lamp produces a highly concentrated beam of light and this indication can be clearly observed up to 3,500 feet. The signal operates in conjunction with what is known as approach lighting so that it is only illuminated when a train has approached within sighting distance of it. This is arranged by having a track circuit about half a mile long outside the outermost signal at stations. The signals are illuminated through this track circuit becoming occupied by the approaching train.

The motors of electric point machines require more current than signal machines and on this account they cannot be operated from a battery unless it is on trickle charge. This difficulty has been overcome by the introduction of the hand generator which provides an economical means of operating points and signals electrically and without the expense of installing and maintaining batteries. The system is only suitable where there are a few points to be operated and traffic is light such as at stations on a single line railway. The circuits for working the point machines may be controlled through contacts actuated by a standard lever in a mechanical lever frame or from a relay energised through a switch on a small control panel.

The hand generator is actuated through a gear train driven by a handle which is turned by the operator. Information is given as to when the points are correctly set and locked by visuals illuminated by the point detection circuits. The operator also experiences a sudden diminution of effort required to turn the handle when the work of the point motor is completed. With the hand generator system it is only possible to drive one point machine at a time and where several machines have to be worked for a train movement the interlocking arrangements prevent the operator from connecting more than one machine at a time. The system can also be used advantageously in a signal cabin where most of the points are close to the lever frame and can be worked manually but where one or two are situated at some considerable distance away. These can be worked by hand generator system thereby saving the maintenance charges and wages of staff required for an additional cabin.

FEEDING SIGNAL LOCATIONS BETWEEN STATIONS

On many railways automatic signals are used and these operate without the aid of a signalman and purely by the action of trains passing over the track circuits that control them. There may be several automatic signal sections between two signal boxes or stations and these signals, and their associated track circuits, need an electrical supply to operate them. If the stations are electrically lit, the lighting mains can be used. On long, single line sections in desolate country, where intermediate automatic signals are necessary between stations, no power supply may be available. In these cases signals and track circuits have to be powered from primary batteries.

In British practice the generally accepted voltage for signalling purposes in 110V and voltages lower than this such as 12, 24 and 30 Volts. The voltage of the signal main supplying a given area or section depends on the load and the length of the section and may be stepped up to the required voltage according to circumstance.

At signal locations, step down transformers are provided for distribution of different voltages for the various circuits to be fed. The main location case houses the signalling relays, fuses, bus bars, terminals etc. and it can also accommodate the main transformer. Where the voltage of the signal main is higher than 110V, the mains power transformer, fuses, etc. is often accommodated in a separate case fixed at the side of the main location case. This separates all high voltage equipment from the rest of the apparatus thereby safeguarding maintenance personnel. Switching arrangements are provided at each station so that a section of main can be isolated in case of a defect.

On some railways, particularly in the U. S. A. power factor improvement is used to increase the efficiency of signal mains. The method used is to connect capacities across the signal mains at places where an inductive load is connected.

POWER FOR LARGER INSTALLATIONS

The amount of power plant required for a large interlocking like York, waterloo, Euston, Paddington, Stratford, etc. is such that a separate power room or building is essential. On British Railways an electrical supply is usually obtained from the British Electricity Authority. If a railway power supply is available this may be taken as a standby or vice versa. Suitable automatic switching arrangements are arranged to bring the alternative supply in should the main supply be interrupted. Power is usually received at 415-V from the electricity authority or, if the same source is used for electric traction, is reduced from the voltage received and supplied at 415-V for signalling purposes.

A signal main is run from the power room around the area controlled from the signal box and it loops into every signal location where a power supply is required. The distribution voltage depends on the distance of the furthermost places to be fed from the power room and the load in between. For short distances a voltage of 110 is used while for larger areas it may be as high as 660-V. The cabin transformers may therefore step down from 415-V to 110-V or step up to 660V. These are arranged to duplicate, one being in service at a time the other acting as a standby. They are changed over by manual switching arrangements and are usually on load for one week at a time.

The voltage of the circuits inside the signal box depends on the type of control apparatus. In the case of a power frame, with miniature levers, operating circuit controllers, voltages of 110 can be used for controlling the signal relays and point control circuits. In relay interlocking installations the controls on signals and points are small rotary switches mounted on a panel bearing a geographical representation of the area controlled, with miniature lights repeating the position of trains on the various track circuits. The voltages handled by these switches is generally not in excess of 12-V and they operate relays governing control circuits of the normal value of 110-V.

The panel control circuits are usually fed from a lead acid battery of 6 cells on trickle charge through a transformer-rectifier charging unit. The power for the point control circuits depends on the type of point operation in use. This may be electro-pneumatic, or all electric a. c. or d. c. In electro-pneumatic installations, the point switches are operated by air motors at

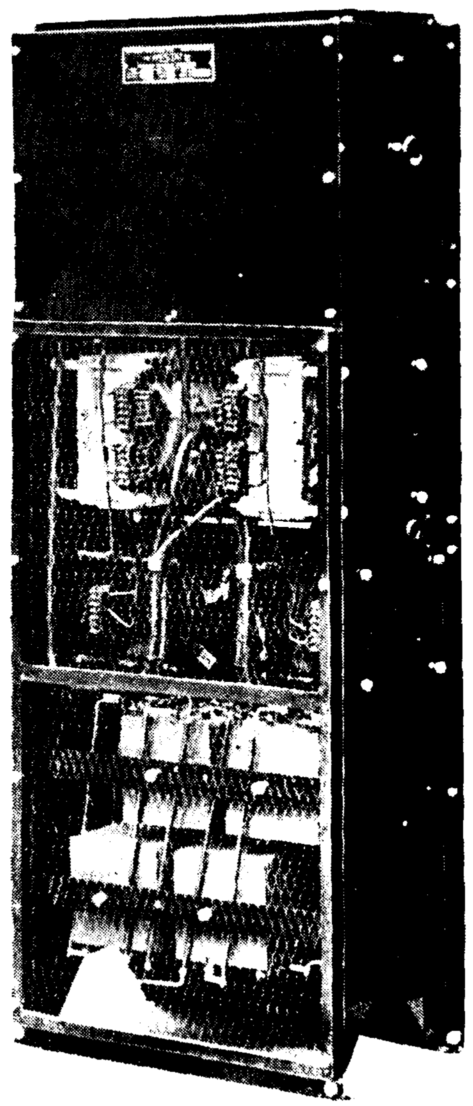
Type SBC. 3 battery charger.

an average pressures of 60 lbs. The passage of air is governed by electrically operated valves energised by normal and reverse contacts on the controlling function in the signal cabin. The control circuit may be a. c. or d. c. but the general practice is to use a. c. with a small rectifier on the point air valve with a d. c. coil for operation. In all electric points the switches are worked by all electric point machines. These comprise an electric motor which actuates the driving bar through a gear train. A clutch is incorporated and cut out contacts for switching out the motor when the work of driving the switches is completed. Both a. c. and d. c. motors are in use though the latter type is probably more popular. These operate from a battery of lead acid cells on trickle charges through a suitable transformer rectifier unit.

The largest relay interlocking installation in the world was opened in the early part of 1951 at York (British Railways). This signal box controls 33¼ track miles and has 317 track circuits. There are 277 power worked points and most of these are electro-pneumatic. The relay room attached to the signal box houses over 3,000 relays. A brief description of the power arrangements for such a large installation will be of interest. Power is received at the signal box by two 660-V single phase feeders feeding a 660-V bus bar through oil filled circuit breakers which are tripped by an over-current time delay relay or reverse current relays in each feeder. From this busbar feeds are taken to the main 660-110-V 35kVA transformers, the 660-110/55 shunt signal lighting transformer and two ring mains feeding north and south of the yard through appropriate switch gear. The two supply feeders to this switchgear may be paralleled and are brought from a main supply contactor and busbars on the control panel in the power house close to the station. An isolating knife switch is provided to direct to incoming B. E. A. feeder direct to the busbars so isolating the control panel and contacting gear for maintenance purposes. The main contactor is energised over a voltage relay connected across the incoming feeder and set to trip the contactor if the voltage falls more than 6% and to initiate the starting of the standby set. There is a time delay of three seconds in this operation to prevent false starting due to switching surges. The standby diesel engine is started up by two starter motors; when the alternator voltage reaches 660-V, the standby contactor is energised and the set takes the load. Eight seconds are required to run up to working voltage. The standby set comprises a six cylinder 1,000 r. p. m. McLaren diesel engine directly coupled to an 85kVA 660-V single phase Lancashire Dynamo-Crypto pedestal bearing type alternator. The main exciter is also directly coupled to the alternator and is provided with a belt driven pilot exciter and an Isonthal voltage regulator. The set starts and runs without attention and will stop should the lubricating oil pressure not build up within a given time from starting, or fail at any time. Once the set has started a return is not made to the main supply until it has been restored and the set is stopped manually.

The air for operating the point machines is supplied by duplicate, electrically driven two stage air compressors, each with a rated output of 200 cu. feet of free air per minute and driven by 40 b. h. p. 3-phase. 375 r. p. m. directly coupled slip ring motors. The operation is automatic and controlled by the pressure in the air storage tank. The main set starts up when the pressure falls to 55 lb. per sq. in. and stops when the pressure rises to 65 lb. If the pressure drops as low as 54 lb—the standby set is then automatically started. A changeover switch permits either set to be on duty as required. There is also an emergency set of similar design to act when there is a power failure. This set can deliver 100 cu. feet per minute and is driven by a 22 b. h. p. two stroke 450 r. p. m. diesel engine.

Another installation in which all electric point



1.2 kW constant voltage charger supplied to Southern Railway. This consists of two 600 watt Westat equipments in series, operating from 220-250 volt 75 c.p.s. single-phase. Output 20 amperes to charge a 480 A.H. battery.

machines are used, is at Potters Bar (Eastern Region). Opened in March 1955 it is one of the largest pattern relay interlockings in the country. All signals are of the multi-aspect type and the points are operated by all electric point machines on a 110-V d. c. supply with a. c. superimposed point detection. The signal box, which is of modern and unusual design, has a separate power room. Power is obtained from the electricity authority at 415-V. 3-phase and is received on the switchboard in the power room. Here it is fed to duplicate transformers and stepped up to 660-V, single phase. The power room also

contains a 30kVA diesel driven generator which automatically takes up the load if the main supply fails. The 660-V supply is fed to cubicle type switchboard in the relay room which contains all the apparatus for distributing the various signal box supplies (except batteries which are housed in a separate room). One half of the cubicle, (screened off from the remainder), receives the 660-V supply, and by means of duplicate transformers and associated control gear delivers 110-V to the other cubicle and feeds 660-V to the outdoor apparatus power cases. The cubicle also accommodates transformer rectifier sets and contactors with the relevant switches, volt meters and ammeters for the following supplies :—

(a) 110-V a. c. for signal lamp feeds, track circuits, relay local coils etc.

(b) 12-V a. c. for illuminated diagram and console lights.

(c) 110-V d. c. for point machine operation: This supply is taken from an 88 cell 35 Ah battery which is on constant trickle charge through a metal rectifier charging unit. The battery acts as a standby in case of power failure.

(d) 12-V d. c. for interlocking and control relays, point contactors, magnetic point indicators on the illuminated diagram etc. The supply is obtained through a constant voltage rectifier with a floating 9 cell 35 Ah battery which maintains the supply in the event of power failure for the period required by the diesel alternator standby to run up to speed.

These supplied are taken from the cubicle to the fuse and busbar racks.

FUTURE DEVELOPMENTS

The previous section has described the power arrangements which are standard for present day practice in modern power signalling installations. The York installation is at present the largest in use but it is not likely that the size of this interlocking will be exceeded.

The modernisation of British Railways and the growing consciousness for the need of modern signalling on railways overseas will no doubt promote the fruition of many interesting signalling schemes. The decision of the British Transport Commission to use the 25kV 50c/s single phase system of electric traction will introduce new problems for the railway signal engineer. These will principally concern freedom of interference with track circuits and other apparatus. Experiments have been made in France with audio-frequencies generated by valve oscillators but there are complications.

Railway signalling has a long and ancient history of achievement and problems surmounted and with its present wealth of experience in mechanical, electrical and telecommunication engineering and electronics it can face the future with confidence.

Metric Woven Metallic Tape Measures

The Indian Standards Institution has just published an Indian Standard Specification for Metric Woven Metallic Tape Measures (IS : 1269–1958), which prescribes the requirements for metric, woven metallic tape measures intended for use, where it is not possible to employ rigid measures of length.

This standard is one of a series of Indian Standard Specifications for Commercial Weights and Measures being prepared by the Institution at the instance of the Standing Metric Committee of the Government of India. The other specifications in the series are :

IS : 1056-1957 COMMERCIAL METRIC WEIGHTS

IS : 1057-1958 METRIC CARAT WEIGHTS

IS : 1058-1958 COMMERCIAL METRIC CAPACITY MEASURES

IS : 1059-1957 COMMERCIAL METRIC LENGTH MEASURES (NON-FLEXIBLE)

IS : 1270– METRIC STEEL TAPE MEASURES (WINDING TYPE)

Copies of the standard published in English and priced at Rs.1.50, can be had from the offices of the Indian Standards Institution, at Delhi, Bombay, Calcutta and Madras.

International Electrotechnical Commission (IEC) To Meet in New Delhi

It shall be the first time in its history of 54 years, that the International Electrotechnical Commission (IEC) shall be holding its annual group of meetings in an Asian country, having accepted the Indian invitation for the annual meetings of its technical committees and of its Committee of Action to be held in New Delhi in the later half of October 1960.

The IEC is the electrical division of the International Organization for Standardization (ISO); and the object of the Commission is to establish international standard practices in the field of electrical technology by facilitating the unification of national standards and by co-ordinating the activities of other international organization in this field. Its scope includes both the heavy electrical engineering and the communication fields.

The Commission was set up in 1904, and celebrated its jubilee in 1954 in the USA. During these years, it has made valuable contributions to the progress of the profession through standardization activity in different fields of electrical engineering and has earned for itself a position of leadership in the international sphere. India together with eight other countries, elected for a term of nine years, form the Committee of Action of the IEC which functions as its executive body.

Upto 1949, India was represented on the International Electrotechnical Commission through the Institution of Engineers (India), when at the request of the Institution itself, and at the instance of the Government Departments concerned, the ISI took over the responsibility of representing India. In 1947, however, the IEC had already become the electrical division of the International Organization for Standardization (ISO) though it retained its autonomous character. ISI, having been a member of the ISO, was thus automatically concerned with the work of the IEC from its very beginning. Yet the transfer of membership from the Institution of Engineers (INDIA) made it possible to centralise the national and international work concerned with electrical standards in one place, both technically as well as administratively.

The Indian Standards Institution has the Secretariat responsibility for the Indian National Committee of the IEC. In July 1958, several technical committees and the Committees of Action of IEC held their annual session at Stockholm (Sweden) which were attended by more than 900 delegates from 30 countries. The Indian delegation of eight, sponsored by the ISI, was composed of electrical and radio industry and the ISI Directorate. The Indian invitation to the IEC for holding its annual group of meetings was considered at Stockholm meeting and accepted for 1960.

It is expected that more than 400 foreign experts in the electrical field will attend the various meetings of its technical committees, and the ISI has already taken in hand the preliminary preparations in this connection.

* * *

SPECIFICATION FOR OPTICAL GLASS

Optical Glass differs from ordinary glass with respect to the extreme care and precise control exercised during its manufacture, so as to ensure perfect homogeneity, freedom from colour (except where certain oxides and elements are deliberately introduced for the manufacture of coloured glass) and faithful reproduction of the physical properties from batch to batch. As it forms the basic material, from which all types of optical components for precision instruments are manufactured, the necessity to lay down a standard to guide the quality of optical glass produced for different purposes, is of considerable importance, both for the manufacturer and the purchaser of optical glass.

With this aim in view the Indian Standards Institution has issued a draft Indian Standard Specification for Optical Glass [Doc: EDC 36 (459)], which describes the commonly recognized types and grades of optical glass, its physical properties, the defects commonly found in the material, and the methods of acceptance tests for the material.

The present standard deals exclusively with the physical characteristics and properties of optical glass, the defects and faults often come across in the material, the methods of test employed for their location, grading of optical glass according to the degree of permissibility of these common defects for different types of work, and the methods of marking and packing of the material.

Copies of the draft standard are being circulated for eliciting comments from interested persons, before *12 December 1958* and can be had free, on request from the Indian Standards Institution at New Delhi, Bombay, Calcutta and Madras.

Alloys, Ferrous & Non-Ferrous Metals Supplement

Scope of Antimony, Tin, Lead, Nickel and Manganese Industries in India

By Manubhai Shah
Union Minister of Industry, New Delhi

OUR civilisation today depends to a considerable extent on the use of many varieties of metals and alloys. Without metals no railway, aeroplane, motor-car, electric motor or turbine would operate. In fact every amenity of life depends on the work of metallurgist and on his ability to produce just the right metal for each particular purpose. Next to steel, the non-ferrous metals occupy a place of great importance in our industrialisation. The consumption of various non-ferrous metals directly indicates the industrial progress and the standard of living of the people of a country. Non-ferrous metals cover a very wide field and theoretically all metals except iron and steel come under its field. In practice, however, copper, lead, zinc and tin constitute the major base metals and aluminium, manganese and titanium constitute the important light metals. Under minor metals come manganese, chromium, nickel, antimony, tungsten, cobalt, molybdenum, etc. Our annual requirement of these metals today is worth about Rs. 30 crores and it is expected to rise to about Rs. 45 crores by 1960—61. The indigenous production today is hardly worth Rs. 7 crores and the balance of about Rs. 20 crores to Rs. 25 crores of metals has to be imported. Here we will only review the position of the antimony, tin, lead, nickel and manganese industries in India.

ANTIMONY

Our present demand of antimony metal is about 600 tons per year. Antimony is mainly used for storage batteries and printing and type metals, the antifriction bearing metals. The main consumers are railways and ordnance factories. As the consumption of antimony by these industries would increase as a result of their expansion during the Second Plan period, it is estimated that our future demand will be 800 to 1000 tons per year by 1960—61. Star Metal Refinery Private Limited, Bombay is the only manufacturer of antimony in the country and its annual rated capacity is 1,000 tons on triple shift basis. The refinery is, however, now producing only about 600 tons per annum. The production and import figures for 1954 to 1957 are given below :

Year	Production (tons)	Import (tons)
1954	539	54
1955	504	45
1956	589	78
1957	502	21

This smelting unit was established in the year 1941 on the basis of supplies of antimony ore from Chitral, which has now gone to Pakistan. As no other workable deposits have so far been discovered, we have to import these ores from the foreign countries, viz. Bolvia, Turkey and China. The Geological Survey of India is reported to have located antimony ore in Shigri Galcier region in Punjab and in Kolari (Nagpur District in Bombay State). Further efforts are being made by the Geological Survey to locate the workable deposits so that the industry may be free from its dependence on the import of ore from foreign countries.

TIN

The current demand of tin is about 4500 tons a year and is expected to rise to about 6000 tons by 1961. The import figures in quantity and value for 1954 to 1957 are given below :

Year	Quantity (tons)	Value (in lakhs)
1954	3,774	370
1955	3,640	352
1956	4,180	398
1957	3,391	409

We are not producing any tin in India at present as no workable deposits have been located so far. A few sporadic occurrences in places in Bihar have been reported, but are not well promising. The main consumers of tin are the tinplate and the alloy making industry. However, there are at present three units engaged in the recovery of tin from tinplate scrap viz. (i) Montana Private Ltd., Bombay, (ii) Metalo Chemical Works, Calcutta and (iii) Detinners Private Ltd., Calcutta. The total tinplate arisings of the major tinplate processing factories is estimated at 6,000 tons per annum, as against the existing capacity of 24,000 tons of the three detinners. At present about 70 tons of tin per year are being recovered by the detinners.

LEAD

Our present demand of lead is about 18,000 tons annually which is expected to increase to about 24,000 tons per annum by the end of Second Plan period. We have only one firm, viz., M/s. Metal Corporation of India Ltd., with their mining and ore dressing plant at Zawar near Udaipur and their lead smelter at Tundoo, Katrasgarh in Bihar, having and annual smelting capacity of 6,000 tons per annum. They are, however, producing about 3,000 tons of lead per annum because of inadequate ore-dressing capacity of the plant at their Zawar mines. It is likely to be expanded to 1,000 tons per day by 1960—61 by which time it is expected that the firm will be able to produce about 6,000 tons of lead annually. The production and the import figures for 1954 to 1957 are given below:

Year	Production (in tons)	Import figures (lead unwrought) (tons)
1954	1,787	10,945
1955	2,234	11,853
1956	2,497	15,833
1957	2,974	13,831

The commercial workable deposits of lead ore are located in the vicinity of Udaipur and Jaipur in Rajasthan which are being worked at present by M/s. Metal Corporation of India Limited as mentioned above. Small 'lodes' of lead and zinc ore have been located in various parts of the country like Hazaribagh in Bihar, Gwalior, Dattia and Dreg in Madhya Pradesh, but their economic value has not yet been established.

NICKEL

The current demand of nickel is estimated to be about 500 tons a year. The quantity and value of imports during the years 1954 to 1957 were as follows:

Year	Quantity (in tons)	Value (in Rs.)
1954	469	28
1955	160	13
1956	316	20
1957	298	29

Regarding indigenous production of nickel, unfortunately we have not been favoured by nature in this respect. So far we have not been able to locate any workable nickel ore deposits. However, traces of nickel are found to occur in the copper ore processed by the Indian Copper Corporation at Ghatsila in Bihar. It is estimated that about 40 to 50 tons of nickel may be recoverable annually when the manufacture of electrolytic copper is undertaken by the above firm, a licence for which has been granted to them in April 1957 and is likely to come into operation by July 1960.

MANGANESE

The use of manganese metal has so far been limited in India as the metal has to be imported from U. S. A. a dollar area. Once the manganese metal is available in large quantities at an economic price in the country, its use is likely to increase considerably. Electrolytic manganese can be successfully used for the manufacture of nickel-free stainless steels and in the production of manganese-brasses, coinage alloys and a number of other non-ferrous alloys. On the basis of our present requirement of stainless steel of the order of 5000 tons per year which may go up to 8000 tons per year by 1960—61, about 800—1000 tons of electrolytic manganese would be required for the production of stainless steel only. Taking into consideration the other application of manganese metal the demand of this metal is expected to be 2500-3000 tons annually. India imports only a small quantity of electrolytic manganese at present, but low carbon ferro-manganese is imported in appreciable quantities as the indigenous production is mainly of the high carbon variety and high in phosphorous.

With regard to the raw materials for the manganese industry we are second only to Russia in the world. Extensive deposits of manganese ore are distributed in parts of Bihar, Orissa, Madhya Pradesh, Bombay and Rajasthan. Most important deposits in quantity and quality are located in Madhya Pradesh. Of the 50 crores worth of minerals exported from India, Rs. 22 crores are accounted for by manganese ores only and is a good source for earning dollars.

At present we are exporting about 85% of India's output of manganese ore. Muchattention is, however, being given to the indigenous production of standard grades of ferro-manganese through electric-smelting. Five plants have already been installed to manufacture ferro-manganese with an installed capacity of 86000 tons per annum. In addition three more firms have been granted licences for manufacturing ferro-manganese with a capacity of 67,500 tons annually and they are likely to come into production by 1959. Thus the present total licenced capacity now is of the order of 1,55,000 tons per annum. Our requirement of ferro-manganese by the end of the Second Plan period when all the three new steel plants would have started working, is estimated to be about 60,000 tons per annum. Thus we will be able to export the balance of about 100,000 tons to foreign countries.

Efforts are being made to utilise the low grade ores by beneficiating them or developing processes of making electrolytic manganese. The National Metallurgical Laboratory, Jamshedpur and the Central Electro-Chemical Research Institute, Karaikudi, have been able to develop processes for production of high purity manganese by electrolysis using low grade manganese ore. The National Metallurgical Laboratory have covered their process by Patent No. 49335 dated 10—4—1953 and are running a pilot plant which produces about 32 lbs. of metal per day. The present cost of production by N. M. L. patented process works out much lower than the present price of celetrolytic manganese in U. S. A. which is about Rs. 3,000/- per ton. Efforts are being made to instal a commercial plant in the country by one party with an annual capacity of 3,600 tons. With the indigenous production of electrolytic manganese, a considerable amount of foreign exchange will be saved and we can also earn foreign exchange by way of exports in the near future.

CONCLUSIONS

Nature has been abundantly generous to us with regard to the supply of manganese minerals. We have, however, only small deposits of lead ores, while for nickel, tin and antimony we have entirely to depend upon the imports of ores from foreign countries. It may be mentioned here that no country in the world is blessed with all the necessary minerals of every metal and it will not be correct to base our production economy on only the ores which are available in the country. No doubt, intensive efforts should be made to locate the deposits of metals for indigenous production. With the expanded programme of the Geological Survey of India, we may hope to discover economically workable deposits of some of these important metals. At the same time, the possibilities of importing ore from foreign countries should not be forgotten, Bauxite and ores of copper, iron, manganese, zinc, etc. have been known to have been carried across the seas from one country to another in order to produce the virgin metals and alloys from them. We are exporting most of our manganese ore to U.S.A. and nearly half of our iron ore is shipped to Japan. It is, therefore, essential that our industrialists should consider the question of setting up smelting plants for all these metals in the country even from imported ores and concentrates. Side by side investigations should also be carried out on the replacement of these metals by other metals and alloys for which we have comparatively larger resources. A number of problems with important economic implications demand urgent consideration by the Indian metallurgists and the industrialists and it is for them to take the challenge of the times and find out solutions with insight, imagination and determination.

MANUFACTURE OF RAILWAY WAGONS BY INDIAN FIRMS

The Railway Board has placed orders on eight Indian firms for the manufacture of 17,613 railway wagons of different types against 1957—58 programme, said Shri Shah Nawaz Khan, Deputy Minister of Railways, in a written reply to a question by Sardar Iqbal Singh in the Lok Sabha on September 10, 1958. Six of these firms are located in Calcutta, one in Muzaffarpur and the remaining one in Bombay The Deputy Minister further said that 13,788 wagons had been delivered by the firms up to July 1958 and the balance was expected to be delivered by December this year. The Deputy Minister added that the Railway Board had also placed experimental orders on ten new firms for the manufacture of 2,350 wagons against 1957—58 programme.

CANADA'S MINERAL RESOURCES

CANADA's Mineral production set another all-time record for value in 1957, in spite of lower prices and lessening demand combining to shrink markets and cut production of many minerals, thus reducing earnings of many companies to well below 1956, the nation's mining industry on the whole enjoyed another big and profitable year. With inclusion of petroleum and natural gas, both of which showed moderate increases, total production value of \$. 2,085 million in 1956 was topped by 2.5 per cent, at \$. 2,134 million.

The year 1958 will be a difficult one in some respects, with further reductions expected in many items unless the overall business picture improves materially. Yet the promised threefold expansion next year in uranium output could turn the tide and result in another all-time record for the industry as a whole for 1958.

BASE METALS, GOLD, AND COAL OUTPUT OFF

Many minerals in 1957 showed a smaller volume of output and many had their production curtailed by reduced prices. Outstanding in this category were copper, lead, and zinc, usually the industry's star performers. Worldwide expansion of production of these metals had raised their production to high levels, while demand from the consuming industries, as well as government demands for stockpiling, had fallen off. Today with more supplies available than demands can absorb, production cutbacks are widespread.

Metals declined in value to \$. 1,136 million from \$ 1,146 million in 1956. Prices of copper, lead and zinc fell. Gold production for 1957 was about the same as 1956 but its value was reduced by about \$. 2 million due to the premium on Canada's dollar cutting the price.

Other metals show a combined reduction of production amounting to some \$ 5 million, while non-metallics production value showed a gain of some \$ 7 million.

The value of coal production suffered another \$ 5 million drop due to the further inroads of competition from other fuels and to the lessening demands from industry generally. Fuels other than coal showed a gain of \$ 42 million, and structural materials gained \$ 15 million.

URANIUM, ASBESTOS, AND NICKEL BETTER

Canada is established as one of the world's top uranium producers and has the advantage of fixed-price sales contracts with the government. Since few of the contract mines are yet in full production, Canadian output will increase sharply during the next two years. Output has jumped to some 12.9 million pounds, worth \$ 131 million in 1957 from \$ 46 million the previous year and by mid-1958 will be established at a rate exceeding \$ 300 million yearly.

Iron ore continued to grow in importance and 1957 output was close to 1956 tonnage despite slackening steel activity in the United States where most of it is marketed. Prices were up 5 to 6 percent. Production in 1957 will reach a total of slightly in excess of 22 million tons with a value of \$ 156 million. A few years ahead it will exceed 40 million tons annually valued at about \$ 400 million.

The outlook for nickel is also encouraging. In spite of abatement of U. S. stockpile requirements, unlimited supplies will now be available for civilian industry for the first time since 1939. Nickel producers will be now able to make unrestricted sales efforts and increased usages and sales can be expected.

INDUSTRY AFFAIRS

A Delegation of Canadian Cabinet ministers conferred in Washington last fall with their counterparts in the American Administration on trade relations and voiced the alarm and dismay felt by the mining industry at the prospect of increased U. S. import duties on lead, zinc and copper. The industry will have an opportunity of voicing its views to the U. S. Tariff Commission when that body reviews the lead and zinc situations.

The Diefenbaker government announced its intention to revise the Industrial Relations and Dispute Investigations Act (Federal Labour Code), a matter of great importance to the mining industry. All uranium producers with one exception now operate under the code.

During the month-long tour across Canada last September the sixth Commonwealth Mining and Metallurgical Congress visited all the important Canadian mining camps and metallurgical centres from

Kitimat and Trail in the west through Edmonton, Beaverlodge, Steep Rock, Blind River, Sudbury, Timmins and Noranda to Schefferville in Ungava and toured the St. Lawerence Seaway. The party included some 350 visitors from 36 countries. The tour was sponsored by the Canadian Institute of Mining and Metallurgy.

METALLICS

Iron Ore

Steel producers who have been worried over an ore famine since World War II now find there is a plentiful supply, yet both prices and consumption are holding close to peak levels. Canada has climbed to fourth place behind the U. S., Russia and France: ahead of Sweden, the U. K. and West Germany Final figures for 1957 showed its 10 producers had turned out 22 million long tons worth $ 156 million, with 1958 production pointing definitely higher.

As a result of the new trend to beneficiation and increased use of high-grade pellets of 64% iron as an ideal blast-furnace feed most big U. S. ore consumers are looking to Canada for lean Canadian ores that can give a richer pellet than U. S. taconites and jaspers.

The bulk of Canada's iron ore is exported: 13.7 million tons of the nation's 1956 production total (22.3 million tons) went across the border 2.5 million tons went to Britain, while shipments to West Germany, the Netherlands and Japan followed in that order. Canada imported 4.52 million tons in 1956, most of it going to Hamilton steel mills. In 1957 essentially the same export import pattern was followed, but with a quickening interest by West German and other European nations for high grade concentrates.

More than half Canada's production comes from the Ungava knob Lake fields. Marketing some 12.6 million tons in 1957 Iron Ore Co. of Canada should expand output to 20 million tons in the next few years. Two new producers are assured for 1958: Hilton Mines in the Ottawa Valley is readying a $ 16 million concentration plant, while Lowphos Ore Ltd., will ship concentrates from its plant near Capreol, Ont. Caland Ore Co. is continuing its huge dredging operation but will not be in production before 1959.

Canadian Charlson, near Steep Rock plans a concentration plant for a 250,000 ton production in 1959. Leading the search for low grade deposits that can be agglomerated and which promise tomorrow's big developments is U. S. Steel's Quebec Cartier Mining Co., 300 miles north of Shelter Bay on the St. Lawrence. With expenditures already reaching $ 10 million by the time production starts in 1961. It may turn out to be a 10-million ton yearly operation. Other big interests in the exploration stage include Canadian Javelin, Quebec Cobalt and Albanel Minerals.

URANIUM

Canada continues to rank third in uranium production after the United States and South Africa though it will probably assume leadership during late 1958 or early 1959. In 1957 Canada produced 12.9 million pounds of uranium oxide, valued at $ 131 million, almost a threefold increase over 1956. Canadian reserves are estimated at 225 million tons, containing some 237,000 tons of uranium oxide, compared with some 175,000 tons of oxide in the U. S., and 370,000 tons of oxide in South Africa.

There was little incentive for prospecting for new deposits during 1957. Deadlines for qualification for premium price contracts are passed and with no promise of five-year amoritization only exceptionally rich further deposits could be mined economically at present. Premium price contracts have been designed to repay capital within a five-year period which made it easier to raise the huge sums of money needed.

The need for cheap energy has forced Europe and to a lesser extent America to make use of oil gas and coal as primary fuels for producing electrical energy. Britain with less plentiful supplies has taken the lead in developing uranium-burning power plants. With demand increasing it is natural to consider possible successors to uranium but, so far, none exist.

Canadian contracts for uranium awarded to companies now producing or with plants under construction total over $ 1.5 billion. These contracts expire in 1963. Prices average around $ 10 per pound of contained uranium oxide. Eldorado has options on further production at prices equivalent to the U. S. Price of $ 8 per pound until 1966. The standard price in Canada for other than contracts calling for premium prices remains unchanged at $ 6.00. Eventual maximum rate of output from companies now in production alone is estimated at close to $ 400 million annually.

PRODUCERS

In the Beaverlodge camp, Eldorado Mines' new plant commenced production in 1957 at 500 tons daily, to be raised to 750 tons in 1958. It takes ore from Cinch Lake, National Explorations, and Cayzor Athabaska Mines. Eldorado moved treatment rate at its Uranium City plant up to 2000 tons daily and handles 150 tons daily from Rix Athabaska on a three year contract. Rayrock started a 150-ton mill at Marian River in June. The Eldorado Plant at Port Radium continued at normal production of 200 tons a day.

In the Bancroft area of Ontario, Bicroft smoothed out operations at its 1000-ton plant, while Faraday started its new plant up in April. This mill also handles shipments from Greyhawk. Canadian Dyno continued construction and will produce 1000 tons daily early in 1958.

At its Blind River plant in Western Ontario, Pronto Uranium stepped up tonnage to 1500 tons daily and is proceeding with deeper development. Algom brought its first 300-ton mill into operation in 1956 at Quirke and the second one of the same size at Nordic was operating at capacity early in 1957.

Precipitate shipments from Consolidated Denison started in June 1957 and the mill is gradually being brought up to 4000 tons daily with a target of 6000 tons daily early this year. Northspan's Nordic Lake Mill of 4000-ton capacity started production at 2000 tons in September. Its Panel Lake Mill will open late in 1958 and its 2000-ton operation at Spanish is close to production.

Can-Met Explorations' 3000-ton mill will be operating below capacity until underground work is opened up further. Stanleigh started feeding its 3000-ton mill late in 1957 while Stanrock expects to have its 3300-ton mill ready for production in February 1958. Miliken Lake Uranium will commence production at its 3000-ton mill in the spring.

NICKEL

With a slowdown in the industrial boom, slackening in defence orders, and large sale diversions of U. S. stockpile, quotas, the grey market for premium priced nickel is tapering off and producers face a struggle to regain markets lost to substitutes. Diversion of stockpile quotas, however, merely means producers may attempt to dispose of nickel contracted for by the U. S. Government to private industry. If unable to get the price they would receive from the Government the producers can require the Government to buy it at the contract price.

Canada, world's largest producer of nickel, produced close to 376 million pounds, worth $ 261.2 million in 1957, compared with 357 million pounds the previous year. This is 75.3 percent of estimated 1957 world production of some 490 million pounds. Anticipated world production is estimated at 650 million pounds by 1961. Available of this greatly increased supply may create serious marketing problems for producers, especially if defence consumption should be further curtailed, requiring a 75 per cent increase in peacetime industrial uses of nickel by 1960.

International Nickel, world's largest producer, sees the most promising field for expansion in stainless steel turbines, machine tools, corrosion resistant uses, and for chemical plants, electronics, nuclear power, missiles and space ships as well as in the hundreds of conventional peacetime uses. A vast increase in Inco's production will come from the new properties in Manitoba now under development. These are being readied for production by 1960.

Arcadia Nickel will commence production early in 1958. Another possible addition is the Gordon Lake division of Eastern Mining and Smelting near Kenora. E. M. & S. is also planning another smelter and refinery at Chicoutimi, Quebec. This smelter will treat ores from Nickel Rim, Gordon Lake, Arcadia, North Rankin and Canalask as well as ores from custom smelting from other parts of the world. During the year 1957 North Rankin Nickel mines brought its 250-ton per day mill into operation.

COPPER

Overproduction and sharply reduced prices spread gloom over the copper mining industry throughout 1957. The all-time high in tonnage production and value in 1956 of 353,293 tons valued at $ 297 million were cut sharply. Production of new primary copper in 1957 averaged some 28,000 tons monthly, off some 1,700 tons from the pace set in 1956. Production for 1957 was valued at $. 199.5 million, a drop of almost one-third.

What this means to Canadian copper mines is shown in Canada's export trade figures. Annually we export some 70 per cent of our output. In the first 8 months of 1957 we exported 37,500 tons more than in the previous year, yet we received $ 4.9 million less for it.

World production has not only caught up with demand, but has passed it by a substantial margin. Fabricators took only slightly less than the previous year's tonnage, but weakness in prices (down to 25¾ cents in October from the all-time high of 46 cents in July 1956) was the severest on record. To remedy the situation producers must develop increased consumption or cut back production, neither of which is easy.

SOME NEW MINES........SOME FAILURES

While the search for new mines slowed down during 1957, Maritimes Mining opened an 1800 ton mill in Newfoundland in September while Buchans Mining Co. continued shaft-deepening operations. Heath Steele Mines began tune-up of their 1500 ton concentrator in New Brunswick. Merrill Island will start up its 650-ton plant in January, Copper Rand, Bouzan, Quebec Chibougamau and Bateman Bay are in various stages of exploration and development. Chibougamau and Bateman Bay are in various stages of exploration and development Chibougamau-Jaculet has suspended operations due to lack of ore. Beattie-Duqusene, Lyndhurst and Duvan have suspended operations.

The five month strike at Gaspe Copper Mines held off a large slice of production. Geco Mines and Wilroy Mines commenced production in Ontario, Coldstream was treating 600 tons daily. Hudson Bay Mining profits were down for 1957 though Sherritt Gordon has done better. In B. C. Woodgreen Copper is in bankruptcy, Midwest and Granby have ceased work, and Britannia is considering closing down.

LEAD

The available supply of lead has been running in excess of consumption. Decreased industrial activity, levelling off of U. S. stock-piling and barter programs and intended British stockpile sales, have upset the delicate pattern of supply and demand. Canadian production for 1957 valued at $ 52.4 million, was 10% below the same period of 1956. Refined output has been running close to 1956 figures when total output was 147,865 tons. Canadian exports have shown some increases over the previous year.

During 1957 due to softer markets and suspension of U. S. barter deals, four price-cuts reduced the price from 16¼ cents in May to 12¾ cents in October. The U. S. Tariff Commission may raise the lead import duty by 2.55 cents per pound from the current 1.0625 cents. Lead imports were slashed considerably in 1957 following the opening late in 1956 of the Ethyl Corporation of Canada plant at Sarnia. Lead consumption in Canada should show an untrend for the full year 1957 due to the opening of this plant.

Principal source of lead and zinc in Canada is the Sullivan Mine of Consolidated Smelters at Kimberley B. C. The Company operates the only lead refinery in Canada and treats domestic and foreign ores and concentrates. It also operates the H. B. and the Bluebell producing mines.

Production at Tulsequah and the open-pit mine at Sullivan, Jardun mines at the "Soo" and the Mayo mine in the Yukon all suspended operations during the year. Consolidated Sudbury Basin Mines has deferred plans to open. Heath Steele Mines in New Burnswick is producing lead from its 1500 ton mill.

ZINC

The year 1957 was discouraging for most zinc producers and the immediate outlook for the future is cloudy. Output in 1957 was valued at $ 99.7 million, 20 per cent below that of the previous year. Price declines due to oversupply forced production curtailment or suspension. The U. S. stockpile of zinc is bulging and is unlikely to be added to. The U. S. barger system initiated in 1956 to trade farm surpluses for foreign metal supplies has met with disfavour. Slab zinc consumption is down for 1957 in the U. S. world's largest consumer.

Zinc producers in the U. S. are urging tariff increases. Hearings were scheduled for year end, with strong probability for a hike in duties. This would be a severe blow to all zinc-producing countries. Four drops in prices between May and August totalling 3½ cents brought Canadian price for prime western zinc to 10 cents.

In spite of all these ills, it was predicted early last year that world production would create a new record. Today the estimate seems optimistic. Many U. S. and Canadian mines have shut down or curtailed production during 1957 U. S. Zinc output was running 3½% over the previous year, though Canadian output for the same period was some 2% lower than in 1956.

Besides the Consolidated Smelters' Kimberley Mine in B. C. where zinc is refined, Hudson Bay Mining and Smelting at Flin Flon produces and refines slab zinc. In 1957 the Company began shaft sinking at a new property at Snow Lake Manitoba with an indicated deposit of nearly four million tons. Elsewhere, Heath Steele mines in New Brunswick commenced production in 1957 which Buchans in Newfoundland continued production and Brunswick Mining will soon be in production. Barvue and New Calumet mines in Quebec curtailed their production. Geco and Wilroy in Manitoba, began production in 1957 which capacities of 3300 and 1000 tons daily respectively. Surveys were under way for a rail route to the south shore of Great Slave Lake in the N. W. T. where large deposits are located.

GOLD

Gold mines of the world have been passing through another difficult year. Free world production will again show a small increase of some $ 10/20 million: this will reflect merely the remarkable expansion in output from South Africa, Canada, in second position, will produce about 60,000 ounces less than in 1956 for a decrease of some $ 2.0 million in value.

From the mine standpoint there were few developments of importance during the past year. One new gold mine had made its appearance. French Mines, in B. C. with a 30/50 ton milling plant having started production. Howe-sound in Manitoba, is on a salvage basis. Some old-established producers have raised their capacity slightly. Only one prospect, Taurcanis in the N. W. T. was doing underground development.

COBALT

Cobalt is passing through a transition period from the stimulus of government stockpiling to the growing pains of a civilian market. Canadian production will be close to the 1956 total of 1,843 tons, though domestic consumption will be sharply lower than the previous year's 218 tons or nearer 63 tons. Exports are expected to total as much as 1,250 tons. Relatively little cobalt is imported into Canada. Price for cobalt in concentrate form, now pegged at $ 2.00 is only about half the rate of a year ago.

Canadian nickel producers are the principal sources of cobalt. Some 35% to 40% of all production is in the alloy field for high temperature alloys, jet engines and atomic equipment, and offers best chances for the future. The permanent magnet industry uses 30% of all production, but is threatened by new materials.

PLATINUM

Revering the position in 1956 when demand for platinum greatly exceeded the supply, the platinum metals are now in oversupply. Falling prices have cut values to $ 84/87 an ounce. The oil industry largest consumer has cut back its buying. Its use was a catalyst for making high-octane gasoline.

The United States is the main consumer of platinoids, last year at 975,000 oz.; Canada exported 287,544 oz. to the U. S. in 1956. A new use for platinum has recently appeared in the U. S.—an automatic electrical system using platinum disc anodes has been developed to protect ships' hulls and propellers against corrosion.

Canada's production for 1957 is not likely to be in short supply. Most of it comes from nickel producers. International Nickel's Manitoba development, and Eastern Mining and Smelting Co. at Kenora are the largest untapped sources of the metal. Canada's domestic consumption in 1956 was valued at some $ 6 million and by 1958 it will rise with the increase in oil production. Canada's exports were down about $ 7 million below 1956 for the first seven months of 1957.

SILVER

Canadian silver production in 1957 was at a rate only slightly higher than that of 1956 at about 30,100 ounces. Exports of silver in all forms based on production for the first three quarters had fallen about 10%, below that of 1956. The market has been stable and indications are that it will continue so.

The three North American countries, Mexico, United States and Canada, in that order, account for over half the world's production. Silver coinage takes much of the metal; Canada has been using greater amounts for the coinage the past few years. The U. S. treasury, Mexico, Saudi Arabia, West Germany and Canada are largest users for this purpose. Most of it comes from producers of zinc, lead and copper.

TITANIUM

Titanium, the 'wonder-metal' has failed to live to the publicity lavished upon it. Now the United States has indicated defence requirements for the metal will be substantially cut back. If it is to maintain its steady record of growth new markets must be developed for commercial use, and price reductions must be achieved in mill products. Today only half of the U. S. capacity production of 31,500 tons is in operation.

Ninety percent of the titanium produced has been for jet aircraft and missile components, where its high strength-to-weight ratio and resistance to corrosion and fatigue gave it advantages. But the metal is meeting sharp competition from nickel alloys which though heavier can withstand more heat.

Potential civilian markets are in civilian aircraft, automobiles, anodizing and plating, papermill and chemical process equipment, and marine fittings, while 95% of world output of titanium-bearing minerals is used in the titanium pigment industry a market of first importance to Canada, which is the world's leading producer of titanium slag and has the largest known deposits of ilmenite and rutile concentrates doubled in five years to 1,789,400 tons in 1956.

Price of titanium sponge has been cut from $ 5 per pound to $ 2.25 since 1951 and will go lower. Titanium mill products at $ 10/12 per pound must compete with stainless steel at about $ 1.00. Recent technological developments suggest its price will fall still further.

Canadian Titanium Pigments Ltd., opened Canada's first pigment plant at Varennes, Que., late in 1957. Slag will be fed to it from Quebec Iron and Titanium's five electric furnaces at Sorel, where three more furnaces were lately added to boost capacity to 375000 tons yearly by 1959. Baie St. Paul Titanic Iron Ore Co., Produces ilmenite and Continental Iron & Titanium Mining plans a 500-ton plant there. Several other companies have prospect in Quebec. Some 10,500 tons were produced in Canada in 1957 compared with 2300 tons last year.

MANGANESE

Canada is not a producer of manganese ore, but relies entirely on imports from India, South Africa and Morocco. Strategic Manganese Corporation is planning an electric smelter at Woodstock N. B. for processing low grade manganese iron ore from its Woodstock property. Capacity will be 5,000 tons daily with annual production of 70,000 tons of 7 6% ferro manganese and 74,000 tons of ingot iron. Manganese ore imports in 1956 totalled 208,000 tons. Ferromanganese exports totalled 59,445 tons valued at over $ 10 million.

MAGNESIUM

Canada ranks third after the United States and Russia in production with 19,000 tons output in 1956. As opposed to the general trend of non-ferrous metal production, output of primary magnesium in the U. S. continued at capacity during the first half of 1957, though July showed the first substantial decline. Figures for Canadian production, exports and imports of magnesium metal are not published but annual capacity amounts to some 8,000 tons 60% from Dominion Magnesium and 40% from Magnesium Co. of Canada an Alcan subsidiary.

LITHIUM

Lithium is a new-comer to Canadian mining. Some 5.4 million pounds of lithia were produced in 1957, vs. 4.8 million in 1956. To date there is only one producing company, Quebec Lithium, which with other partners has discovered the largest and richest deposits in the world. With a 1,500 ton per day mill capacity, it has a 5-year contract with Lithium Corporation of America to supply 165 tons daily of concentrates. The Company will proceed in 1958 with construction of its own lithium refinery and chemical facilities to process its lithia concentrates produced at Val d' Or. Quebec at a cost of some $ 3 million. A 450 acre area has been brought at Rouses Point, in New York State just south of the Quebec/New York border where work will be started next April.

MOLYBDENUM

World production of molybdenum reached a new high in 1955 at an estimated 33,600 short tons of ores and concentrates of which the U. S. produced 31,000 tons. U. S. Production in 1957 indicates it will compare favourably with 1956.

All Canadian production comes from Molybdenite Corporation of Canada at Val d' Or which in 1956 produced 707 tons of molybdenite and 117,044 pounds of bismuth metal. In 1957 the company produced 874,600 pounds. The company expects to mine 188,000 tons and mill 168,000 tons during the full year of 1957.

Developments in Metallic Materials with Particular Reference to Materials for Tool Making

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ADVANCES in aviation and transportation, automation and mass production have called into service an enormous variety of materials possessing a wide range of properties according to the nature of service to be performed. Some of these materials are light and strong, others hard and tough, heat and corrosion resistant, good conductors of heat and electricity or possessing high electrical resistance thereby making them suitable for varied specific purposes. The onslaught of atomic and then the sputnik era, have brought with them peculiar problems of materials suitable for the construction and control of atomic piles and shooting of transcontinental missiles and space satellites. The perfection called for is extremely exacting and requires the development of new types of materials to accommodate complex stresses and widely altered conditions of service. We shall not go into the details of these materials, which have almost hypnotized the common man of to-day. Our main consideration will be confined to those materials, which have brought about a silent revolution in our homes, factories, workshops and day to day living. They have not only helped to eliminate waste and delay, decreased cost of production and modified methods of manufacture, but also have made working conditions safer and much better.

We often hear of various metallic materials described as ferrous materials. All these essentially have iron as their base and on account of their varied compositions and useful properties constitute an extremely large family of metallic alloys. This vast group includes such different types of materials and alloys such as brittle and weak gray cast iron, wraught iron of which our familiar hooks and chains are made, plain carbon steels varying in carbon content from plates, sheets, rails, files and scissors non-staining stainless steels, as popular in the kitchen and chemical factories, hard tool which keep on cutting even at red heat and a large number of other kinds and types of alloys. In contrast to these iron base alloys, all other metals and alloys are known as non-ferrous. Alloys of copper, aluminium, magnesium, nickel, zinc, lead, tin, titanium etc. are all included in this group. Among these the ferrous alloys for excel the non-ferrous. However, this does not mean that all other metals and alloys are insignificant in importance. For many of the purposes such as aviation and transport, electrical conduction and transmission, making of sparkless tools for use in explosive mines and factories, iron and its alloys are limited in importance because of their high density, low electrical conductivity and high sparking property. In such cases, light alloys of aluminium, magnesium and titanium, better conductors of copper, aluminium and silver and non-sparking tools of copper-beryllium alloys are indispensable. For making solders, type letters used for printing, alloys of lead, tin and antimony are used. For coinage and jewellery mostly alloys of nickel, copper, silver and gold are employed. But for the making of heavy machines and constructions, where high strength and ductility are most desired, the challenge is frequently met by ferrous materials. Ferro-magnetism, which is maximum in iron and less in nickel, cobalt is the basis of all electrical engineering. This is one very important property of iron. Modification in properties by suitable heat treatment giving a wide variety of properties varying from extreme hardness, strength, toughness, ductility, deformability etc. is perhaps the biggest single factor making iron and steel the most important engineering material for severe stresses and heavy duty. These account for the pivotal role played by iron and its alloys.

Discovery of some of these alloys may have been accidental in the part but in most cases they have been developed by scientific research and investigations. Copper and its alloys were probably the very first engineering materials used by man for making the weapons, tools and utensils. This can well be understood as copper has been found to occur native. Bronze is harder than copper and gold, gold also occurs mostly native and is much brighter and softer as well as rarer and therefore used for ornaments and jewellery. In spite of its great importance in modern times, iron did not come into wide-spread use until comparatively recently, mostly on account of its non-availability in sufficient quantities. Meteoric iron, was probably the only source of its supply, which was far from abundant. The gradual development of methods for reducing different ores to useful metals must have at first started as accidents repeated and later improved and prefected as years passed and more and more experience was gathered. In certain parts of Chota Nagpur, one can still find some adivasis labouring hard on their primitive furnaces to get a few pounds of the metallic iron. Aluminium although the most abundantly occurring metal in the earths' crust was a very scarce thing almost until the close of the last century. It was valued more than gold until in 1886, Hall in America and Heroult in France, independently and almost simultaneously discovered a method of its commercial production. Many of these methods and processes owe their start to chance discoveries. It is only recently that the art of metal making is developing into a metallurgical science, the development of many processes for producing such new metals as magnesium, titanium, zirconium, beryllium etc. are achievements based on scientific reasoning and research.

Extensive use of iron and steel became possible with the growth and increase in production capacity of the iron blast furnace and the spectacular rise of the bessemer and the open hearth processes. The converter process of steel making can be visualized as one of the greatest scientific inventions of the nineteenth century, which made possible economic production of steel in large tonnages. This was soon followed by another big-scale steel-making method, the open hearth process. For a variety of reasons, most of the worlds' steel production, which has exceeded 300 million tons annually, is obtained from the basic open hearth process. The systematic examination of metals and alloys under the microscope was initiated by Professor Sorby of Sheffield in 1861, and this laid the foundations of correlating the properties and behaviour of different metals with their micro-structures. This important branch of metallurgical science known as metallography is very useful for predicting and testifying the behaviour of metals and investigating the causes of failure. A number of destructive and non-destructive tests are performed on the materials to ensure safe behaviour in service. All these are very powerful tools with the metallurgical engineer for various investigations.

Various developments in different materials can be attributed mainly to two reasons: The developments in technology call for improved and better types of materials as compared to those already existing. This can be looked upon as a primary development. When some of the constituents or raw materials of the existing ones are in short supply and are not easily available, investigations are aimed at developing substitutional materials. During the period of World War II, N. E. S. (National Emergency Series) steels were developed with a view to conserve some of the alloying elements, new types of tool steels and bearings metals with almost no tin were investigated and put into use. We are faced in our country with the problem of developing alternative compositions of stainless steels and bearing alloys as we have no significant nickel and tin deposits. Similarly, for electrical transmission, copper is being replaced by aluminium conductors. We shall now consider some of the most salient advances in tool making materials of most direct interest to us as engineers.

TOOL MATERIALS

Every engineer makes use of a number of tools which may be used as cutting tool, shear blades, chisels, punches etc. The tool materials should in addition to wear resistance possess shock resistance, strength and non-deforming characteristics. Tools for high speed cutting, hot forging, hot extrusions, hot molding should possess the property of maintaining the hardness at red heat known as red hardness.

HIGH SPEED CUTTING TOOLS

High speed steels of the general type designated as 18:4:1 were in general use before World War II, the sequence of number indicating the contents of tungsten, chromium and vanadium respectively carbon content varying between 0.6—0.75%. These steels after proper heat treatment attain a hardness exceeding 60 on the Rockwel C scale and maintain it even when cutting at high speed, when the tool actually gets red hot owing to the friction due to machining. For such uses, plain carbon or low alloy tools are quite unsuitable as they soften at the high temperature and lose the sharp cutting edge. Since tungsten is an strategic metal not quite abundant in supply, molybdenum and cobalt high speed steels have been developed. A number of different compositions have been recommended and used, which contain varying amounts of molybdenum, chromium, cobalt and vanadium. Steels with 0.8% carbon, 1.5% tungsten, 4% chromium, 8.5% molybdenum and balance iron have been found to give satisfactory service after proper heat treatment. Emergency steel of war period, the so called 6:6 type analyzing 1.15% carbon, 6% tungsten, 4% chromium, 3% vanadium and 5.5% molybdenum were used to conserve both molybdenum and tungsten. There is a trend towards the development of almost carbon free alloys of iron with cobalt and tungsten or molybdenum for better shock resistance. Owing to precipitation hardening characteristics due to iron-tungsten-cobalt or iron-molybdenum-cobalt intermetallic compounds by aging, high hardness value is secured, which persists for long periods.

STELLITE

These contain ordinarily about 1.25% carbon, 65% cobalt, 28% chromium and 4% tungsten with small additions of other alloying elements. Heat treatment has little effect on the strength, hardness or ductility of these alloys, the control of these characteristics generally being secured by variation in composition. These alloys retain their hardness when hot, are highly resistant to corrosion and oxidation and possess low coefficient of friction with respect to steel and many other materials. Being expensive these are generally used as inserts or as thin facing layers welded on to the cutting edge by standard welding processes. The process known as stelliting is used to protect the cutting edges and wearing surfaces of hot shears, trimming dies, agricultural instruments, cams, gauges, punches, valve seat for high pressure steam lines, and exhaust valve seats in internal combustion engines. By adding 1—5% molybdenum to the alloys, the cobalt content can be made as low as 20% without decreasing the hot hardness markedly. A recent development, which enhances performance materially has been the addition of about 0.2% boron.

SINTERED CARBIDES :—

Tools for the most severe service are made from compressed mixtures of various metal carbides, sintered in non-oxidizing atmospheres with some binding material having a lower melting point. Carbides of tungsten, tantalum and titanium are generally used either singly or in combination, depending on the application with cobalt as the most common binding agent. The mechanical and physical properties of the tool depend on the composition and the proportion of the mix used, as well as the conditions of sintering. The hardness measured on the Vickers Scale will frequently run between 1300 to 1400. These tools are finding extensive use in drawing dies for bars, rods, wire and tubing as well as for dies for extrusion, deep drawing and forming both hot and cold. They are also used for cutting tools for machining cast iron, aluminium, brass, bronze, copper, babbit, zinc and for many non-metallic materials. Cemented carbide tools are generally made up for use as a tip or insert and brazed or silver soldered into place on shanks which frequently are made of silico-manganese steels of the chisel type. High strength cast iron shanks are also becoming very popular because they have the same coefficient of expansion as the carbides. This sets up less stress in cooling the assembly after brazing and therefore, assures a good strong bond. After the tip is fastened to the shank, grinding to shape should be done with diamond dust or other special abrasives. These tools are fairly brittle and this must be considered in their use. Generally, speeds about twice as fast as those suitable for high speed tools with feeds about a third less are used. The proper use of cemented carbide tools frequently leads to average increases in production of about 60% with cast iron, 35% with steel, and sometimes as high as 500%, or as low as 15% with non-ferrous metals. Savings in production costs may run from 10 to 75%, averaging around 25%.

NON-SPARKING TOOLS

Alloys of copper with about 2% beryllium are heat treated to strengths as high as 175,000 to 200,000 psi and hardness of 350 Brinell without losing all their ductility. Because of the predominance of copper in them, they have non-sparking characteristics which make them suitable for hand tools for applications where sparking would be serious, such as around explosives, gas plants, petroleum refineries or gassy mines. Although they are much better than steel tools for this purpose, they are fairly expensive. The aluminium bronzes have also found some usage for non-sparking tools largely because of their wear resistance and great hardness.

Die Steels

MANGANESE NON-DEFORMING DIE STEELS

These are widely used for general purpose tools such as stamping and trimming dies, punches, thread rolling dies, special taps, master tools, gauges and blanking dies. They contain about 0.85—1% carbon, with 0.2 to 0.4% silicon, and generally 0.2 to 0.4% vanadium and 1.5 to 1.75% manganese. The composition is sometimes varied to include molybdenum, chromium and tungsten. All of these steels are oil hardening and usually will tend to crack if water hardened. Because of low dimensional changes during hardening, they are classed as nonedeforming. However, they have no red-hardness.

HIGH-CARBON, HIGH CHROMIUM STEELS

Steels of this type contain 1.9—2.35% carbon, 12—17% chromium, are oil-hardening and are characterized by a very high wear resistance, appreciably greater than that of the manganese non-deforming steels. Sometimes 1% molybdenum is added to impart air hardening properties. The combination of high resistance to wear, non-deforming nature, and air or oil hardening characteristics make them adaptable for a wide variety of tools for which wear resistance is desirable, such as dies for blanking, drawing, coining, forming, thread rolling or, trimming, and for shear blades, punches, lathe centres, guides and mandrels. As a rule they are not used for cutting tools for ferrous metals, although their high abrasive resistance makes them very satisfactory for cutting non-ferrous metals. Because of the high wear resistance of the tool and the relatively high thermal conductivity of the non-ferrous metal being cut, red hardness which these tools lack is not generally needed.

TUNGSTEN-ALLOY CHISEL AND PUNCH STEELS

The original steel of this type contained 1% each of tungsten, chromium and silicon as well as about 0.5% carbon and was known as 1 : 1 : 1 type. Now the amounts of tungsten and chromium are usually increased to eliminate the silicon and still retain the wearing properties. These steels can be bent without breaking even when hardened to Rockwell C 55—57. These are oil hardening and have low warpage, but are not non-deforming and hence are seldom used for dies, where this characteristic is of importance. They are used most frequently for punches, chisels, shear blades and battering tools.

Tools for Hot-Work

CHROMIUM DIE STEELS FOR HOT-WORK

Steels of this type contain 0.85 to 1% carbon and 3.25 to 4.25% chromium. These are air-hardening and are apt to crack on oil quenching if the chromium is on the higher side. Dropping the carbon content to 0.65 to 0.75% gives a steel, which is adopted better for oil hardening with the higher chromium content, but which is not so rigid nor so resistant to deformation at temperatures of about 260°C as those with the higher carbon. The addition of about 0.4 to 0.6% molybdenum increases the air-hardening characteristic marked by steels of this type are quite brittle in the fully hard condition, and hence, are not particularly adapted for dies, which involve more than a relatively small amount of shock. These steels show a considerable rigidity to deformation at moderate temperatures and hence their largest use is for gripper dies for hot-heading round headed rivets are bolts, for compression or hydraulic riveters or for many types of bending dies for hot work upto about 300°C.

TUNGSTEN DIE STEELS FOR HOT-WORK

Several steels that are satisfactory for hot working operations upto 595°C contain 0.25 to 0.6% carbon, 8–19% tungsten, 2.5—4% chromium and 0.3—0.6% vanadium, higher the carbon the greater the brittleness, as a rule. The red hardness depends largely upon the tungsten content so the steels are not recommended for use above 540°C if the tungsten content is less than 12% chromium on the high side tends to give good hardenability and high hardness, but has a tendency to increase brittleness. Vanadium adds some fatigue resistance and ability to withstand elevated temperatures without softening.

These steels in many respects are similar to the high speed steels. They are air or oil hardening with medium wear resistance, and are prone to crack if water-cooled in operation, so this should be avoided. As compared to other types of hot working die steels, these show much less tendency toward erosion at temperatures in the vicinity of 540°C. They have low warpage and high red hardness. Since they carburize readily, they should not be packed in a carbonaceous material during heat treatment, as their mechanical properties depend upon a low carbon content.

Steels of this type are used widely for dies for the hot forming of metal, such as forging dies for brass, and for many types of punches and shears for hot-work. They are also used as dies for the die-casting of aluminium and for permanent mold castings of brass and bronze. When the percentages of tungsten, chromium and vanadium are high, they are used for dies for extrusion of brass and for many types of forming and blanking dies, which are apt to become fairly hot in operation.

TUNGSTEN-CHROMIUM DIE STEELS FOR HOT-WORK

The use of these steels is a relatively new development. The hardest alloy, and the one which is best adopted for dies usually contains 6.5—7.5% of both tungsten and chromium and 0.2—0.6% vanadium for improving the fatigue resistance. To improve wear and erosion resistance and to decrease scaling on air cooling, usually 0.8—1% silicon is added. Sometimes, 1—1.5% molybdenum is added as a less expensive substitute for tungsten, attaining almost the same hardness.

These are all deep-hardening steels, which are air or oil-hardening. They have a medium wear resistance, good strength and shock resistance, low warpage and high red hardness. Although, they are inferior in heat resisting properties as compared to the tungsten die-steels, they are definitely stronger and can withstand more shock in use. They also may be water-cooled in operation and do not show the same tendency to deep cracking as the tungsten die steels. These steels have a tendency to carburize readily and care must be taken to avoid this as their value lies partially in their low carbon contents. They can be nitrided very successfully and have been found in some cases to give two to three times as long life in the nitrided condition as in the ordinary form. Their most general use is for dies, for die-casting aluminium and aluminium base alloys and for forging dies subjected to considerable shock.

The developments in tool materials and other metallic materials are far too many to be covered adequately in such a short resume. Keeping pace with the developments in technology, an amazingly vast number of combinations have been put forward. These, evidently have to consider the availability of the different raw materials. Every important development in technology has to wait till appropriate type of materials are available to put it into practice. This is true about all phases of development.

STEEL REQUIREMENTS OF RAILWAYS

9,28,000 tons of steel were acquired by the railways for 1957-58 against their requirements of 10,00,000 tons. This short fall has impeded the laying of certain new railway lines. The Khandwa-Hingoli section of the Central Railway and the Rourkela-Manoharpur section of the South-Eastern Railway were affected. At present only Khandwa-Hingoli line is affected. This information was given by the Deputy Minister of Railways, Shri S. V. Ramaswamy, in reply to a question by Shri T. B. Vittal Rao in the Lok Sabha.

INDIAN MICA

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MICA is a Complex Potash-alumina-Silicate containing proportions of Magnesia and Iron and also contains small amount of Soda, Calcium and Lithia and rearly fluorine. The Muscovite mica is a Potash mica having an approximate formula of H2KA13 (Si04)3. Phlogopite mica is a magnesian mica having a formula of H_2KMg_3Al (Si04)3.

Mica is used largely in Electrical Industries and in Insulating material and is also a good dielectric. Mica is resistance to sudden change of temperature and are good heat insulators. Mica possesses perfect cleavage and can be easily split to .001 inch in thickness.

There are 3 distinct mica field in India—(i) The Bihar Mica Belt is approximately 100 miles in length and 20 miles in breadth. There are about 700 mica mines in Bihar out of which about 200 mica mines are either fully mechanised or partly mechanised. Bihar produces the best quality Ruby Mica in the world. (ii) The Madras Mica Field is about 60 miles in length and 8 to 10 miles in breadth. The mica mines in Madras produces mostly green and black-spotted mica and some ruby coloured mica. (iii) The extent of the Rajputana mica field is about 200 miles in length and 60 miles in width. There is a small deposit of Phlogopite mica in Travancore. There is also a deposit of Vermicullite in Mysore.

We have learnt on good authority that research work in the U. S. A. and in Europe has resulted in the successful invention of synthetic mica. This is certainly a disquieting piece of news for the Indian Mica Industry. No one can be stopped from carrying on scientific investigation and research. There are some people who think that the news of invention of synthetic mica is just an international hoax. But we must not be lulled into a sense of false security. Scientists in Europe and in America have been working to find out a substitute for mica since World War No. 1. I am quoting below some extracts on the subject which are self-explanatory.

1. Extract from the October 1946 issue of the Harper's Magazine.

"Mica was another thing. None is mined in Germany, so during the war our Signal Corps was mystified. Where was Germany getting it? One day a certain piece of mica was handed to one of our experts in U. S. Bureau of Mines for analysis and opinion. "Natural Mica", he reported, "and no impurities". But the mica was synthetic. The Kaiser Wilhelm Institute for Silicate Research had discovered how to make it and—something which had always eluded scientists—in large sheets.

We know now, thanks to Fiat teams, that ingredients of natural mica were melted in crucibles of carbon capable of taking 2,350 degree of heat, and then, this the real secret, cooled in a special way. Complete absence of vibration was the first essential. Then two forces directly perpendicular to each other were applied. One, vertically, was a controlled gradient of temperature in the cooling. At right angles to this horizontally, was introduced a magnetic field. This forced the formation of the crystals in large laminated sheets on that plane".

2. Taken from The New York Times of August 1st 1948:—

"Work on strategic substance now is in pilot-plant stage.

A research program undertaken several years ago to develop the production of synthetic mica in commercial quantities and make the United States independent of foreign sources of this strategic mineral has reached the pilot-plant stage, the Army and Navy announced yesterday.

The Synthetic mica has all the characteristics of natural mica that is used widely in electronic equipment as an insulating material and resistors, the office of Naval research, The Army Signal Corps and the Navy Bureau of Ships reported.

The success of the research program also raises the possibility that mica parts may be fabricated directly from the synthetic product without the time-consuming and laborious tasks of sorting, grading, splitting and trimming necessary with natural mica.

The natural substance is a translucent silicate mineral with unique electrical properties that make it particularly suited for use in radio, radar, television and other circuits. It is split easily into thin sheets and can be shaped as desired. It is not affected easily by chemical corrosive agents.

Mica is mined extensively in India and Brazil. In spite of Government subsidy of $ 6 a pound, fields in this country were able to supply only 15% of the amount needed in the critical war years of 1943 and 1944, the announcement said. Commercial production of the synthetic product can fill this country's needs and make it unnecessary to stockpile for future emergencies.

U. S. Research Began in 1946

The synthetic is of a type known as fluorine phlogopite mica. Patents on mica substitute have been granted from time to time during the last thirty years, but none of them have resulted in the preparation of crystals large enough to be used in place of the natural mineral. Government sponsored research began with a Signal Corps contrast at the Colorado School of Mines of June 15, 1946. The Bureau of Mines Electrotechnical Laboratory began pilot-plant work on September 1, 1947, under a contract with office of Naval Research.

The Owners-Corning-Fiberglass Corporation has been retained under a consulting contract to make available all data and patents acquired by that company and the Corning Glass Works during investigation of mica synthesis in 1945 and 1946, the announcement said. Other groups also participated in the work.

The present Army-Navy research project is expected to solve the engineering problems involved in the synthesis of mica on an industrial scale and to define the conditions under which the manufacture of mica may be feasible economically.

Organisations interested in the possible application of fluorine-phlogopite mica were invited to communicate with the office of Naval Research for further details ".

Lately a substitute for natural mica has been successfully found out in some of the European countries known as SAMICA. This is natural mica in every respect. It is a type of mica paper produced from Ground Mica and may endanger the Mica Splittings Industry in India. Micanite Boards are prepared by using loose splittings with a binder or bonding material known as Glyptal a Phthalic anhydride and glycerine compound dissolved in alcohol. A varnish made with shellac and spirit is also used as a binder.

Most of the mica produced in India is exported to foreign countries and I am giving below the figures of export through Calcutta Port during 1957 :—

	Quantity in Cwt.	Value in Rupees
Block Mica	31,976	Rs. 2,74,51,396/-
Mica Splittings	1,05,483	Rs. 3,26,74,164/-
Scrap Mica & Washers	1,39,990	Rs. 8,24,701/-
Mica of Mixed description	2,180	Rs. 49,51,994/-
Total—	2,79,629	Rs. 6,59,02,255/-

If the consumption of Indian mica is analysed countrywise we find the position of the different countries as follows :

U. S. A.	Approximately	34.5%
U. K.	,,	20%
Germany	,,	19%
Japan	,,	12%
All other European countries viz : Holland, France etc.	,,	14.5%
	Total :	100%

It is still a long way before we can use Mica in the manufacture of electrical appliances in India. But we may look forward to progressive use of mica in India as envisaged in the FIVE YEAR PLAN.

Standard Specifications and Commercial Quality of Tough-Pitch Electrolytic Copper Wirebars

By J. L. Chender
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THE user of Electrolytic Copper wire bars has come to depend over the years on an empiric approach to the quality problem of his raw materials, which has yet to receive sufficient attention. The uninitiated do not even suspect that a problem exists in the first place, since international standards are available and currently used. Nevertheless, new fabricators must often set their own standards over and above those theoretically applicable. It will be our endeavour to review briefly the gap which must be filled by the practising technician.

STANDARD SPECIFICATIONS

There are two basic Electrolytic tough-pitch Copper wire bar specifications: the British BS—1036 and the American ASTM B5—43. Both specify the same electrical characteristics which the ASTM arbitrarily sets to 100% conductivity; the same chemical requirements that Copper plus Silver be not less than 99.90%; and the same freedom from standard physical defects. The BS—1036 adds the requirement that all impurities besides Silver and Oxygen be limited to 0.030%, keeping Bismuth and Lead to a maximum of respectively 0.0010% and 0.005% within this total.

In practice, standard wire bars usually have a conductivity of between 101% and 102%; a Copper plus Silver content of 99.93% to 99.98% with impurities other than Silver and Oxygen below 0.015%; and a good physical appearance. Nevertheless, the producers generally guarantee no more than full compliance with one of the standard specifications, and do not volunteer detailed information on their specific production.

The consumer soon finds out that his experience is not always the same with all such apparently suitable materials and that, in the absence of constantly verified chemical and physical analyses, he must depend on specific brands and reject others.

WIRE BAR PRODUCTION

The main reason for differences between brands of wire bars which all conform to international standards, is the particular refiner's production practice.

The wire bars are produced in reverberatory furnaces where cathodes are melted and the metal is poured into moulds mounted on special casting wheels. During the process, the metal is oxidized, then skimmed and finally deoxidized again to the proper "tough-pitch" oxygen content of between 0.020% and 0.060%. The process thus goes through several steps, each controlled by several variable factors which must now be examined.

We must first consider the physical feed of the wire bar furnace. In addition to cathodes, wire bars which have not passed physical inspection are normally fed back into the next furnace charge. In many refineries, the same applies to other Electrolytic Copper rejects sometimes including pure scrap. Such practices are common and of no consequence. In times of Copper shortage, however, some refineries were known to add Electrolytic scrap purchased from the outside and not carefully checked as to quality. The resulting quality defects soon became widely known and this practice was abandoned. It took several years for these refiners to live down such production methods.

Without looking to extremes, it should be pointed out that the quality of the cathodes necessarily varies from refinery to refinery. Basically, it depends on the chemical analysis of the anode, the purity of the electrolyte and the care with which the cathode is washed of tank slimes. The Electrolytic process generally sets a theoretical upper limit on any individual impurity to 0.002%. Nevertheless, we have seen several wire bar productions with some elements assaying 0.0035%. A typical example of the results can be seen in Bismuth, which is not specifically limited by the ASTM B5-43. The presence of an excess over 0.001% may cause a great deal of trouble in the fabricating process, and spoil the performance of an otherwise perfectly acceptable wire bar.

This is not the place to discuss the effect on Copper performance, of the various impurities deleterious in minute quantities. Suffice it to say that a refinery which feeds material into the wire bar furnace which is chemically close to the practically acceptable maximum tolerances must necessarily occasionally produce wire bars which may spoil great quantities of finished or semi-finished wire.

This is also true of Oxygen. The finished wire bar will have an Oxygen content between 0.02 and 0.05%. A controlled content is important both per se and in relation to other impurities, the results of which it may partially offset. The bath of molten cathodes is oxidized to a content close to 1% Oxygen and as the reduction takes place, there is danger of absorption of Hydrogen and Sulfur from the products of combustion in the usual fuel-fired furnace. Sulfur in particular must be kept very low and timing of the pour thus becomes very important to properly balance the content of absorbed gases.

The temperature and speed of pouring and cooling also affect gas absorption and the physical characteristics of the finished wire bar. While the metal is poured into the mould and until it sets, care must be taken for a quiescent transfer and cooling, in order to prevent malformations. These factors are not only of great importance, but are among the most common sources of trouble. Cold sets, blow holes, rough or concave surfaces, edgewise depressions, inclusions, oxidations and cracks are the results of faulty temperature and pouring control. Both the British and American specifications spell out the physical requirements and rule out the above described defects. The description is nevertheless a purely qualitative one and it is difficult to draw a line on the marginal product. There again, the consumer must rely on his own experience.

It is conceivable that the ruling specifications could be improved to give the fabricator a better advance idea of the wire bars which he purchases. The main trouble with such improvements would be in two directions. On one hand, the all-important physical characteristics are now fully, if inadequately, covered. To enlarge on them requires setting up more complicated qualitative limitations, i. e. create more grounds for arguments without necessarily improving quality in any where near the same proportion. On the other hand, while the ASTM could at least be brought up to the BS, by adding definite limits on Bismuth and Lead, it must be remembered that some deleterious impurities are not necessarily always deleterious by themselves, and are often functions of the whole and of the Oxygen content. As an instance 0.005% Iron without sufficient Oxygen may lower Copper conductivity several percent. But, in a well made tough-pitch wire bar, the same Iron content will have no effect on conductivity at all. This applies to some extent to other impurities and other characteristics. Furthermore, the same wire bar may be perfectly well used by one fabricator and disliked by another. Let us then examine now the requirements of the user.

WIREBAR CONSUMPTION

Wire bars are used for the manufacture of electrical wire and their name is derived from their use. First, they are preheated, rolled in a rod mill to a diameter of 1/4 to 3/4 inches, then the rod is pickled and drawn.

Heat treating is an integral part of the various operations and its economics are controlled by the number of operations required, their temperature and their length. These operations are, in turn, a function of the physical and chemical makeup of the wire bar and the specialized work of the fabricator. In practice, an efficient operation is one where the wire breaks the least, but this breakage may arise from various reasons.

The hot rolling of the wire bar may force into the finished rod isolated oxide inclusions. These inclusions are as much a cause for breakage as the chemical composition defects and, depending on their size, will appear at various stages of the drawing. Both physical and chemical defects which will be ignored in large diameter wire will often appear in finer sizes, rendering the wire bar useless for the intended purpose.

Generally speaking, frequent annealing will permit better drawing. But whether these extra heat treatments or the extra work resulting from the breakage, it is evident that wire bars which give such trouble should be avoided, even though they may fully conform to the standard specifications.

This becomes especially important when the manufacturing of magnet-type wire is involved. The fabricator risks to lose too much if he chooses a wire bar brand which is not certain to be fully suitable.

Last, but not least, each fabricator will find out from experience the performance of his own equipment, whether involving heat treating furnaces, rod mill or drawing benches. Automatic or automatically controlled machinery removes the human variation element and thus provides for constantly operating characteristics which allow for more leeway between permissible quality limits.

PURCHASING PRACTICE

We have tried to summarize in a few paragraphs the difficulties which may be encountered with wire bars which otherwise fully conform to standard specifications, and the main reasons behind these difficulties.

Each consumer of wire bars soon finds out the technique to use on the material which he purchases or the wire bar brand to use to conform to the most efficient operation. Unless a research program is set-up, the first alternative is often and unfortunately chosen. The result is that as soon as trouble has been encountered with one particular brand, it is rejected, even if the trouble has come from poor handling, or one occasionally bad batch of material, even if the wire bar production defects were promptly corrected. Since several brands are generally available in any given geographical location, the consumer often prefers to stay away from further experimentation and summarily dismisses further use of the offending brand. In the case of fine wire manufacturing, the risk becomes even larger.

This has created a brand loyalty which is sometimes illogical, but always welcomed by the benefitting producer. At times, "fashions" rule the consuming market as was the case in Japan not too long ago. These fashions originate in times of tight supply or difficult price situations, when some fabricators are forced by circumstances to change to a new brand. The performance of such material is widely discussed with some resulting wholesale loyalty switches.

The opposite is just as well true. A south European country has spread the bad reputation of a wire bar brand which is very well used everywhere else. The result has been that some drawers of building wire, in whose hands even worse material would have been perfectly suitable, were neglecting available wire bars to hunt for material hard to get at the same terms.

All these considerations, some sound and some not, have created a peculiar pattern of Copper purchasing by consumers, which is likely to undergo little change in the forseeable future. The advantage of this situation resides in the producers' competition to establish the best possible reputation within the same established international standards and as a result, the consumer is getting generally excellent material from the large refineries, and continuously improved wire bars from smaller producers.

THE ALL-INDIA SIGNAL & TELECOMMUNICATIONS SCHOOL PASSES OUT ITS FIRST BATCH OF TRAINEES

A colourful function was held at the All-India Signal & Tele-Communications School, Secunderabad, on 19—8—58 to mark the conclusion of training of the first batch of trainees at this institution. Shri B. Arora, General Manager, Central Railway, presided over the function. Shri S. A. Srinivasan, principal of the School, in welcoming the General Manager and requesting him to preside over the function and give away the prizes and certificates of merit to the successful trainees, referred to the circumstances leading to the establishment of this institution for the training of the Signalling staff for the various Railways.

In his address Shri Arora referred to the considerable importance now attached to the proper training of Signal & Tele-Communications staff and hoped that with the intensive training that they have received at this institution they would go forth into the field and give a good account of themselves and maintain the high traditions which the Department expects of them.

A programme of variety entertainment followed in which trainees and guest artists participated. The evening's programme was rounded off with a delightful dinner at the School Hostel.

INDIAN STANDARDS INSTITUTION NOTES

SPECIFICATIONS FOR HEAT DUTY FIRECLAY REFRACTORIES

Fireclay refractories intended for general purposes have been classified into high heat duty and moderate heat duty refractories, the latter being subdivided into two groups, namely Group 'A' and Group 'B' on the basis of certain well-established properties.

An Indian Standard Specification for Moderate Heat Duty Fireclay Refractories, Group 'A' (IS : 6—1958) has just been issued by the Indian Standards Institution. The standard covers the requirements for moderate heat duty fireclay refractories, Group 'A' for general purposes. It relates only to burnt fireclay refractory bricks and their shapes. This standard was first issued as a tentative standard as IS : 6—1949, and then further revised in 1953. As a result of the experience gained during these years, the Institution has decided to issue the same as a firm standard.

The Institution has issued another Indian Standard Specification for High Heat Duty Frieclay Refractories (IS : 8—1950) which covers the requirements for high heat duty fireclay refractories for general purposes. It relates only to burnt fireclay refractory bricks and their shapes. The second standard was also issued as a tentative standard in 1949, and again revised in 1953. As a result of the experience, the Institution has issued the same now as a firm standard.

Copies of the standards, published in English and priced at Rs. 1.50 and 1.00 each respectively, can be had from the offices of Indian Standards Institution, New Delhi, Bombay, Calcutta and Madras.

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SPECIFICATION FOR RECTANGULAR PRESSED STEEL TANKS

The Indian Standards Institution has issued an Indian Standard Specification for Rectangular Pressed Steel Tanks (IS : 804—1958). Pressed mild steel tanks have come into use to a large extent because of their ease in erection, facility in transport, standard construction, ease in dismantling and re-erection.

The specification lays down the requirements for the materials, fabrication, erection and supply of rectangular pressed steel tanks used for the storage of cold and hot water and certain other liquids and chemicals, under pressure not greater than the static head corresponding to the depth of the tank. This specification does not cover the requirements of tanks subjected to earth or other external pressure other than wind pressure and of those used to store liquids having temperature higher than 100°C.

Copies of the standard, published in English and priced at Rs. *2.00*, can be had from the offices of the Indian Standards Institution, New Delhi, Bombay, Calcutta and Madras.

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HORIZONTAL CENTRIFUGAL PUMPS FOR CLEAR, COLD, FRESH WATER

The Indian Standards Institution has drafted an Indian Standard Specification for Horizontal Centrifugal Pumps for Clear Cold, Fresh Water [Doc : EDC 35 (447)], which covers the minimum requirements for horizontal centrifugal pumps for clear, cold, fresh water.

The object of the specification is to provide guidance to both manufacturers and users of horizontal centrifugal pumps for clear, cold, fresh water. The specification covers only the minimum essential details for goods quality horizontal centrifugal pumps. The standard while defining the classes and types of pumps, their standard units, explains the terminology and nomenclature used in the standard, and prescribes general and specific requirements for such pumps.

Copies of the draft standard are being circulated freely, so as to elicite comments by 1 January 1958. Copies can be had from offices of the Indian Standards Institution, located at, New Delhi, Bombay, Calcutta and Madras.

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INTERNAL COMBUSTION ENGINES

The Indian Standards Institution has issued the following four draft Indian Standards, relating to Internal Combustion Engines, for comments from interested persons, before *5 December 1958* :

1. Code for Rating Test of Constant Speed Internal Combustion Engines [Doc: EDC 14 (396)], which applies to the following types used for marine, auxiliary, stationary and industrial purposes :
   - (a) Gas engines
   - (b) oil engines
     - (i) Diesel (compression ignition), air injection
     - (ii) Diesel (compression ignition), airless injection
     - (iii) Surface ignition type, and
   - (c) Carburettor type engines.

2. Code for Rating Test of Variable Speed Internal Combustion Engines [Doc: EDC 14 (392)]. This standard code applies to the following used for automotive purposes :
   - (a) gas engines ;
   - (b) diesel (compression ignition), airless injection and
   - (c) carburettor type engines.

3. Code for Type Testing of Constant Speed Internal Combustion Engines [Doc: EDC 14 (442)]. This standard applies to the following, used for marine, auxiliary, stationary and industrial purposes :
   - (a) Gas Engines,
   - (b) Oil Engines,
     - (i) Diesel (Compression Ignition) air injection
     - (ii) Diesel (Compression Ignition), airless injection
     - (iii) Surface Ignition Type,
   - (c) Carburettor Type Engines.

4. Code for Type Testing of Variable Speed Internal Combustion Engines [Doc: EDC 14 (441)], which applies to the following used for automotive purposes :
   - (a) Gas Engines
   - (b) Diesel (Compression Ignition), airless injection, and
   - (c) Carburettor type Engines.

Copies of the draft standards, can be had, free on request from the offices Indian Standards Institution, New Delhi, Bombay, Calcutta and Madras.

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