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Future Trends in Locomotive Power for the World's Railways

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PREDICTING the future is always a fascinating, although quite often a somewhat risky business. This is particularly true in forecasting probable trends in railway motive power developments for the next decade.

Barring a revolutionary technological break hrough future development of locomotive power in all probability will be limited to (1) refinement of the diesel-electric locomotive, (2) further development of the gas turbine-electric, (3) progress in electrification and (4) application of atomic power to locomotives. Each of these is based on the electric transmission of power from the prime mover to the rail. In the experience of a vast majority of the world's railways, this system is the most efficient, the most reliable, the most easily maintained, the easiest to operate and in the long run by far the least expensive.

Obviously the direction in which motive power will progress is directly related to the operating, maintenance and financial requirements of the railways. In addition, continued economic development in areas throughout the world will also have a decided effect on railway practices. As the industrial output and the demand of the people for more and more goods increases, transportation facilities of necessity will have to become more efficient to keep pace with this stepped-up industrical production and the increased demand for consumer goods. Railways are pre-eminently fitted for such a role as no other form of transportation can approach their efficiency for the mass movement of goods.

In an expanding economy, railways will be unable to afford the luxury of working a freight car only 50 miles per day, or of taking four hours to drag up grade which could be pulled in one hour. More and more power will be needed, and only machines can supply power in the quantities which will be required.

In the light of the requirements of an expanding economy, what are the relative merits and the chances for development of each of the four types of motive power?

DIESEL-ELECTRIC LOCOMOTIVE

Considering all the factors on which a sound estimate of the future can be based, it is reasonable to assume that the diesel-electric locomotive will provide the bulk of motive power requirements for at least the next ten years, and probably for quite a bit longer. Diesel engine progress over the past fifty years has been truly significant. The first diesel engine for locomotive service in the U. S. was built by General Electric in 1918. Since it was a naturally aspirated engine and represented a real pioneering effort, it had an output of 25 horsepower per cylinder. In 1935, before turbosupercharging was perfected, a horsepower of 110 per cylinder was normal. At the present time, the type F engine in the universal line of General Electric (U. S. A) locomotives is rated 165 horsepower gross per cylinder and under test conditions engines have been run at over 200 horsepower per cylinder. All these ratings are on cylinders of nearly the same size.

With such a record of past progress there is every reason to believe that the diesel-electric locomotive will continue to improve in reliability and specific fuel consumption; that further reductions will be made in maintenance cost; and that it will have even longer life in the future. Considerable sums of money are being spent by private industry in the United States for continued research on diesel locomotive power which is indicative of the confidence we have in the future of the diesel-electric locomotive. Changes which will probably occur within the next ten years will be mostly evolutionary rather than revolutionary. They will include a continued growth in specific horsepower, elimination of maintenance points, increase in reliability, and the perfection of a better adhesion loss detection and correction device to allow maximum use of high horsepower per axle.

In connection with mainterance, it is not improbable at all that in the far distant future a locomotive will be sealed at the factory and not require any maintenance during its entire life. Steady progress is already being made along the path of developmpent leading toward such an ideal objective. Many positive steps already taken in this direction include the wide use of synthetic resins in impregnating coils and the complete encapsulation of some control elements. These synthetic materials utilize the good properties of natural oils and resins while eliminating those that are undesirable. Each future step will be made commercially available as soon as it has been thoroughly proved in service as well as in the laboratory. The trend is inescapable—the eventual development of a maintenance-free locomotive.

GAS TURBINE-ELECTRIC LOCOMOTIVE

Although General Electric has manufactured a total of 55 gas turbine-electric locomotives, all of these have been purchased by one railway, the Union Pacific. The reason for this lies in several unique factors which make these units well suited to operation on this particular road. In the Western United States there are large amounts of residual fuel suitable for use in the gas turbines. Even though the specific fuel consumption of the gas turbine is higher than that of a good diesel engine, the resulting overall cost is competitive. Also, Union Pacific has long hauls, with extremely high tonnages at high speed. This requires full power from the locomotive for long periods of time, the condition under which the gas turbine is at its best. It is quite common for one of the 8500 hp. locomotives to haul a 6000 ton freight train at 65 mph on the level. Although the majority of the run is quite flat, the ruling grade is 1.14% for 34 miles, and good speed must be maintained there also.

What then is the application of the gas turbine other than to Union Pacific? Where conditions are right; that is, where there is a good supply of residual fuel, where average speeds and tonnages are high, and where schedules are frequent enough to ensure high locomotive utilization, the gas turbine is a fine locomotive. But the number of railways in the world where all of these conditions exist is quite small, and we see only limited application of this type of locomotive. Twenty-five of the locomotives built for the Union Pacific are 4500 hp, which appears to be just about the lower horsepower limit. The problems, however, are economic, not technological, and accelerated volume of freight traffic may produce a demand for gas turbine locomotives both sooner and in greater quantity than what we now anticipate.

ELECTRIC LOCOMOTIVE

The electric locomotive is another form of motive power that has been hampered by economics rather than engineering. In fact a great many engineers are firmly convinced that the electric is the greatest locomotive ever conceived. It meets all the requirements of good engineering—it is simple, it is clean, it is powerful, it is durable. But unfortunately, where there is not enough traffic, it is also uneconomical.

There are some other factors which influence electrification of railways. The inherent cleanliness of electric power and the ability of electrically-powered trains to operate underground have already forced the electrification of lines which otherwise would not have been ready for that step for quite sometime Also, steep grades have brought electrification to some lines because of the high power necessary for proper operation of the railway and the ready availability of such power only with electrification.

Without doubt, the future trend of electrification will follow much the same pattern as in the past. It will be used wherever and whenever traffic density is high enough and the price ratio of electrical power to diesel fuel is low enough. Also, the cost of money must be low enough to permit attractive returns on the large amounts of capital required for overhead structures and substations. Relatively new developments permitting the use of commercial frequency high voltage a-c make electrification more attractive by reducing this investment.

What of the future? Without question, electrification of additional systems and expansion of existing lines will continue, probably faster than has been the case in the past. However, as is the case with the gas turbine, only in a few places do all the required elements exist, and for some time the percentage of trains hauled with electric motive power will increase rather slowly. In certain areas electrification may be justified as a means of conserving natural resources or obviating dependence on imported fuel, even though the direct economy might not warrant the investment.

ATOMIC POWERED LOCOMOTIVE

Probably no term has more attention commanding

ability these days than "atomic power". Can it, will it be applied to motive power for railway use? Undoubtedly it will; but we believe that its widest application will be for central station generation of power to be used on the railways via electric locomotives.

The problems which surround railway application of nuclear propulsion by means of a mobile power plant are far greater than any yet approached in either the railway or atomic power engineering fields. According to the most recent studies the weight of the reactor shielding alone would exceed the permissible weight per axle of the locomotive. This figure does not take into account any of the actual propulsion equipment required on the locomotives. Additionally, the danger involved in the day-to-day operation of a locomotive with a reactor on board would present extremely serious hazards to life and property.

It is evident that, at the present state of the art, an atomic locomotive which carries a reactor on board is highly unlikely. But work in progress in laboratories throughout the world may some day make the self-contained atomic locomotive a reality, particularly if a direct conversion device with the required shielding and having a high enough rating can be produced.

MOTORIZED WHEEL

Another development along a different line in the motive power field, so new that it really should be included in a discussion of the future, is the motorized wheel. A wheel which incorporates an electric motor inside the hub of rubber tire has been designed and thoroughly tested by General Electric. The motor drives directly to the rim through a single set of planitary gears, and the unit can be mounted directly on the side of a vehicle or suspended by means of any type of spring system. Power can be drawn from a diesel-electric or gas turbine power plant, or from an overhead trolley wire or third rail.

Although this wheel was originally designed as a drive system for off-highway vehicles, several studies of rail haulage problems involving particularly severe grades indicates that a rubber-tired locomotive may be a unique and significant development. A line laid with extra long concrete ties projecting on both sides of the rails would provide a roadbed for the locomotive, and grades of 15% could be negotiated satisfactorily while hauling conventional freight cars. The rubber-tired locomotive is not intended as a replacement for the conventional type, but would be used for specific, difficult applications.

SUMMARY

In summary, for the next ten years at least, the diesel-electric locomotive will continue to occupy the major place in the motive power of the world's railways. Electric locomotives will become increasingly important as traffic density increases or other compelling factors enter the picture. Gas turbine-electric locomotives will fill a special need for some railways, and atomic power will be used in stationary electric generating plants to supply energy for railway electrification. Great strides will be made in reduction of maintenance, and simplification of components. Whatever the form of motive power, standardization on a single locomotive type for entire railway systems will become virtually universal.

All this progress in the development of motive power is aimed at producing railway progress—using electric power and machines to lift the load from the backs of human beings. The more this is done the more sound will be the economic progress of the railways, and a sound railway system is the keystone of a solid national economy.

Indian Standards Presented

To assist in the promotion of standardization movement in Iran, the Indian Standards Institution presented on 31st May, a complete set of its publications consisting of some 1400 Indian Standard Specifications, copies of its Journal ISI Bulletin, Handbook of Publications, etc. published by it during its thirteen years of existence, to Edardh Standards-ha, the National Standards Department of Iran which was established about 3 years ago. Mr. H. Hakimi, the First Secretary in the Iranian Embassy in New Delhi, received at Manak Bhavan, the Headquarters of ISI, the gift on behalf of his country's Standards Department from Dr. Lal C. Verman, Director, ISI.

A. C. Traction Comes to India

By H. D. Awasty
General Manager & Chief Engineer, Railway Electrification

For over 30 years accustomed to D. C. electric traction, Indian railways decided in 1957 to switch over to A. C. traction. Despite the many difficulties inherent in the adoption of new techniques, they were able to energise the first rail section on A. C. towards the close of 1959, and are now well set for the achievement of second Plan electrification targets. All this is being done with maximum emphasis on the use of Indian materials and trained manpower.

THE first electrification scheme on the Indian railways was completed around Bombay in 1925, followed by electrification from Madras to Tambaram in 1931. These schemes used the 1,500V D. C. overhead system of traction.

Before sanctioning the electrification of the suburban lines from Howrah to Burdwan on the Eastern Railway in 1954, the choice of the traction system between 3,000V D. C. and 25kV 50 Cycles A. C. was carefully gone into, but as the A. C. system on industrial frequency had not been extensively used, it was considered prudent to adopt 3,000V D. C. system. This project of 88 route miles was completed and put into operation in successive stages, the last section being commissioned in August 1958. It is a matter of some pride that the entire scheme of electrification was carried out under the technical control and supervision of the Indian railway engineers.

The second Five Year Plan made a provision for 826 route miles of electrification at a cost of Rs. 80 crores on 3,000V D. C. system. The lines selected were those where an increase in line capacity was urgently needed on account of anticipated increase in coal and steel traffic which could not be carried by steam traction.

Some time in 1951, the French National Railways had published a report on the potentialities of A. C. traction system on industrial frequency. The developments subsequent to 1954 were, however, so rapid and satisfactory that the Indian railways decided to make further enquiries.

In 1956, a comprehensive report was obtained from the French National Railways on the comparative merits of A. C. and D. C. systems on certain sections of the Indian railways. The report showed conclusively the operational and financial advantages of adopting the A. C. system. Subsequently, comparative tenders were called for D. C. and A. C. rolling stock. It was also made sure that the effects of single phase A. C. traction would not adversely, affect the power supply system.

MOMENTOUS DECISION

Only thereafter did the Indian railways take the momentous decision in 1957 to adopt A. C. system as their future standard and also to convert the D. C. electrification at Calcutta to A. C. at a suitable opportunity. Because of comparative cheapness of A. C. traction, it was found possible to increase the electrification mileage within the Plan provision.

The A. C. 25 kV 50 cycles system being new to India, the Ministry of Railways entered into a contract for technical collaboration in August 1957 with the French National Railways. A number of French Railway officials are now stationed at Calcutta at the headquarters of the Railway Electrification Administration. As and when necessary, French Railway experts also come from France to advise us on specific problems.

The electrification work has been phased in close co-ordination at all levels with the power supply authorities and the Posts and Telegraphs Department. The work now going ahead may perhaps be considered under two phases.

Phase I

(i) From Durgapur to Gaya, with a branch line from Pradhankanta to Pathardih on the Eastern Railway.

(ii) From Asansol to Rourkela, Tatanagar to Sini, Kandra to Gomharria, with a branch line from Rajkharswan to Dongoaposi on the South Eastern Railway.
These two cover a route mileage of 464, and a track mileage of 1,139.

Phase II

(i) From Gaya to Mughalsarai, Sealdah to Ranaghat, Dum Dum to Bongaon on the Eastern Railway.

(ii) From Kharagpur to Tatanagar on the South Eastern Railway.
These two cover a route mileage of 298 and a track mileage of 620.

Over and above these, detailed project studies have been made on a number of other sections on the Eastern, South Eastern and Southern Railways.

SEPARATE ELECTRIFICATION ADMINISTRATION

The nature of the work is highly technical and its magnitude colossal. Since the Eastern and South Eastern Railway Administrations had their hands full with the work of remodelling of large yards, doubling and construction of new lines, a separate Administration with headquarters at Calcutta was set up in September 1957 to direct railway electrification projects. The Administration now has 104 officers and 588 supervisory technical staff. A number of officers are posted at Asansol and Chakradharpur to supervise the field work; 18 officers and 32 supervisory staff, including drivers, instructors etc. were sent to France for specialised training and they are now all back to give us the benefit of their specialised training.

One hundred and ten A. C. locomotives which were ordered in 1957 have now started coming to India. Trained drivers and staff would be needed to run and maintain them in good condition. A Loco Training School was, therefore, set up at Asansol in May last to give special instruction to 600 drivers and assistant drivers, who have been selected for their aptitude from amongst the steam and diesel loco drivers already in railway service. We have obtained a "school car" from France which is equipped somewhat like an electric locomotive. This car is invaluable in training the staff in locating and removing defects likely to occur in a locomotive on the run. The drivers are given intensive training on this "school car" before they are permitted to handle a locomotive on line.

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(Sd.) **S. M. Sivaprakasam**
Signature of Publisher

Dated: 1—3—1960

The power supply required by the railways is obtained from five regional grid supply authorities including D. V. C., the Bihar State Electricity Board and the West Bengal State Electricity Board. All the power supply authorities concerned have placed orders for the essential substation equipment and are now progressing the construction of substations and the erection of the transmission lines to feed the substations. It is the function of these authorities to convert the 132 kV supplies to 25 kV single phase, which railway electrification will carry over their own short feeder lines to switching posts erected just alongside the railway tracks.

The Posts and Telegraphs Department are busy replacing the aerial telegraph and telephone lines running along the railway track under electrification by specially designed aluminium sheathed cables. This work is, however, far more complicated than it sounds. After detailed and prolonged studies an entirely new technique has been evolved for use in India. On the railway side miles and miles of underground cables and new end equipment specially designed for the new conditions are being installed at over 100 stations in Phase I alone.

PROGRESS IN PHASE I

Rajkharswan-Dongoaposi, with 45 route miles of double line carrying iron ore to India's steel mills, has been selected as one of the pilot sections. A temporary 66/25 kV substation has been erected and commissioned. A short length of track near Kendposi was energised and the first A. C. locomotive made its inaugural run on December 15 last year when members of the Permanent Commission of the International Railway Congress Association visited Calcutta after their meeting in New Delhi. A length of about 15 route miles was energised early in March this year for carrying out trials on A. C. locomotives.

The second priority section to be electrified is the Asansal-Dhanbad section with a route mileage of 38. The substation which will serve this section is being set up at Kumardhubi by D. V. C. making use of some 25 kV equipment obtained from the French National Railways by the Railway Electrification Administration. Both these sections are likely to be commissioned by the end of June. In another two months, therefore, it is expected that over 80 route miles would be operating upon 25 kV A. C. system. Trials on these sections will not only give the necessary footplate training to the drivers but also provide invaluable data to Indian engineers to test the efficiency of the equipment designed by them for the first time in India and to remove defects, if any, before the remaining sections are commissioned towards the end of this year.

The progress of works in all the sections in Phase I, is in an advanced stage of completion. Half of about 31,000 foundations for structures have been cast and masts erected. A number of ancillary works, such as construction of new electric loco sheds, raising of bridges and alteration to tunnels to provide the necessary electrical clearance, staff quarters to house the traction staff etc. have almost been completed.

To facilitate operation and maintenance, as many as 62 supply control posts will have to be erected alongside the electrified route. All these posts are arranged for unattended operation, the switching operations being centrally controlled from two remote control centres, one at Asansol for the Eastern Railway, and the other at Chakradharpur for the South Eastern Railway. Orders for the necessary remote control equipment have been placed and installation work is in hand.

EMPHASIS ON INDIGENOUS TALENT AND MATERIALS

From the above it would be seen that railway electrification is not a turnkey job, constructed and supervised by foreign experts. Indeed, a major portion of the work is directly carried out by Indian engineers and the responsibility for the entire scheme is that of the Railway Electrification Administration.

The progress of work in Phase II is also very satisfactory. The ancillary works are in hand. A large number of foot bridges at stations have been raised to provide necessary clearances. Tenders have been invited for supply and erection of overhead equipment on the sections Gaya to Mughalsarai and Tatanager to Khargpur.

Unlike the earlier tenders for sections in Phase I, the work of designing the overhead equipment has now been undertaken by the Railway Electrification Administration which has resulted in reducing costs and saving in foreign exchange. It has been stipulated in all the contracts for overhead equipment that maximum use shall be made of indigenous labour and materials.

The Railway Electrification Administration has been

EDITORIAL NOTICE

The Editor invites contributions from the Engineers and Works Managers of Railway Workshops as well as company-managed Engineering Workshops in the form of original articles, research write-up, production technique etc. relating to Workshop practices in India and abroad. Besides, suggestions for the technical improvement of various aspects of Railway Workshop practice are also invited with suitable write-ups accompanied by photographs wherever possible.

Contributions are accepted on the distinct understanding that they are sent solely to "THE INDIAN RAILWAYS WORKSHOP MAGAZINE". The Editor accepts no responsibility for the views and statements of the contributors.

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Editor

making sustained efforts in locating and encouraging indigenous industries. A railway galvanizing plant has been set up at Chittaranjan. From the time it was commissioned in May 1959, over 11,600 steel masts have been galvanised. For the first time, copper contact wire and cadmium copper catenary wire have been manufactured in India. There are good reasons to expect the indigenous manufacture of solid core insulators to materialise within the course of this year. A few of the bronze fittings are already being manufactured in India and efforts are being made to see that aluminium bronze fittings are also manufactured in India before long.

Despite innumerable difficulties, not the least being the new technique in A. C. electrification, satisfactory progress has been made uptodate and it would be fair to anticipate that the railway electrification scheme will not fall short of the targets set for the second Five Year Plan.

REFRACTORIES

The Indian Standards Institution has prepared the following four draft specifications covering refractories used in steel plants, foundries, railways, etc :

1. *Magnesite Refractories for Steel Plants* [*Doc*: *SMDC 18 (216)*]—This draft specification lays down requirements for magnesite refractories for use in steel plants after taking into account the quality and availability of the indigenous raw material, the needs of the steel plants, and the manufacturing and trade practices followed in the country in this field.

   The main field of application of magnesite bricks in steel plants is in the hearth of basic arc and open hearth furnaces. Substantial quantities are also used in the lining of barrel type inactive mixers, in back walls, front walls and end walls of furnaces, and recently in the tope course of the checker setting.

2. *Pea Magnesite* [*Doc*: *SMDC 18 (217)*]—The draft specification covers the requirements for dead-burned magnesite, commercially known as pea magnesite used in steel plants. 'Pea magnesite' is obtained from the raw magnesite after calcining it in a rotary kiln at a temperature between 1 650° and 1 750° C and is named so because, after calcining, the particles are rounded and have the shape of a pea. It is used for brick-making, monolithic hearths and in the ramming mixtures for furnace lining.

3. *Fireclay Cupola Refractories* [*Doc. SMDC 18 (218)*]—The draft specification covers the requirements for fireclay cupola refractories. The object of the draft specification is to make available suitable refractories for lining cupola furnaces which are bound to be established all over the country in view of the heavy programme of industrialization visualized in the Third Five-Year Plan.

4. *Recommendations for Refractories for Railways* [*Doc*: *SMDC 18 (219)*]—This draft standard is a revision of IS: 194—1950 Recommendations for Refractories for Railways. Its purpose is to indicate the types of refractories most suited for different locations and classes of work on the Indian Railways. The recommendations are expected to assist the Railways in the standardization of designs and use of the right type of refractories in the different locations. The draft standard is also expected to assist the refractory manufacturers in regulating their production programmes.

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Thickness of Sheet and Diameters of Wire

The Indian Standards Institution has recently published IS: 1137-1959 Thicknesses of Sheet and Diameters of Wire which lays down the basic thicknesses of sheet and diameters of wire in millimetres. Up till now, in trade and technology, the sizes of sheet and wire were expressed in terms of the various sheet and wire gauges used in the countries following the fps system of weights and measures, for example BG (Birmingham Gauge), SWG (Standard Wire Gauge), etc. The decision of the Government of India to adopt the metric system of weights and measures makes it essential that the sizes of metal products should be standardized in metric units. Accordingly the following aspects were kept in view while undertaking this work :

(a) Maximum possible advantage should be derived from the inherent qualities of metric system by the adoption of preferred numbers for the selection of sizes.

(b) International co-ordination should be achieved to as great an extent as possible.

Permanent Way—Backbone of Railways

By Karnail Singh
Member, Engineering, Railway Board

An army of 200,000 trained Indian Railway workers is each year assigned the duty of maintaining and periodically renewing 52,000 miles of "permanent way", a job vital to safe and efficient travel. Into this permanent way, conservatively valued at Rs. 7,500 million have so far gone some 6,000,000 tons of steel rails. The author here traces the century old evolution of the permanent way in India, refers to contributions of international significance made by Indian Railway engineers in this important field, and outlines the task that faces the young engineer in India.

THE track for railway trains, comprising a pair of rails fixed on sleepers, is known in railway parlance as the "permanent way". It is the backbone of rail transport. The expression permanent way is a legacy of the earliest days of railway history, when the track used for haulage of heavy coal tubs in English collieries was adopted for use by the world's first railway. By and large, the tracks used in collieries were temporary, because they required frequent transfer to new locations. With the emergence of the steam locomotive, and its use for drawing a train of vehicles, it became necessary to use stronger and heavier tracks which did not require movement from place to place. To distinguish them from the earlier temporary ways, the railway line was called the "permanent way", and has ever since remained a permanent feature of the landscape.

In its earliest form, the track used by collieries consisted of stone slabs or timber baulks set flush with the road surface. Later the timber baulks were covered with iron plates to protect them from wear, and angle irons were fixed to their outer edges to confine the wheels to the track. The terms "plate-layer" and "plate-laying" are echoes of this period. By 1820 the plates had been raised above the surface of the road and the flanges transferred from the rails to the wheels. From these humble beginnings the ingenuity and the perseverence of many generations of railway engineers have evolved the present efficient permanent way, a complex structure of specially contoured rails, and a variety of sleepers and fixtures, which together provide a firm but resilient bed on which the giant locomotives and trains of the 20th century thunder past at speeds which perhaps Stephenson, the father of the railways, did not even dream of.

Its name, no less than its look of solid permanence, has led to the mistaken impression that, once laid, the permanent way is there for good and requires only occasional attention and care. One has only to watch a mail train tearing across it a mile a minute or the hundreds of wheels of a freight train roaring over the "aching" track to appreciate the terrific punishment the permanent way has to withstand day in and day out, all through the year. Naturally, no permanent way can be really permanent under such heavy wear and tear. Even the best of track requires constant care through regular maintenance and complete renewal every 25 to 40 years, depending upon the volume of traffic that passes over it. I takes a lot of effort to keep this backbone of the railways in proper shape in all types of weather—through the hot summer, through heavy rains during the monsoon months, through the sand storms of Western India and through the bitter cold of the northern parts of the country.

P. W. ARMY OF 2,00,000

The Indian railways spend well over Rs. 100 million every year on keeping up their track, and an army of 200,000 workers is assigned to handle this gigantic task of maintaining and renewing it. The permanent way constitutes the most valuable single asset of a railway, and on its efficient design and proper maintenance depend not only the speed and smooth running of trains, but also their safety. The 52,000 miles of track (including sidings) on the Indian railways would at a conservative estimate be valued today at Rs. 750 crores, a very substantial part of their total assets.

Essentially, the permanent way consists of a pair of rails, held level a fixed distance apart on sleepers by suitable fixtures, the whole resting securely in a bed of ballast about eight to ten inches deep, with suitable devices to prevent its movements laterally or longitudinally under traffic. This distance between the rails, called the gauge, is 5′—6″ on the broad gauge, 3′—⅜″ on the metre gauge and 2′ or 2′—6″ on narrow gauge.

Unlike the road vehicles which can negotiate steep gradients, the length and weight of railway trains makes it necessary to provide only easy gradients and curves on the track. The permanent way is, therefore, laid on carefully prepared earth formation designed specifically to ease the curves and gradients as far as possible. The most important element of the permanent way are the rails and the sleepers, but the ballast also plays an essential part in providing stability to the track, ensuring proper drainage, and giving it the resilience necessary for smooth running.

WORLD'S FIRST RAILS

The first rails were short lengths of cast iron, barely three feet long. In 1820, these gave way to the fish-bellied wrought iron rail, 12 to 18 feet long. A decade later, under the impact of the industrial revolution, and with rapid improvements in the production of steel, the concept and production of rails underwent a radical change. By 1837, the first double-headed steel rails had appeared, their design based on the expectation that when one head had worn out, the other could be used. This expectation was not realized in practice.

The next step was, therefore, obvious. The head was made heavier than the foot, to give the "bull-headed" rail, till lately in widespread use in England and in many other countries.

The first railway line in India, laid in 1853 between Kurla and Thana, consisted of 65 lbs. wrought iron double headed rails. These soon gave way to bull-headed rails, as in England. However, in 1857, the Indian railways also adopted a new design of rail, used for tramways and on railway bridges in England, which because of the design of its foot is called the 'flat-footed rail' (F. F. rail). The Indian Midland Railway, constructed in 1890, used the 80 lbs. F. F. rail extensively.

INDIA'S PIONEERING CONTRIBUTION

The use of the F. F. rail for railway tracks was pioneered in India and has been developed consistently over the past 70 years by Indian engineers, and is today acknowledged, all the world over, as the most rational and economical rail section. Indian railway engineers can feel legitimately proud of this contribution to permanent way engineering.

As the locomotives and vehicles used by the railways became heavier, and the speeds of operation increased, it became necessary to make the rails sturdier to withstand the greater strain imposed on them. The 65 lbs. rail used on the first Indian railway, was therefore replaced successively by heavier rails of 75, 80, 90 and 100 lbs. per yard on broad gauge. Besides increase in size, important advances have been made over the past century in the quality of steel used for rails. The heavy duty to which they are subjected requires a hard wearing surface combined with a resilient body. Further, the repeated impacts given by the numerous wheels of a train, calls for high fatigue strength. These are trying specifications.

Failure of the rail table by flaking, and of the rail section under fatigue, have understandably set problems to the permanent way engineer from the earliest times. The development of work hardening chromium steels has been a big step forward, but the solution of these problems is still not in sight. During the last decade, however, these problems have been tackled with vigour. Helped by modern techniques and painstaking research, the causes underlying these failures are now understood much better. The research programme now under way in various countries, in which the Indian Railways Research Centre at Lucknow is taking keen interest, will, it is hoped, lead to a satisfactory solution of these problems in the near future.

VAST QUANTITIES OF STEEL USED

The importance of efficient and economical rail design cannot be over emphasized. The quantity of steel used for just this one item of the permanent way is really staggering. The 52,000 miles of track in India have used over 6,000,000 tons of steel rails, and their periodical renewal entails an annual purchase of 200,000 tons of steel. Even small savings in the weight of a rail will, therefore pay rich dividends.

In the case of the Indian railways, the economical design of rails is of special importance because these massive quantities of steel have to be imported not only for renewal, but also for our ambitious new construction. Our steel plants can meet only a part of the railways requirements, and even today a substantial quantity of steel rails has to be imported.

However, after the three steel plants set up during the present Plan reach full production, India will become self-sufficient in this major item of railway equipment.

The present standard rails used on the Indian railways have been evolved by Indian railway engineers over the years, and the railways Research, Design and Standards Organisation continue to give this matter constant thought. Although these I. R. S. rails have given excellent service in the past, it is necessary to look ahead and design new sections which will give equally satisfactory service in the more strenuous conditions of the future. The size of the rail is governed by the volume of traffic carried on it and has of necessity to be increased to stand up to more frequent services, higher axle loads and higher speeds.

This development was foreseen early in the second Plan, and has been under examination by a high level committee since November 1958. Their detailed investigations including a study of developments in other countries have led to the development of a new 105 lbs. yard rail for trunk routes on the broad gauge railways.

EVOLUTION OF THE SLEEPER

The sleepers, which support the rails, and keep them a fixed distance apart have, like the rail, seen considerable development from their humble beginnings early in the 19th century. The earliest sleepers were stone slabs laid longitudinally, the rail being set in chairs fixed to them at intervals. The first railway line in India between Kurla and Thana was laid on similar sleepers.

As good timber was plentiful in India, stone was gradually replaced by wood, laid longitudinally at first, and then by cross sleepers which carried the rails on cast iron chairs. About the turn of the century, when a shortage of wooden sleepers developed, cast iron was used not only for the chairs, but for sleepers as well. These imported cast iron sleepers consisted of two circular pot bowls connected by a tie bar, the rails being supported on the inverted pots in fixed jaws, while the tie bar maintained the track gauge.

The difficulties in packing these sleepers, the necessity of providing a wide spacing between sleepers at rail joints, the tendency of rails to creep due to unsatisfactory anchorage to the sleepers, as well as poor lateral stability of the track laid on them led to a succession of designs both in India and abroad.

Variations of the circular pot sleeper used elliptical pots and different methods for holding the rail and making gauge adjustments. The urge to overcome the disadvantages of these designs led to the development of the plate sleeper designed both for carrying bull-headed and flat-footed rails.

INDIAN ENGINEERS' CONTRIBUTION

Indian permanent way engineers also developed a number of cast iron plate sleepers, during and after the first world war. Of these the 'Fowler' of the Oudh and Rohilkund Railway; the "lines" and "haughton's" of the Eastern Bengal Railway; the 'NWR' type of the North Western Railway, and the 'Denham' and 'Olphert' of the East Indian Railway deserve special mention.

With the setting up of the Central Standards office in 1924, the best features of these designs were put together to produce the first IRS cast iron sleeper—the CST I. Based on careful observation, experimentation and trials with this sleeper for over ten years from 1926 to 1935, this design was modified from time to time.

The nineth design, known as C. S. T.—9, is the present standard. The base of the C. S. T. 9 sleeper is not flat, as in the case of its fore-runners, but has shallow pockets on either side which effectively retain the ballast packing, to give increased lateral and longitudinal stability. A shallow keel provides additional anchorage and lateral stability. The rail is carried by fixed jaws on either side of the rail seat, and is fixed in position by a two-way double key applied against the inner jaw. The key may be driven from either side of the inner jaw which has a double taper, and thus forms an effective anti-creep device. A narrow rail seat prevents rocking of the sleeper during movement over the rail it holds. An easy and effective anti-sabotage feature (obtained by using reverse jaw sleepers on each rail length); ease of gauge adjustment; and improved support at rail joints due to less width are other advantages of this design. Moreover, this sleeper weighs only 96 lbs. against 120 lbs. for the earlier pot sleeper.

Considering its first cost and service life, the C. S. T. 9 is under Indian conditions the most economical sleeper. The annual cost of a C. S. T. 9 sleeper is estimated at only Rs. 0.36 against the wooden sleeper's Rs. 1.41 and the steel sleeper's Rs. 0.76.

TYPES OF SLEEPERS USED IN INDIA

Although the earlier cast iron sleepers were imported, their production within the country has been developed gradually over the years, but the Indian Railways' mainstay has been wood and steel sleepers. In the post-war years there has been a sharp drop in the supply of wooden sleepers from Burma, and our own forest resources have also been depleted. As steel is a vital raw material for many other industries, the manufacture of steel sleepers was also out of the question. On the other hand, pig iron is freely available, and the C. S. T. 9 sleeper is a simple casting which can be produced even by small foundries. The development of the C. S. T. 9 sleeper has, therefore, become a virtue forced by necessity.

It is satisfying to know that, in the very near future, the Indian railways' demands for sleepers will be met entirely by indigenous production. Although this sleeper has achieved significant success, railway engineers continue to look ahead, and are planning for the day when cast iron itself may require replacement by a cheaper and more abundant material.

Towards this end, both reinforced concrete and prestressed concrete sleepers are being developed, and Indian engineers using the experience of European and American railways as a base, are working hard to produce a design from indigenous materials which will meet Indian conditions.

IMPORTANT ROLE OF BALLAST

Ballast, which consists of stone chips of uniform size, forms the bed on which the sleepers rest. The ballast, filling up the space between the sleepers and extending about a foot on either side, prevents the track from longitudinal or lateral movement under the impact of the wheels of the rolling stock. To provide this stability the ballast must be packed hard, specially under the sleepers. Another important function of the ballast is to provide drainage for rain water, so that the bed of the track always remains firm. As the permanent way is laid on earth formations, any accumulation of water can lead to a dangerous subsidence. Moreover, under the impact of heavy showers, the earth may be washed away, leaving the rails unsupported.

The ballast, by breaking the force of even the severest storm, protects the formation from damage. In service, the ballast is displaced, and even embedded in clayey soils, and also breaks down into smaller chips, and finally into powder. This together with the ashes from locomotive ash-pans, and dust blown into the track, gradually fills up the voids between individual chips, consolidating the ballast into a solid mass. In this state, the ballast becomes ineffective from the point of view of drainage, and also loses its 'give', or resilience, under load. The ballast must, therefore, be kept clean from dust, dirt and weeds, and also repacked at regular intervals. The track literally lives on ballast. Starved of it, the track deteriorates and the quality of riding suffers. Even the best of rails and sleepers give poor service without a good bed of ballast.

NEED FOR TRAINED MANPOWER

While the design of the permanent way, and the development of indigenous materials for it are vital, the training of staff for the construction and maintenance of the permanent way is equally, if not more, important. Indian Railways have fortunately a fine tradition of hard work coupled with skill and ingenuity in these spheres. The maintenance of track, so important for the safety of train operation, is entrusted to an army of devoted men who work in small gangs of 10 to 20 men.

Each gang is entrusted with the maintenance of a small portion of the track from three to four miles in length. By constant association they come to know every inch of this beats intimately, learn their vagaries and weak spots and know how to deal with these. These gangs are supervised by mates who by virtue of their service and experience, are well-equipped for the day to day task of keeping the track in good repair. In addition, over a thousand trained enginers inspect the track at regular intervals, to see that every section of it is fit for traffic.

The weather is perhaps the permanent way engineer's greatest enemy. During the rains, and even more so during cloud-bursts, when every one seeks shelter and safety indoors, the permanent way man must be out. Braving the inclement weather, each man must patrol his sections, and guard the weak spots and approaches to bridges, so that those who journey may travel without fear. In the scorching heat of mid-summer, these loyal men are hard at work, packing and cleaning the ballast, aligning the rails and securing the keys. But devotion and hard work will not be enough in the day ahead.

TRAFFIC DENSITY SETS PROBLEMS

The density of traffic has increased sharply during

the past few year, and some of the trunk routes carry over 20,000,000 gross tons miles of traffic a year. This unprecedented increase in traffic imposes a severe strain on the permanent way, and the men who maintain it. The track has no doubt been maintained in a reasonably safe condition against these odds by intensive maintenance, but the standard of our track leaves much to be desired. The maintenance gangs have been augmented, but this has not overcome the inherent difficulties of the situation. The result is that over 1,600 miles of track can be used by the heavier locomotives at restricted speeds only.

One way to improve the standard of the permanent way is to use heavier track materials—heavier rails, more sleepers and a deeper bed of ballast. Admittedly, the track on the Indian railways is the lightest in use for comparable traffic in the world and the 90 lb. I. R. S. rail is decidedly light for the present heavy traffic on our trunk routes. But the replacement of the vast network of permanent way by one of heavier design will require many years to complete, besides the outlay of a fabulous sum of money, and of human labour. This approach can, therefore, be only a long-term one.

Another solution is more effective maintenance. Putting more men on the job is not the answer. The high density of traffic, and the short interval between trains, requires a radical change in the present methods and techniques of permanent way maintenance. What is necessary is more frequent attention, and more efficient tools to do the work quickly and effectively. The pick, the rake and the beater have served the "P. W." men well in the past, but have outlived their utility at least on the heavily worked suburbun and trunk routes. With the rapid advance of technology, many advanced countries have developed reliable, handy and efficient mechanical tools for the permanent way engineer. Their adoption in India is now a "must". A start is, therefore, being made in the more important sections of each railway with mechanical tie-tampers of various designs, and on the basis of experience gained, wider application of successful designs will be planned, together with their production in the country.

It goes without saying that the use of modern tools will require a greater degree of skill in the staff employed to use them. The gangmen are a disciplined and devoted lot. They have learnt their job through long years of hard work. Nevertheless, they will require special training in the use and care of these tools. The supervisors will, in addition to their normal training in railway schools, have to learn the management of these modern tools and the economical deployment of labour with them.

POONA SCHOOL TRAINS "P.W." ENGINEERS

Above all, the direction given at the engineer's level should be more effective. The rapid expansion of railways has, however, led to a dearth of railway engineers and promotion in the engineering services is more rapid than in the past. What the engineers lack in years of experience must, therefore, be made good by intensive training and refresher courses.

With this end in view, the Indian railways have set up an Advanced Permanent Way Training School at Poona which will conduct refresher courses not only for junior engineers, but also reorientation courses for senior engineers who have not had experience of new developments in permanent way engineering. In due course, this training school will meet the requirements for training permanent way engineers, not only for India but also for other countries of South East Asia.

GEARED FOR FURTHER PROGRESS

The Railway engineer in India has reason to be satisfied and even proud of his achievements in the field of design, construction and maintenance of permanent way. He can, however, ill-afford to rest on his laurels. He must be ever vigilant and strive to keep track standards abreast of the needs of ever-mounting intensity and speed of traffic. The world of engineering and technology is dynamic and is rapidly advancing.

The railways in particular must keep in touch with advances being made by competing forms of transport. To meet this challenge, the railway engineer must develop a dynamic personality—ever ready to learn, to adapt and thus improve the materials he uses and the methods of construction and maintenance which he employs. The rising cost of labour must be met by economy of labour, the mounting strain of more traffic by the efficient use of new tools. He must also be a leader to his men, inspiring them with confidence and enthusiasm by his own example of devoted hard work, and inculcate in them by his own imaginative and receptive approach to problems a ready acceptance of newer and better techniques.

As one who has served a life-time on the Indian Railways, I have full confidence that the new generation of railway engineers will measure up to their by no means easy task and live up to the fine traditions set up in our profession and even to improve on the performance of their forebears.

Integral Coach Factory begins Year 1960 by Crossing the 1000th Coach Mark

By K. G. Hiranandani
Chief Administrative Officer, Integral Coach Factory

SINCE October 1955, when INTEGRAL COACH FACTORY near Madras first stirred into productive life, its story has been one of continuous development, rapid progress and impressive achievements. Starting with the assembly of Coach Shells from imported components, this factory has repeatedly beaten its targets, has successfully surpassed its capacity turnout rate of a coach shell every 6 working hours, and is now producing about 40 Coach Shells per month, with about 95% Indian made components.

This year 1960 started with a special significance when Integral Coach Factory ceremonially rolled out from its works the 1000th coach almost a year ahead of original production schedule.

THE SHELL UNIT

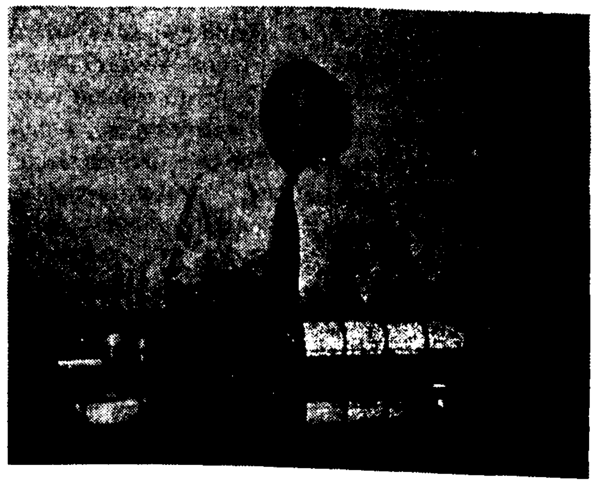
This Unit of the Integral Coach Factory, set up to attain self-sufficiency in the matter of coaches, has produced in its first, second, third and fourth production years, 43, 150, 308 and 423 Coach Shells respectively, much more than the original targets. The comparison of targetted and actual outturn is given below :

Production Year	Original target	Revised target	Actual output
1. (Oct. 55-Sept. 56)	20	40	43
2. (Oct. 56-Sept. 57)	100	120	150
3. (Oct. 57-Sept. 58)	200	240	308
4. (Oct. 58-Sept. 59)	300	350	423
5. (Oct. 59-Sept. 60)	350	350	530*

* Anticipated

To meet the increasing requirements of coaching stock during the third five year plan, it has been decided to increase further the production capacity of this Unit to about 700 coaches per annum by working double shift.

The efficiency of the shops, has been increasing from year to year as the men have been gaining skill and experience. The man hours spent on each coach have come down steadily from about 19,600 at the start of production to about 8,500 at present. It is expected that there would be further improvement with the incentive system of payment which has been introduced recently.



Shri K. G. Hiranandani, Chief Administrative Officer, Integral Coach Factory.

The production costs have also been coming down. The cost of a coach shell produced in the Factory has come down sharply from initial Rs. 186 thousands to Rs. 82 thousands inclusive of all over-heads and depreciation. The ex-works cost of a similar coach, imported from Switzerland, was about Rs. 107 thousands while its landed cost in India including freight, was Rs. 187 thousands. Thus a saving of nearly Rs. 105 thousands per coach shell over the imported one has been achieved.

THE FURNISHING UNIT

The original intention was that this Integral Coach Factory would produce only Shells while they will be furnished in the Railway Workshops. Due, however, to the impact of the second plan, it has since been finally decided to furnish all the shells in the factory itself. A separate furnishing unit, therefore, with a project cost of Rs. 3.69 crores is being set up in close proximity to the shell unit.

The construction work for this furnishing unit is already in hand. All land required has been acquired and a two mile long railway siding, leading from Villivakkam Railway Station, and connecting the shell unit, has been completed and brought into use. Ancillary works such as roads, compound wall for the factory, the works entrance, the Electrical receiving station and its power supply connection, have been completed. The pipe line required for water supply to the new factory has also been laid. The construction of a 3 lakh gallon capacity, underground reservoir and a 2 lakh gallon capacity overhead tank is in hand. Side by side, the construction of the Main Works Office is also well in progress. The construction of the workshop structures in prefabricated reinforced concrete (a technique which is being tried out for the first time in this sector) will be taken in hand shortly. For this Unit 200 additional quarters have been planned out of which 80 units have been completed, 72 more are under construction and the balance are proposed to be taken up for construction during this year. On the mechanical side, pre-planning work such as preparation of shop layouts and other details have been finalised and procurement of machinery and plant is being arranged. It is expected that early in Third Five Year Plan, this permanent furnishing unit will go into production.

In the meanwhile furnishing of shells on a small scale has been commenced by providing temporary facilities. Starting from May, 1957, this temporary furnishing unit has gradually developed its output capacity and is furnishing now about 22 coaches per month. It has furnished so far, nearly 500 coaches i. e. about 50% of those turned out by the Shell Unit. The furnishing cost has come down from Rs. 97 thousands to Rs. 60 thousands and man hours from initial 12,900 to 5,900 per coach.

At the launching ceremony of the 1000th Coach, the Governor of Madras, Shri Bisnuram Medhi addressed ICF workers as "Makers of Modern India".

While launching the 1000th Coach from ICF in January, 1960 Deputy Minister for Railways Shri S. V. Ramaswamy remarked "To us, in India, this factory is a matter of pride and to the foreigners who come from abroad, it is a star attraction".

THE PRODUCT

Manning of the Factory was taken due care of from the very early stage of the project and by now, there are about 7,000 men at work in both Units of the Factory. After successfully assimilating the technical 'know-how' from our Swiss Collaborators, the skill of our Workers in the manufacture of these Integral Coaches, is now second to none.

The Factory has contributed to a very great extent to the growth of several small and medium industries in India. Purchase of materials worth about 7 crores of rupees is involved in the annual production of 700 fully furnished coaches. 16,000 tons of steel have to be processed through the different manufacturing shops. Apart from raw materials, the coach manufacture involves use of other finished and semi-finished components like steel castings, springs, aluminium extrusions, Aluminium castings, Rubber Profiles, Fastenings, interior fittings etc. When this Factory started about 159 items excluding steel were imported for Shell Unit costing about Rs. 17,600 per

(Continued on page 17)

Equipment for Indian Railways—Contract Signed with U.K. Firm

A further contract for the supply and installation of overhead equipment for railway electrification has been awarded to the British Insulated Calenders Cables Group by the Indian Railway Board, the group announced on 23—6—60.

The contract is valued at £ 1,200,000 (Rs. 16 million) and covers some 300 track miles of Eastern Railways system on the main line from Delhi to Calcutta. It is to be ready for use by July, 1961.

* * *

RAILWAY ENGINEERS CONFERENCE

A five-day conference of Chief Engineers of Indian Railways concluded on 21—6—60 at Simla. The conference discussed the question of strengthening the track to avoid possible dislocation of rail services caused by breaches and landslips. Other engineering matters connected with railways were also considered.

* * *

The Telegraph Condenser Company Ltd., of the United Kingdom, and Sprague Electric Company, of the U. S. A., announce that they have come to an arrangement whereby :—

(a) T. C. C. acquire the right to all Sprague United Kingdom patents and applications, together with the technical and engineering information necessary to exploit them,

and (b) Sprague will make available to T. C. C. all its present research and technical information and engineering knowledge and for the next 21 years the two companies will exchange research, development and manufacturing knowledge, extending beyond the field of capacitors and embracing all the products of the two Companies.

Both Companies are confident that as the leading manufacturers of capacitors in their respective countries, their close co-operation in research and manufacture will be of the greatest benefit not only to T. C. C. and Sprague but also to the Electronic Industry as a whole.

* * *

MANUFACTURE OF CO-AXIAL CABLES

The Hindustan Cables factory, a Government of India project leaped a step forward in the direction of "more tele-communication facilities in the country" when it began production of high-grade underground co-axial cables, hitherto imported from abroad.

The Indian Posts and Telegraphs Department will receive the first indigenous supply of 200 miles of such cables this year from the factory to link up Kanpur and Banaras. The P. and T. Department proposes, as an initial measure, to link up the major cities in India-Agra-Bombay *via* Ahmedabad, Bombay-Madras, Madras-Coimbatore and Delhi-Amritsar—with co-axial cables and associated equipment.

This would minimise congestion on trunk channels and curtail delays or dislocations of traffic on trunk routes considerably, it was stated.

With the swift changes in technological trends and the rapidly increasing demands for additional long distance telephone channels, it was felt that the existing overhead long distance circuits were inadequate specially on the more important trunk routes.

The installation of the Rs. 82-lakh plant for manufacture of co-axial cables was the culmination of a process started six years ago when the factory began manufacturing certain types of cables and reduced the drain on foreign exchange. The plant will have a capacity to produce 600 miles of co-axial cables a year, worth Rs. 1.40 crores.

* * *

RAIL EXTENSION TO J & K STATE SURVEY ORDERED

The Railway Board has sanctioned a final location survey for the extension of the existing broad gauge railway line from Madhopur to Kathua, in Jammu and Kashmir State, including the fixing of a site for a bridge across the Ravi river.

The extension of the line beyond Madhopur into Jammu and Kashmir State has already been accepted by the Government of India in principle. The Railway Minister, presenting the Railway budget in February last year, announced the decision to initiate action on certain new line projects which would mature in the third Plan period. The extension of the line from Madhopur to Kathua was one of these.

shell coach, but now all items, except five costing about Rs. 3,500 per shell coach are imported. These are laminated springs, roller bearings and 3 types of seamless tubes. Required steel will be available progressively from the Indian Steel Plants starting from the middle of this year. It is anticipated that the requirements of seamless tubes will also be met in future from indigenous sources. The design of the bogie is being changed to eliminate the use of laminated springs. This will leave only roller bearings to be imported for sometime.

Originally the Factory was designed to produce third class (T) B. G. passenger coaches for Indian Railways but now it is producing other types of

President Voroshilov of USSR after visiting ICF in January 1960 said, "We have seen your very fine factory — it is a wonderful enterprise".

passenger coaches also in integral design, such as passenger-cum-luggage vans (TLR). The manufacture is also in hand for the light weight first class (F) coaches, and Third Class (T) sleeper coaches, turnout of which is expected to commence during this year.

Besides these B. G. Integral Coaches, the manufacturing activities of this factory have covered the following other rolling stock :

(a) Prototype for BOX Mark II and Low sided iron ores wagons,

(b) Bogies for refrigerated fish vans,

(c) Bogies with improved riding qualities for high-speed Deluxe train power cars,

(d) Bogies with improved riding comforts for air-conditioned twin car sets.

It is also proposed to design M. G. passenger coaches and Diesel Rail Cars required by Indian Railways during the Third Five Year Plan in this Factory. Integral Coach Factory has, therefore, won a unique name in India in the design and manufacture of all welded railway vehicles.

CONCLUSION

The Integral Coach Factory, an important production unit of the Indian Railways, with a capital cost of Rs. 7.35 crores has already saved to the country much valuable foreign exchange, more than its capital cost. During its last about 4½ years it has produced more than 1000 coaches and is now nearly a year ahead of its original production schedule. The factory is now producing every month about 40 coaches, modern in design, equal if not better in quality, and at a cost which is less than even half that of a similar imported coach.

About 50% of the coaches are also being furnished in Integral Coach Factory itself. Arrangements are in hand to furnish all the coaches by providing a permanent furnishing unit.

What has been achieved so far in this Public Sector Integral Coach Factory, has been the result of the closest team-work of its officers and workers, who now jointly look forward with confidence to achieving still greater results, results which contribute towards Industrial progress and prosperity of India.

RAIL STRAIGHTENER

Hero of Socialist Labour D. Matveyenko, a fitter on the Bendery railway division, Moldavian Republic, has built a machine for straightening rails, his third invention in the last few months. The other two — an electric hydraulic spike puller and an eight-ton hydraulic track lifter — have been approved by the USSR Ministry of Transport for mass production. As a result of wear and tear the rail track inevitably deforms. Straightening is an extremely laborious process, and the main tool used is a clawed crowbar. Matveyenko's gadget is simple in operation and can be transported by a single person. The necessary pressure for shifting the track is created by a hydraulic pump. Tests have shown the straightener to be highly efficient.

PAYMENT BY RESULTS

By C. G. Devaya
Deputy Chief Mechanical Engineer, Integral Coach Factory

IT is the objective of every industry to obtain the maximum output from the manufacturing capacity installed and there are certain recognised ways of achieving this. Technologically it would be possible to install speedier machines and better equipment to raise production—this, however, calls for greater expenditure and consistent with the need for economy in production there is a limit beyond which no expenditure may be incurred. On the other hand it would be possible to obtain greater productivity from the already existing installation by increasing the overall plant efficiency. Such increase in efficiency is obtained in a factory by a simultaneous dual approach—Technical and human. The technical approach aims at eliminating waste, improving the operational methods in the actual process and the incidental handling work. The human approach is to ensure that there is a proper relationship between the management and labour—the well being of the worker should be assured so that his whole-hearted co-operation is forthcoming. The industries in the public sector in particular are national enterprises demanding a sense of loyalty, enthusiasm and initiative equally from both management and workers. The worker is to be given his rightful place in the industry and made to feel that he is participating in a joint endeavour wherein the management is doing the planning by means of the organisational set-up instituted and the worker is contributing his efforts in order to give the required output. Schemes such as Joint Productivity Councils, Staff Councils, which visualise affording the sincere recognition of the workers place in industry play a great role in promoting such an outlook, but there should also be a way in which the worker is made to feel that he has a positive share in the profits to the extent to which he produces. This calls for a system of payment which introduces an element of incentive in it and whereby the take-home pay has a relation to the quantum of output by the worker, duly ensuring that the worker does not have to strain himself in any way to gain a reasonable increase in the percentage as a bonus.

In the days gone by such a system of payment usually was described as 'piece-work' system of payment whereby a worker was paid at a certain rate for each piece turned out by him. The piece rates were usually fixed more on a trial and error basis from the experience in the Plant or in the neighbouring Plants and generally the methods could not be described as systematic. The modern systems of Payment by results are, however, scientific and primarily aim at perfecting the work methods by a systematic Work and Time Study and provide an incentive to ensure that for a normal effort on the part of the worker he will be able to produce sufficient number of pieces, which would enable him to earn a reasonable percentage of profits.

The most important prerequisite for the introduction of an Incentive System of payment, therefore, is the preliminary Work Study. For the product to be turned out from the Plant the Production Planning or the Industrial Engineering department makes out the process planning for each operation deciding on the materials to be used, manufacturing operations to be adopted, the jigs fixtures and tools to be employed and the speeds and feeds at which manufacturing processes are to be carried out on the machines. Such planning also caters for the most efficient handling methods to be employed and other conveniences that may be necessary to relieve the strain from the worker to the utmost possible extent. Instructions are made out in forms which are easily understood to serve as a guidance for the worker so that he does not have to spend his time racking his brain as to how best he could perform the job. It is to be ensured that the raw materials required are available in time and at the correct place—that the machinery and tools are in good condition and all the other equipment required are made available as soon as the job is required to be commenced. The waiting time that usually occurs between operations in a manufacturing plant for handling by means of cranes etc., are eliminated by careful planning of the sequence of operations. All these aspects are carefully examined during the Work Study and the actual process is split up as a Work-Cycle consisting of elements each of which can be positively defined and timed. By building up the elemental timings the actual time required for the effective work is fixed. It is obvious that in going through a day's work apart from this actual time required for the work itself there are other items of indirect nature and incidental delays that occur, which have no direct bearing on the work and for

which time is required to be provided for the worker. Allowances are, therefore, established for each such indirect factor taking into consideration the conditions of working in the particular plant. Such allowances may generally be grouped as allowances for—

(a) General handling and contingencies.

(b) Personal allowance required by the worker for taking tea during working hours, going to the toilet, receiving instructions from the Supervisors, etc.

(c) Allowance for fatigue—it is natural that a worker has to pause after he has done certain amount of continual manual working so that he may again recuperate his energy. The extent to which he should be given time for recovering from the fatigue depends on various factors, such as the position in which he has to work, the temperature conditions in the shop in which he is working, the lighting conditions, the concentration required for the particular type of work and various other factors which exist in the different types of industries.

(d) Special allowances for items of work which cannot be definitely fixed for each cycle of work such as Tool Grinding, measuring, gauging etc.

The time required for the actual work together with the above allowances is usually termed as the Standard Time. To this is added the profit element generally ranging around 30% in order to inflate the time to a certain extent so that it may enable the worker to earn a bonus by putting in just a normal effort. The fundamentals of any Incentive System is to ensure that an average worker with a normal rating can earn at least about 25% to 30% more than his basic rate under normal working conditions.

The Indian Railways have also realised that for this great industry to function in an efficient manner a sound human relationship between Management and workers is absolutely essential and the necessary incentives should also be provided to the workers. This is a national enterprise of which the worker is a working partner and without his whole-hearted co-operation the desired efficiency cannot be achieved. The desired relationship between management and workers has to be achieved by ensuring that justice is meted out to him in day-to-day working in such matters as seniority and promotions apart from providing various welfare measures in respect of which the Railways are second to none. Of special significance to the individual worker is naturally the monetary benefits that he obtains at the end of each month for the special effort put in by him for this enables him to ensure reasonably good standards of living for himself and his family. Following the examples of major industries all over the Railways have also decided that in all their factories and workshops within the next few years the workers should be brought on to the Incentive System of payment. The first experiment in the introduction of a recognised modern method of payment based on results was carried out in the Locomotive Manufacturing Factory at Chittaranjan. The experience has shown that this experiment is a success and the system of payment introduced there has provided necessary incentive for the workers enabling them to indulge in greater earnings and at the same time producing larger number of locomotives for the Railways. The locomotives were being imported from abroad previously and these can now be produced at competitive prices in the country. It has been accepted that similar system of payment in the other workshops of the Railways will produce equally good results, firstly in perfecting the methods of working, secondly in reducing the cost of production or repairs and thirdly by contributing at the same time to greater earnings to the workers. Therefore, Production Planning and Time Study organisations have been set up on the various Railways to introduce similar systems of payment in their workshops. After Chittaranjan the next factory to go into such a system of payment is the Integral Coach Factory. Having been started as a new industry the prospects of introducing the Incentive System of payment in due course has always been kept in mind. The machinery layout, the tooling, the handling methods and the process planning have all been done bearing in mind the need for introduction of the Incentive System in later years. A separate Time Study section has been in operation for the last one year and norms have been established for the various operations and times have been built up on the basis of the standard data system. A schedule has been drawn up for introducing the incentive system of payment in gradual stages commencing from the Machine Shop, where the system was introduced on 2—1—1960. There are bound to be initial snags in the beginning as in the case of all major changes generally, but it is hoped that all these will be cleared before we proceed

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Role of the Integral Coach Factory in the Development of Industries

By R. K. Tandon
Deputy Controller of Stores, Integral Coach Factory

THE various major industries and projects in the country which have developed after the Independence have contributed to a very great extent to the growth of the small industries, and Integral Coach Factory, Perambur, is one of them.

No major industry can function economically by meeting all its requirements from its own factories. Apart from raw materials it has to depend for so many items in semi-finished or finished conditions, and items like fastenings, lubricants, electrical accessories, spares for machine tools, hand tools, abrasives etc. which have necessarily to be obtained from ancillary industries. Therefore the establishment of any major or medium sized industry gives an impetus to the development of so many other industries, small and big.

Any industry when first established has to face the most difficult problem of establishing sources of supplies for the various materials required from raw, semi-finished or finished condition. This is particularly so in our country where the Engineering industries are at infancy. The development of the various industries in the country, major, medium or minor, are complementary to one another. As already stated above, it is the development of the major industries that will help the growth of the medium or minor industries.

Not only the growth of the various major industries help other industries for their development because of their requirements of various materials for processing in these major industries but also because of the large employment that is afforded, the standard of living of the people is raised, thereby increasing the demand for consumer goods. The fast development of the medium and minor industries at present in the country is the result of the various big factories, industries and projects coming up one after another.

When the Integral Coach Factory was established and went into production in the year 1952, it had also to face the very difficult task of obtaining various items of raw materials including steel, coach components, rubber profiles, fastenings, etc. from the sources in the country. In the beginning, therefore, almost all items had to be imported and steps were simultaneously taken to locate sources of supply in the country and prospective manufacturers were approached. The problems were intimately discussed with the various producers, educational orders were issued from time to time and a stage has now been reached when it can be said that almost all items except steel, roller bearings and seamless tubes that go into the production of integral coaches are produced in the country. Steel will also be available progressively starting from the middle of 1960 till the end of 1961, when it is hoped that the full requirement of the Integral Coach Factory will be met indigenously. M/S. India Tube Co. have also gone into production for seamless tubes and it is anticipated that the requirements of these items for the integral coach will also be met in future by this source. As regards Roller bearings, there are not bright prospects in the immediate future of any indigenous source developing capacity.

In the beginning when the Factory was started, about 159 items excluding steel were imported, costing about Rs. 17,600 per coach. Now only 5 items costing about Rs. 3,500 per coach are being imported. This shows the rapid progress that was made in locating the indigenous sources of supplies which was not only mere going about and finding out the possible sources, but an uphill task educating the various industries to come up to the required standard.

With a view to give an idea, the following summary giving the steps taken for the various items will be of interest. The various items can be divided into the following groups :—

(a) Steel castings

(b) Springs

(c) Aluminium extrusions

(d) Rubber profiles

(e) Aluminium castings

(f) Fastenings

(g) Other smaller fittings for the interior of the coaches.

(A) STEEL CASTINGS

At the time of Partition there were very few Steel Foundries in the country which were just able to meet the demands of ordinary castings. Since then not only the demand has gone up considerably but the industry has been called upon to produce better castings. As far as the demand of the Integral Coach Factory is concerned, there are only three items of steel castings of which adequate capacity has been developed for two, leaving one, namely, Axle Box Housing. It is hoped that the various Steel Foundries will be able to achieve the manufacturing technique of this intricate casting and soon be able to meet the demand of the Factory in adequate quantities. For developing the sources of supply for these items the Integral Coach Factory had to approach the various Foundries individually and in close collaboration with them the manufacturing technique has been developed.

(B) SPRINGS

There are two types of springs, namely, helical and laminated. Even though the various spring manufacturing units have produced the helical springs, difficulty was experienced by them to produce bigger sizes of springs within the specified tolerances. The integral coaches are fitted with springs to very rigid tolerances to ensure better riding quality. Here again, it may be said to satisfaction that a couple of the major spring producing firms have now been able to achieve the manufacturing technique and we may expect that the future supplies will be made satisfactorily and no import may be necessary. As regards the laminated springs, the main difficulty is the non-availability of the raw material. Moreover, the future design of the bogies is being changed to eliminate the use of the laminated bearing springs. Therefore, no efforts have been made to develop the manufacturing capacity for this item.

(C) ALUMINIUM EXTRUSIONS

As already stated, a number of fittings made of aluminium are being used in the integral coaches. These fittings are manufactured in the Factory with the raw material purchased. There was not much demand for aluminium extrusions in the country and great difficulty was felt by the only plant of M/S. Indian Aluminium Co. to meet the requirements of the Integral Coach Factory. This firm has, however, steadily increased production and in close collaboration between the Engineers of the two concerns the growing requirement is being satisfactorily met. There is good scope for other enterprisers to come in the field and start the manufacture of aluminium extrusions, the demand for which will go on rising. The value of the annual requirement of this item will be in the order of Rs. 24 lakhs.

(D) RUBBER PROFILES

There were several industries producing the rubber products when the Integral Coach Factory went into the market for their various items of rubber profiles. But great difficulty was experienced to obtain the requisite quality in the beginning. With sustained effort, the various manufacturers slowly came up to the required standard and it can now be said that these industries are satisfactorily supplying the annual requirements of the Integral Coach Factory for rubber profiles costing Rs. 5.5 lakhs.

(E) ALUMINIUM CASTINGS

There are mainly three items of aluminium alloy castings of intricate design, requiring the adoption of die casting technique and the various industries found it extremely difficult in the beginning to come up to the required standard. Even now only two or three have developed the manufacturing technique and there is scope for others to come into the field. The annual requirement for these items costs Rs. 3.6 lakhs.

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further on this scheme. With the greater understanding which the workers are bound to develop after gaining experience with this scheme, it is hoped that commensurate results will be obtained. The coaches are already being produced at costs very much below the imported costs. As a result of the introduction of the incentive system an increase in efficiency to the extent of 20 to 25% is anticipated. The wage bill will no doubt be higher to this extent but the resulting increase in outturn will reduce the overhead percentages and this should result in a further reduction in the cost of the coaches.

(F) FASTENINGS

The original design required several items of fastenings produced from stainless steel. With a view to help the indigenous industries, the specifications were revised and fastenings produced from bright steel bars have been accepted. The industries felt difficulties in meeting the requirements adequately for want of the raw material. As soon as the bright bars are produced in the country, the difficulty will be overcome. It is anticipated that some of the industries will start the production of the bright steel bars by the end of this year. In the meantime, various manufacturers of bolts, nuts and screws have to use the imported raw material. When the raw material is available indigenously, there will be scope for others also to undertake the manufacture.

(G) OTHER SMALLER FITTINGS FOR THE INTERIOR OF THE COACHES

The various industries had already experience behind to produce the different fittings that go to furnish rail coaches. However, the new designs of the various items like seat frames, chair frames, lavatory door locks, flushing valves, roof water tanks, etc. put a great strain on their ingenuity to come up and meet the challenge and produce materials strictly to specifications. All these fittings require more rigid tolerances and better materials too. Difficulty was felt by the industries to come to the required standard in the beginning. The collaboration of the industries with the Integral Coach Factory has enabled the production of these items in the country itself not only to the required standard but in sufficient quantity to meet the requirements of this Factory. Still, in many items, the production is just sufficient to meet the present demand which is to the extent of about 500 coach requirements a year. This demand will increase to about 700 coach requirements by the end of the Second Five Year Plan which throws very great scope for the various industries to develop themselves further and meet the growing demands as and when they arise.

The above efforts not only established the indigenous sources of supplies but also enabled the reduction in the cost of materials used for the manufacture of coaches by about ten percent. It is expected that as the industries get into the stride the cost may come down further.

NEW RAILWAY LINES

The Deputy Minister of Railways, Shri S. V. Ramaswamy, said in a written reply to a question by Shri Ram Krishan Gupta and Shri Yajnik in the Lok Sabha on December 21, 1959 that the work regarding the final location survey of the Himmatnagar—Udaipur railway line had not construction work on items like formation bridge foundations etc. would start after the final location survey was completed and the required land became available.

In a written reply to a question by Shrimati Mafida Ahmed, the Deputy Minister said that the survey of Amjanga-Dudhnai-Darangiri railway line had not yet commenced. The Deputy Minister said that the terrain was extremely difficult and there was also shortage of trained personnel who could take up work in such difficult terrain. He added that some time was therefore, necessary to collect personnel and equipment, which would be completed as early as possible and field work commenced.

Replying to another question by the same member, the Deputy Minister said that the contract for construction of superstructure of the Brahmaputra Bridge had been settled. The work of manufacture, supply, erection and maintenance for one year of ten main spans of 397 ft. and 2 shore spans of 104 ft. 9 inches had been entrusted to the Indian Combine M/S. Braithwaite, Burn & Jessops Construction Co. Ltd. Calcutta.

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EXTRA LOW VOLTAGE TRANSFORMERS

The Indian Standard Specification for Extra Low Voltage Transformers (IS: 1416—1959) published by ISI applies to single-phase transformers rated at less than one kilovolt-ampere having separate input and output windings for connections to extra low voltage circuits. The input voltage to the transformer shall not exceed 250 volts and output voltage shall not exceed 25 volts. It covers transformers used for both outdoor and indoor purposes.

This standard does not cover transformers used in mines or of special types like flameproof transformers, or transformers normally required for use with electronic equipment, or those in which voltage across any two points in the transformers, in normal use, exceeds 250 volts.

ALUMINIUM-ALLOY INGOTS AND CASTINGS

The Indian Standards Institution has recently published IS: 202—1960 Specification for Aluminium-Alloy Ingots and Castings for Aircraft Purposes (*Revised*) which covers the requirements of eight aluminium-base alloys, in ingot form for remelting for the manufacture of castings, and aluminium-base alloy castings for aircrafts purposes.

This standard was first issued in 1950 as a tentative standard. As a result of the experience gained by the industry in using this tentative standard, it was decided to revise it and to issue it as a firm standard. The main modifications made in this revision relate to certain changes in designation, chemical composition, mechanical properties and inclusion of four more alloys.

This standard is one of a series of Indian Standards for aluminium and its alloys for aircraft purposes, prepared at the instance of the Aircraft Industry and the Directorate General of Civil Aviation. Other standards in the series are:

IS: 23—1959 Specification for 99 Percent Primary Aluminium Notched Bars and Ingots for Remelting for Aircraft Purposes (*Revised*)

IS: 30—1953 Specification for Aluminium-Coated High-Tensile Aluminium Alloy Sheets and Coil for Aircraft Purposes.

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COVERED ELECTRODES FOR THE METAL ARC WELDING

The Indian Standards Institution has recently published IS: 1442—1959 Specification for Covered Electrodes for the Metal Arc Welding of High Tensile Structural Steel which lays down requirements for covered electrodes of 2.5 mm (or 12 SWG) and thicker sizes for manual metal arc welding of high tensile steel. The type and quality of an electrode play a very important role in getting welds of required characteristics. The performance qualities of an electrode should be such that satisfactory weld deposits can be made by a welder of average skill and experience working under normal conditions existing at the site of work. This standard lays down requirements of covered electrodes used in metal arc welding of high tensile structural steel having a maximum tensile strength of 68.0 kg per mm^2 (or 43.0 tons per in.^{2}) and maximum yield stress of 44.0 kg per mm^2 (or 28 tons per in.^{2}).

In the past, the absence of a specification for electrodes which deposit metal having tensile properties in excess of those of mild steel has meant that the stresses in welding joints in higher tensile steels have been limited to those which were permissible in mild steel. The use of this specification will ensure that the electrodes are capable of depositing metal having tensile properties comparable with those of high tensile structural steel thus enabling such steels to be used more economically.

This standard is one of a series of Indian Standards on covered electrodes for the metal arc welding of steel. Other standards published so far in the series are:

IS: 814—1957 Specification for Covered Electrodes for Metal Arc Welding of Mild Steel

IS: 1395—1959 Specification for 1/2-Percent Molybdenum Steel Covered Electrodes for Metal Arc Welding

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HORIZONTAL CENTRIFUGAL PUMPS

The object of IS: 1520—1960 Specification for Horizontal Centrifugal Pumps for Clear, Cold, Fresh Water published recently by ISI 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 good quality horizontal centrifugal pumps. The standard is divided into three sections. The first section covers terminology, nomenclature, standard units, classes and types, direction of rotation, accessories, and suction limitations of the pumps. The second section gives details of information to be supplied by the purchaser. The third section, besides detailing information to be furnished by the supplier, covers pump tests, guarantees, tolerances and general requirements.

The specification is not intended to be restrictive in character and, subject to agreement between the purchaser and the supplier, some of the requirements of this specification may be either modified or made more elaborate.

Integral Coach Factory—Furnishing Project

By K. M. Aiana
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Integral Coach Factory, Madras

The present article makes a contribution of interest on the conditions in which endeavours are being made in setting up a Coach Furnishing Factory in an expansion scheme, as an Annexe to the existing Coach Factory. This is a project of quite a major financial involvement, but has been accepted as a specific and inescapable necessity, being of national importance in the expanding economy of the country. Under the extraordinary circumstances prevailing in the country, the technical achievements herein dealt with are note-worthy.

SOME INTRODUCTORY REMARKS

THE introduction of the "Integral Coach" of a modern design, and with modern amenities provided, is one of those exciting ideas, which has engendered high enthusiasm in all quarters. The users believe that it will ensure safer, better and comfortable travel, and the Railway technicians see prospects of maintenance problems diminishing.

In this important sector of national activity, the Furnishing Project, at a capital out-lay of about 3.7 crores, was expected to go into production by the end of the Second Five Year Plan Period. The primary purpose of this large extension is to enable us to undertake the manufacture of a complete Coach, duly furnished, ready for traffic, as the existing Coach Factory produces only unfurnished steel coaches.

In projects of such complexity and magnitude, the causes of delay can unavoidably spring up from the most unexpected quarters, as will be appreciated from the details given below :—

PROJECT IN HAND

The genesis of this Project was a report prepared and submitted by my predecessor Shri R. Rajagopalan in October 1956, after which the Ministry of Railways authorised this Project in November 1956. The present stage of the works, being undertaken, makes it worthwhile, however, to describe the salient features of this Project, despite the fact that work is still going on and that completion is now scheduled for 1962. It is felt, moreover, that a brief account of this Project cannot fail to be of interest.

On receipt of the sanction to the Project, the necessary Construction Organisation was immediately set up, and as soon as design drawings for the workshop structures were finalised, global tenders were called for in the middle of 1957, and received. However, in view of the stringent ways and means position, the tenders could not be progressed further, as the necessity of setting up of this Project was under examination and review by the Planning Commission. After obtaining the necessary clearance from the Planning Commission, it was decided early in 1959 to go ahead with the construction of the Workshop structures in pre-fabricated reinforced concrete, a technique, which, it is believed, is being tried out for the first time in this sector, with a view to conserving as much steel as possible.

PROGRESS SO FAR MADE—DIFFICULT PROBLEMS

The contract has, since, been placed on Messrs. Hindustan Construction Company, Bombay, who are collaborating with their Hungarian Technical Consultants. The design drawings are now ready, and so also the detailed drawings for the installation of pile foundations. The actual work on the installation of the pile foundations, has since commenced, under a contract placed on a specialist in this field.

At this stage, the work being carried out, is largely on the Civil Engineering side, along with some progress made on the Electrical side. All the land required for the establishment of the Factory and future expansion, has been acquired and a two mile long Railway siding, leading from Villivakam Railway Station to the site of the Factory, has been completed and brought into use. Ancillary works such as roads a compound wall for the Factory, the Works Entrance, the Electrical Receiving Station with a temporary power supply connection, etc., have been completed, to enable the construction of the main Workshop structures being taken in hand. The necessary pipe line from the Kilpauk Waterworks of the Madras Corporation, required for water supply to the new Factory, has also been laid. The construction of a 3 lakh gallon capacity under-ground reservoir and a 2 lakh gallon capacity over-head tank, is in hand. Side by side, the construction of the Main Works Office is also well in hand.

On the Mechanical Engineering side, pre-planning work such as preparation of shop layouts and various other details are in hand, and are being finalised to keep pace with the construction of the various shop structures. As regards Machinery and Plant, procurement has, per force, to be arranged in three phases, keeping in view, the financial stringency and an embargo placed on import at present, due to a serious shortage of foreign exchange. In addition to importing a few items of Machinery and Plant, the procurement of which is inescapable, full advantage is being taken, in selecting some American Excess Machines graciously offered by the International Co-operation Administration of the U. S. Government, to the Indian Railways, and some Machinery to be spared with co-operation from Railway Workshops, so that the bare minimum number, required to set up production, will be made available for installation, as the Project advances.

In the Project Estimate, a colony to house 200 employees and consisting of various types of quarters, has been provided for. Out of these, 80 have been completed and brought into use. 72 more are under construction, and it is proposed to take up the construction of the remaining quarters also during the course of this year.

At the time of the submission of the Project Estimate, it had been visualised that this Project would be completed and the Factory would go into production within the Second Five Year Plan Period ending in March 1961. In view, however, of the difficult ways and means position prevailing in the country, it was proposed, after weighing all factors carefully, to restrict the overall expenditure during this Plan period, with also a curtailment in the foreign exchange content. The present pace of work is therefore directly correlated to the limited expenditure to be incurred during the Second Plan Period, and the balance of the work is being thrown forward to be completed during the Third Plan Period.

INTERIM ARRANGEMENTS ADOPTED AND RESULTS ACHIEVED

In order to avoid the normal time lag between the physical completion of the Workshops and the establishment of full production, the establishment of a Temporary Furnishing Unit had been visualised right from the outset and a proposal had also been made to set up a production organisation simultaneously with the construction of the Project. It was envisaged that this would enable, firstly to create some initial capacity, which would be of advantage to the Project itself for developing the necessary production technique, the know-how and training of staff, and secondly to determine the actual capacity of the Trade to supply finished fittings to the quantity and quality required, so that the target production level of about 400 furnished coaches a year in one shift would be attained within a short period, after completion of the construction of the Permanent Factory, instead of the production having to be phased over a period of some years. Accordingly, for a start, furnishing work on a small scale, making use of covered space wherever available in the existing Coach Factory, was commenced and the first furnished Third Class Coach was ceremoniously launched by H. E. the Governor of Madras, late Shri A. J. John on the 21st February 1957. In order to speed up the production of furnished coaches, the construction of the Temporary Furnishing Unit, sanctioned at an estimated cost of Rs. 21 lakhs was also taken in hand early in 1957, utilising some temporary sheds procured from the Avadi Military base nearby, and keeping in view as comfortable working conditions as possible for the workers. The construction of this Unit together with sidings facilities were all completed in a very short time, and furnishing work was commenced from May 1957. The 100th furnished coach was launched on 19th June 1958. Although the pyramid of skill is still in the process of building up, besides Indian Engineers and other staff, the strength of Workshop staff is now nearly 1000. Hitherto over a hundred Trade Apprentices have been trained in our School and employed as Artizans, and nearly 200 are under training which provides for the Supervisory category as well. Initially, the staff was built up with the co-operation of the Railways, and by direct recruitment from the open market.

PERFORMANCE VIS-A-VIS TARGETS

The targets fixed, visualising the setting up of the

Permanent Furnishing Factory according to schedule and the actual out-turn from the Temporary Unit are given below year by year :—

Year	Target	Actuals
1956—57	—	2
1957—58	50	72
1958—59	175	171
1959—60	250	250 (Anticipated out-turn upto 31—3—1960)
1960—61	350	—
	Total	495

A capacity to furnish 22 coaches per month has so far been developed upto 31—3—1960, despite the limited facilities for a good production flow.

TYPES OF COACHES

At present there is by far the largest demand for Third Class coaches. Hitherto, out of the 495 coaches, so far furnished, 455 are Third Class coaches and 40 are TLR coaches (Third Class with luggage and Guard's compartments) the prototype of which was launched on the 3rd January 1959, when the ceremony was honoured by the presence of the Hon'ble Deputy Minister for Railways Shri S. V. Ramaswamy. During the year 1960—61, the furnishing of 150 Third Class Sleeper coaches on first priority and thereafter 155 First Class coaches will be undertaken, and the out-turn is expected to be stepped upto 25 coaches per month.

Consequent to the increase in the out-turn, and with the gradual building up of the production technique, it has been gratifying to note that it has already been possible to considerably reduce not only the direct man-hours per coach, but also the cost of furnishing. The materials used for furnishing, are now of indigenous manufacture to the extent of about 90 per cent. There is no doubt that such a corporate effort on the part of our workers will produce even better results in due course when our overall manufacturing facilities substantially increase.

TRIBUTE TO ANCILLARY INDUSTRIES

Numerous parts required in the furnishing of coaches of different types are being attempted to be produced by different small units around Madras and elsewhere in the country, on a basis which would prove to be more economical than if we ourselves tried to manufacture all these parts under one roof. Therefore, the setting up of a Coach Furnishing Unit, it is envisaged, will also largely contribute to the growth and establishment of several ancillary industries, and scope for further development as years advance. With the impetus and encouragement, already extended in the Interim stage of activities of the Temporary Furnishing Unit, the Industrialists, even despite difficulties encountered by them, have risen to the occasion and are helping us in a considerable measure to tide over a difficult period.

FUTURE PROSPECTS

The Second Plan has entered its final year, and the first of the Third Plan is in sight. If not all the physical targets have been hit, sufficient ground work would have been done for the take-off for the Third Plan, even though it may seem too early to assess in our thinking on our Third Plan achievements. However, it is envisaged that the first year of the Third Plan, should enable us to gear up to our planned capacity.

After the Permanent Furnishing Unit is established during 1962, as anticipated, the production already commenced in a small way is expected to be stepped up in due course in keeping with the production of coach body shells, the ultimate targetted out-turn aimed at being of the order of 700 coaches a year.

The Furnishing Unit as an Annexe to the Integral Coach Factory, when completed, will also have an important role to play in the context of the Second and Third Five year Plans, by contributing in a great measure to the Rolling Stock assets of the Indian Railways, besides fuller opportunities for employment within and outside, and in extending to the travelling public modern amenities and comfort.

In the meanwhile, it is proposed to make the best use of the temporary furnishing facilities available, and to continue obtaining assistance from some of the Zonal Railway Workshops, where Integral Coaches are also being furnished as a temporary measure, to keep pace with the increasing out-turn of coach body shells.

A WORD TO THE USER

Reactions to exhortations or incentives to achieve standards of performance are taken as axiomatic in more developed countries. In our motherland, we look to our users whom we have a desire to serve, to look after Railway Property as if it were their own.

CONCLUSIONS

What we have, so far, achieved, has been the sequel of the closest and untiring team work of our Indian Engineers and workers, who, despite the great deal of hard work still to be done till the Factory is established and capacity consolidated, look forward with pride, to achieve still better results, in the service of the industrial progress of the Nation and our conscious pursuit.

Some critical years lie ahead, which even the most optimistic Planner has to admit. It is in fact a time for only sober rejoicing in having progressed so far along a difficult road. It is said that enthusiasm is the essential prime mover to an expanding technique. It is also said that enthusiasm is capable of over-riding all obstacles and of breaking new ground on inspired lines, if tempered with patience and a prudent approach.

IT IS ALWAYS PLEASANT TO HEAR A GOOD WORD ABOUT OUR ACHIEVEMENTS and the occasions of those numerous visits of our countrymen and people from overseas, to the Integral Coach Factory, continue to be full of appreciation.

ELECTRICAL CONDUCTORS AND ACCESSORIES

The Indian Standards Institution has prepared the following three draft Indian Standard Specifications covering rectangular copper conductors for transformer windings, reels and drums for bare wire, and hard-drawn aluminium and steel-cored aluminium conductors respectively :

1. *Paper Covered Rectangular Copper Conductors for Transformer Windings* [*Doc*: *ETDC 2 (51)*]—This draft standard covers the requirements of high conductivity annealed copper conductors of rectangular section having thicknesses between 0.8 mm and 10 mm and widths upto 25 mm, insulated with two or more layers of paper, primarily intended for winding coils for oil-immersed transformers. The conductors covered by this standard have been classified into two categories, namely, (a) Double Paper Covered (with a minimum total increase in dimensions of 0.25 mm due to the covering), and (b) Multi-paper Covered (with more than two layers of paper).

   The object of this draft specification is to achieve uniformity in the requirements of these conductors and also to introduce rational size dimensions based on the metric system.

2. *Reels and Drums for Bare Wire* [*Doc*: *ETDC 2 (69)*]—This draft standard provides the requirements for reels and wooden drums for bare round wire and stranded conductors. It has been based on the standard sizes included in IS : 482-1953 Reels for Covered, Solid, Round Electrical Winding Wire.

3. *Hard Drawn Stranded Aluminium and Steel-Cored Aluminium Conductors for Overhead Power Transmission Purposes* [*Doc*: *ETDC 2 (95)*]—This draft standard is revision of IS : 398-1953. It covers the requirements for :

(a) Hard-drawn aluminium stranded conductors;

(b) Aluminium conductors, steel cored, including the solid aluminium and steel wires used in their construction,

for overhead power transmission purposes.

While revising this standard, the opportunity has been utilized to specify all quantities and dimensions in metric system. The other salient points included in this revision are :

(a) The practice of specifying the minimum average ultimate tensile stress has been discontinued and only the minimum breaking load for both the aluminium wires as well as steel wires has been specified.

(b) A wrapping test for both the aluminium wires as well as steel wires has been introduced in place of the elongation test originally specified for aluminium wires.

CRANE WEIGHING MACHINES

The Indian Standard Specification for Crane Weighing Machines (IS: 1438—1960) published recently by ISI belongs to a series of Indian Standards on commercial weighing instruments being prepared at the instance of the Standing Metric Committee, Government of India, in connection with the introduction of metric system of weights and measures in the country. The other standards published in the series cover the general requirements for weighing instruments, and specifications for beam scales, counter machines, platform weighing machines, weigh-bridges, automatic weighing machines and steel yards.

In determining the limits for sensitiveness and greatest error, due consideration was given to the views of manufactureres and testing organizations, prevalent rules and regulations pertaining to weights and measures in India and the practices current in several metric countries. It is to be pointed out that the values for sensitiveness and greatest error specified in this standard are for new machines only.

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ELECTRICAL CABLES, CONDUCTORS AND SLEEVING

The following four draft Indian Standard Specifications are about to be issued by ISI for wide circulation for eliciting comments :

(1) *Draft Indian Standard Specification for Rubber-Insulated Cables and Flexible Cords for Electric Power and Lighting (for Working Voltages Up to and Including 1.1kV)—Revision of IS: 434—1953* [*Doc*: *ETDC 2 (102)*]—This revision has been undertaken mainly to introduce metric system in this standard. The conductor sizes are based on Indian Standard Metric Sizes of Wires and Conductors for Electrical Purposes Doc: ETDC 2 (47) (under preparation). In addition, this revision incorporates the accepted recommendations of the Commonwealth Standards Conference on Cables held in New Delhi in 1957. This also incorporates amendment No. 3 to IS: 434—1953.

(2) *Draft Indian Standard Specification for Aluminium Conductors in Insulated Cables* [*Doc*: *ETDC 2 (84)*]—This specification has been prepared to cater for the increasing use of aluminium conductors in insulated cables. This draft, however, confines itself to the requirements of the aluminium conductors but does not give any requirements or tests concering the insulation of the cables for which reference has to be made to the corresponding Indian Standards for insulated cables with copper conductors.

(3) *Draft Indian Standard Specification for Polyvinyl Chloride Sleeving* [*Doc*: *ETDC 2 (105)*]—This document covers plastic sleeving which are used to insulate the bare conductors in light electrical appliances, such as radios. These sleevings are also used in aircraft electric cables. In this draft, an attempt is made towards standardization of dimensions and wall thicknesses in addition to specifying the performance requirements.

(4) *Draft Indian Standard Specification for Braided Cables with Copper Conductors for Overhead Transmission Lines* [*Doc*: *ETDÇ 2 (98)*]—This specification covers cables with braiding over them used for overhead transmission purposes particularly in locations where such overhead lines pass through trees or similar obstructions. These cables are not considered as insulated cables but as cables with some amount of mechanical protection over the conductor. The draft lays down mechanical requirements such as the tensile strength and also some requirements of the braiding.

These draft standards are being circulated for eliciting technical comments to producers, consumers, technologists and other interests concerned.

Single Wheel Wagon Marshalling Pusher

By An Engineering Correspondent

The transports of the incoming and outgoing materials and products with the manifold industries are performed by preference by governmentally managed railway services. In many cases, the procuring of a rail shunter would be too expensive, and, consequently, railway wagons have to be moved by labour force often yet. This method of operation, however, is normally uneconomical.

This is why a SINGLE WHEEL WAGON MARSHALLING PUSHER has been developed by the VEB (K) Schmiede — und Schweibwerk Zwickau (German Democratic Republic), and this very Pusher is now doing the job of shunting wagons mechanically.

PARTICULARS ON THE SINGLE WHEEL WAGON MARSHALLING PUSHER

THE Wagon Marshalling Pusher (Fig. 1) is consisting of a welded steel pipe frame (1) with welded-on reinforcements. The support of the shearing plunger (2) has been designed that even under heaviest load any deformation of the frame will be impossible. Below the motor gear

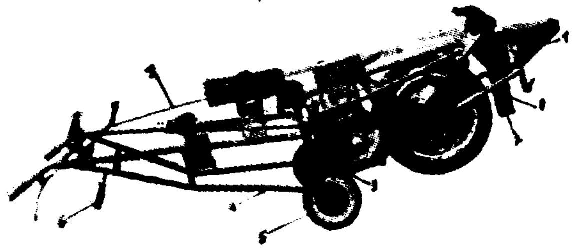


Fig. 1. Single-wheel wagon Marshalling Pusher Type 100.

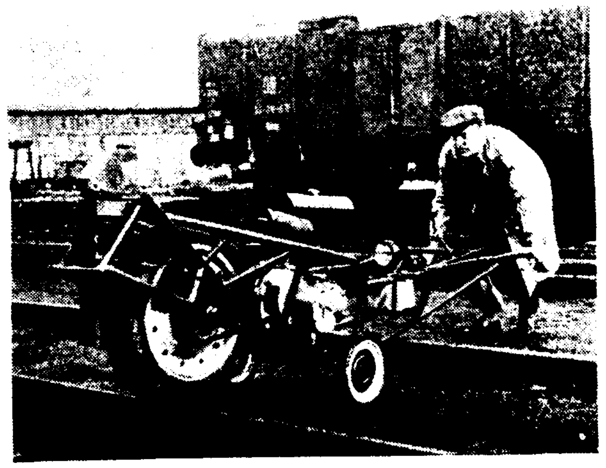


Fig. 2. Wagon Marshalling Pusher on duty.

block (3), the bottom plate has been perforated to guarantee an objectionless view on the driving wheel during the driving performances on the rail.

The width of the frame at the plane of the handle bars is guaranteeing a safe manipulation of the wagon Marshalling Pusher. Two supporting wheels (5) are admitting the driving even laterally from the rails. There are two additional handles (6) fitted to the frame which are to facilitate the engagement of the Wagon Marshalling Pusher beneath the wagon. With its profilated solid tyre the driving wheel is warranting top adhesion at the rail.

The built-in free wheeling which is actuated by a twist grip with bowden control allows a withdrawal of the Pusher. The motor gearing block (3) is supported by a three-point rubber mounting. The change gear with its 4 speeds is supplying speeds up

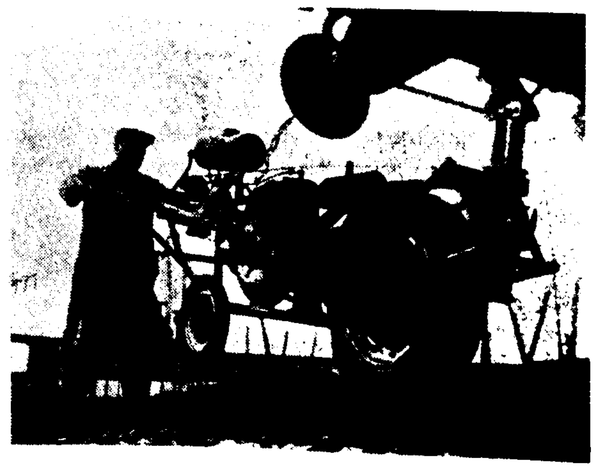
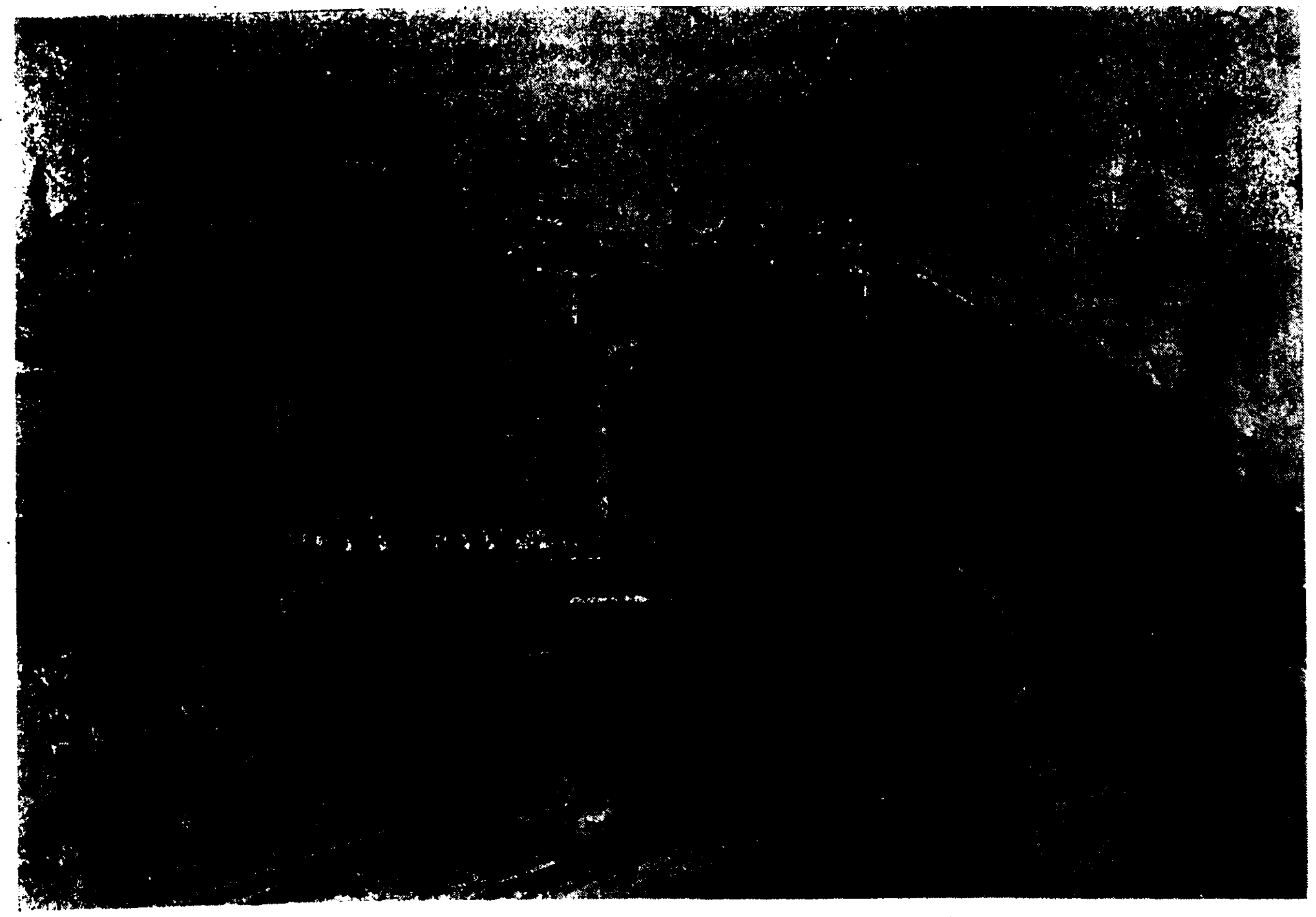


Fig 3. Wagon Marshalling Pusher during operational performances with a group of wagons.

to 6 km per hour (approx. 3.7 miles). The pre-selection shifting of the gearing is guaranteeing an objectionless shifting process even during the pushing performance with the wagon. At this instance, attention is to be given that the clutch must not be actuated unless the shifting will have been performed before. Besides, this preselection shifting does not allow to omit any speed of the speed sequence. The



motor has been fitted with a speed regulator which is limiting the admissible engine speed. The shearing plunger (2) is positioned by a cable pull (7) which is actuated by a knee plate. It is kept in its adjusted position by means of a ratchet which is engaging a toothed rail (8).

The shearing plunger is to be lifted up to the edge of the wagon to give the supporting wheels clearance from the ground, or the rail respectively. The shearing plunger can be inserted into operation position by actuating of the manually operable bowden control. The devices for shifting and operation have been arranged objectionlessly accessible. To give the Wagon Marshalling Pusher serviceability also at night, as an additional feature, it has been provided with a car type lighting plant which is consisting of a spotlight SU 100 and a battery of 6 volts 8 Ah.

Fig. 4

TECHNICAL SPECIFICATION

Engine :	Type EL 308, two-stroke, with speed governor, Single Cylinder, cubic capacity/294.6 cm³ (17.9777 cu. ins.) Rating at 3.000 r. p. m. : 6 PS = 5.9 HP. Fuel consumption : approx. 400 g per PS per hour (.88 lb per HP per hour)
Clutch :	Dry single-plate clutch
Gear box :	1 change-over speed gear 1 epicyclic gear within the driving wheel
Shifting :	Pre-selection shifting (manual shifting) Number of speeds : Four
Power transmission :	Engine/Gearbox From engine over clutch to gearbox Gearbox/driving wheel by roller chain 5/8" × 3/8"
Tyres :	Driving wheel : Solid rubber 147 × 400 × 630 mm = 5.8 × 15.8 × 24.8 ins. Supporting wheels : Solid rubber 300 × 210 × 50 mm = 11.8 × 8.3 × 2 ins.
Measures of Vehicle :	Length : 2700 mm = 106.0 ins. Width : 930 mm = 36.6 ins. Height : 900 mm = 35.4 ins.
Weight :	201 kg = 443.13 lb
Capacity :	100 to at 0 per cent gradient. 65 to at up-grade of 1 : 300 Licensed for up- and down-grades up to a ratio of 1 : 300

THE RANGE OF APPLICATION OF THE WAGON MARSHALLING PUSHER

The Single-Wheel Wagon Marshalling Pusher can be used with any railway trackage system, unregarded whether this has been mounted elevated (see Fig. 3) or flush either. The Pusher can be operated objectionless on rail points, turnouts, crossings, bends, and turn-tables. It must, however, not be operated across assembling pits.

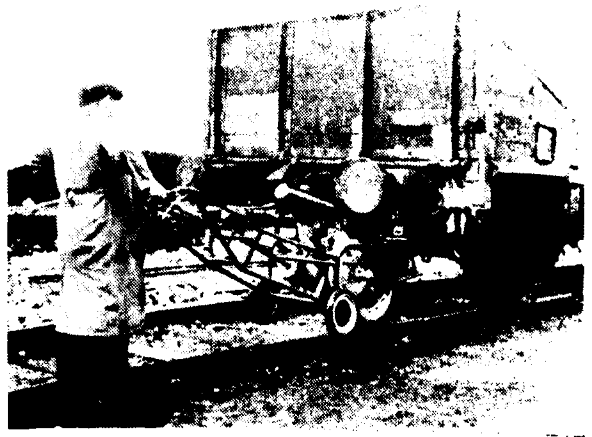


Fig. 5

Groups of wagons are to be separated by the Wagon Marshalling Pusher Type 100, as well, by engaging the shearing plunger laterally to the wagon, outside the rail, at a stake. Doing so, the wagon is

Fig. 6

pushed-off in an angle of approximately 30 degree. After having obtained an interspace of approximately 3 metres (9.8 ft.), the Wagon Marshalling Pusher is to be engaged at the rear of the wagon. Where the rails have been embedded flush, the Pusher can be operated outside the rails also, if the ground conditions are admitting to do so.

It will be easily appreciated that it is a must with any separating operations with groups of wagons that the driving wheel is always resting on firm bottom. By lack of this, a wood plank of a length of approximately 1.5 metres (4.9 ft) will do if placed beneath the driving wheel, and the driving wheel will be safely prevented from any penetration into the bottom.

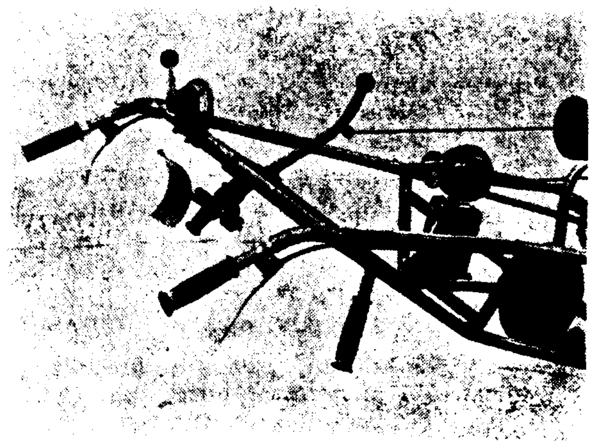


Fig. 7

The capacity needs not decrease with snowed up or wet rails since the Wagon Marshalling Pusher can be provided with a sand box (9). This way, the driver will be placed into the position to grit the rails with sand by actuating of a bowden cable.

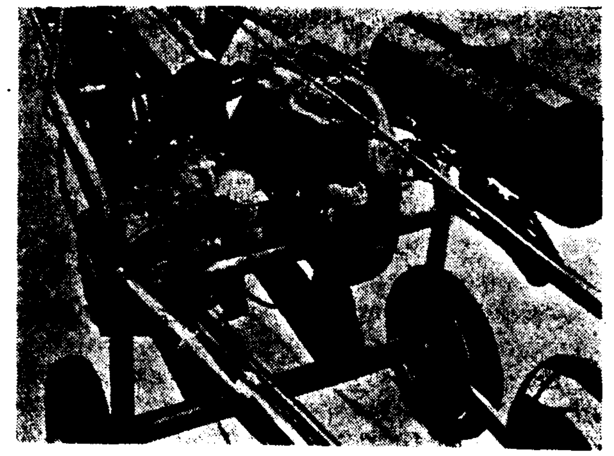


Fig. 8

With the Wagon Marshalling Pusher Type 100 all standard wagons of governmental railway services can be removed. For the marshalling of wagons of narrow gauge track systems, and of rail mounted works railways, an additional shearing plunger has been designed. The engaging clearance for the shearing plunger should measure at least 250 mm (9.8425 ins.) between the upper rail edge and the lower edge of the wagon.

The experiences made up with the employment of the Wagon Marshalling Pusher with the various branches of industry are demonstrating that, with proper use of this vehicle, great performances are to be obtained. Therefore, the Wagon Marshalling

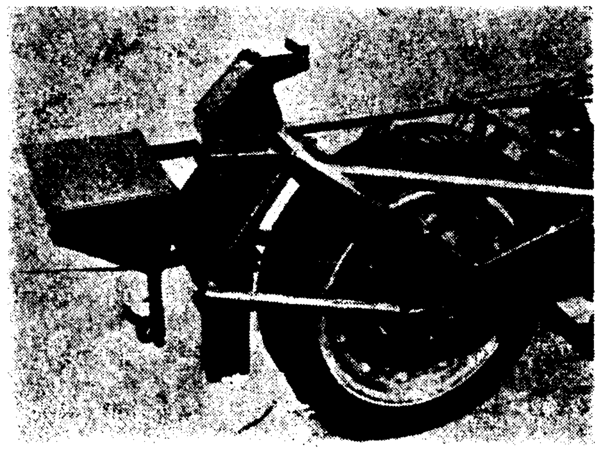


Fig. 9

Pusher is being an essential auxiliary implement with all factories, dispatch stations, harbours, transshipping plants etc. which have been provided with their own siding tracks, but are not being in the possession of own rail shunters, or where the employment of rail hunters being not economical. It has been amply confirmed by the customers, that the ratio between the expenditures for the vehicle and its service performances is being more advantageous yet than reckoned with initially. The cycles of wagon circulation are being reduced, the prime costs are being decreased and man power is saved.

For reason of working protection, the Single Wheel Wagon Marshalling Pusher should never be operated but by two operators simultaneously, since, at any time, the resp. groups of wagons, or any particular wagon, can be secoured properly by a wheel block by the second operator.

It is handy to operate and handle the Wagon Marshalling Pusher, and its driving is to be learned quickly. Besides, this device is amply facilitating the performances of the workers' team. It need not be mentioned that only experienced personnel should be entrusted with the operation of the vehicle. All customers, at any rate, which have carefully attended to this recommendation, always procured best results with it. This fact is proving that the conception of mechanization is simultaneously comprising the professional education of the personal employed with conveyance of goods, since only then, new means of transportation will be employed properly and result in the desired economical success.

ECONOMICAL CALCULATIONS

Condition :	Five wagons with a total load of 100 tons are to be removed over a distance of 200 metres (appr. 656 ft.)
Manual conveyance :	To perform this, a team of 8 workers (wages IM 1.18 per hour) should be employed for approximately two hours, since each wagon is to be moved individually.
Costs of transportation :	8 × 2 hours, DM 1.18 each = *DM 18.88*
Conveyance with Wagon Marshalling Pusher :	In the same case, the Wagon Marshalling Pusher operated by one driver (DM 1.36 per hour) and one unskilled worker (DM 1.18) is doing the job within about a quarter of an hour, including the advancing of the vehicle. The inherent operational expenditures of this device per single operational hour are to be calculated as follows :

Item	Group of Expenditure	Kind of costs	Basis of Calculation	Amount DM
1	Purchasing price	Vehicle including trade extras	Price free factory	3,800.—
2	Reserve for renovation	Writing off	For 3 years 33⅓% writing off + Item 1	1,267.—
3	Maintenance	Maintenance	Estimate 20 min. per shift = 100 hrs/year DM 1.36 p.hr. each	136.—
4		Repairs	Estimate 7% of purchase price	266.—
5		Total	Item 3 + 4	402.—
6	Total costs on vehicle	per year	Item 2 + 5	1,669.—
7	Total costs on vehicle	per hour	Item 6 devided in 2,250 operational hours per year (300 days of working)	—.71

Item	Group of Expenditure	Kind of costs	Basis of Calculation	Amount DM
8	Operational costs	per hour	Item 6 divided in 500 operation hours per year. Factual operation period (estimate)	3.34
9	Fuel and lubricating media	Gasoline and oil per hour	400 g / PS-hour (.88 lb. p. HP/hr) at DM 1.40 p. litre	4.40
10	Total costs of operation and maintenance	per hour	Item 8 + 9	7.74

Transportation costs :

Operation costs	DM 7.74 p. hr. x .25 hr.	DM 1.94
Wages	DM 2.54 p. hr. x .25 hr.	DM —.64
Total		DM 2.58

Savings :

Expenditures	DM 16.30
Man hours	15.5 hours

LECLANCHE TYPE DRY BATTERIES

The Indian Standards Institution has recently published IS : 586-1959 Specification for Leclanche Type Dry Batteries for Telecommunication, Signalling and General Purposes (*Revised*). The standard prescribes the dimensions, tests and performance requirements of Leclanche type cylindrical dry batteries of a nominal voltage of 1.5 V and intended to be used for telecommunication, signalling and general purposes under the climatic conditions prevailing in India.

This standard is a revision of the same specification published in 1955. The revision has been done in the light of experience gained during the currency of the standard. The following are the main modifications :

(a) The designations of batteries have been modified to conform to IEC practice

(b) Tests and requirements have also been aligned with the IEC Recommendations, as far as practicable.

(c) Definitions of terms originally included as part of the standard have now been deleted. These definitions have been covered in a separate standard, namely, IS : 1025-1957 Glossary of Terms for Primary Cells and Batteries.

(d) Reference to internal constructional details of the cells has been deleted.

(e) The rated life and performance requirements under delayed continuous discharge test have been slightly raised in the light of experience and progress in the manufacture.

PRODUCTION OF LOCOMOTIVES

MAJOR INVENTION BY INDIAN—NEW DESIGN FOR DIESEL TRACTION

A major invention which promises to revolutionise the manufacture of diesel locomotives the world over has been made by Mr. M. M. Suri, 32-year-old Indian Railway engineer.

Mr. Suri, Deputy Director (Diesels) in the Indian Railway Research, Design and Standards Organisation, Simla, has been responsible for the invention of a new system of diesel locomotive power transmission which has officially been named "Suri Transmission". The invention of the Suri Transmission puts Indian 'know-how' in the field of diesel locomotive design ahead of contemporary knowledge in advanced countries like U. S. A., West Germany, the U. K. and Japan.

Mr. Karnail Singh, Chairman of the Railway Board announced the invention in New Delhi at a Press conference.

He congratulated the inventor on the wonderful achievement and said that India was proud of it. Even though they knew of it for two years they had to keep it a closely guarded secret till it bore fruit completely.

Explaining the significance of the invention, Mr. Karnail Singh said that it was the transmission which carried power from the engine to the wheels and made movement possible. Diesel locomotives now in use in different parts of the world were fitted either with electric or hydraulic power transmissions. Future locomotives manufactured by the West German manufacturing firm, MAK, to whom world rights for the commercial exploitation of the invention had been granted, would be fitted with the newly-invented Suri-Transmission which had already been internationally acclaimed by technical opinion as markedly superior to both the electric and hydraulic transmissions.

COMMERCIAL EXPLOITATION OF INVENTION

The Government of India have officially taken over the invention for commercial exploitation.

Government have already covered this unique invention with patent applications in 12 major countries of the world namely India, Japan, Australia, U. S. A., France, West Germany, Italy, U. K., Czechoslovakia, Poland, Brazil, and Canada. Some patents had already been granted in U. K., West Germany, Italy, France, Czechoslovakia and Japan.

Under the terms of the licence the first seven prototype diesel locomotives fitted with Suri Transmission are now under manufacture at the MAK works in West Germany and would be delivered for service on the Indian Railways later this year. MAK had been licensed to market the Suri Transmission locomotives to railway systems all over the world. However, a condition in the agreement provides that whenever indigenous production is established in India, the Indian manufacturers would be free to utilise the invention independently of MAK and to market Suri Transmission locomotives in India or abroad.

The Government of India have agreed to place Mr. Suri's services for about four months at the disposal of Messrs. MAK as the latter requested that the inventor should be made available to them for constant consultations on the spot.

Mr. Suri is expected to leave India shortly. MAK engineers too, have paid frequent visits to India for consultations with the Research Designs and Standards Organisation and Mr. Suri.

SAVING IN FUEL COSTS

In locomotives of the future, the introduction of the Suri-Transmission will be a substantial factor in saving manufacturing and recurring operating costs. For instance Suri-Transmission, if fitted on to locomotives similar to the 2,000 H. P. diesel-electric locomotives recently imported from U. S. A. and now in service in the eastern region of the country, would secure a saving in fuel costs of something like Rs. 16,000 per year per locomotive.

The manufacturing cost of the Suri-Transmission locomotives is also expected to be substantially cheaper than current types because of its lighter and simpler and more compact constructions. When fully developed the Suri-Transmission would pave the way for the construction of very powerful locomotives of 3,000 H. P. to 4,000 H. P. locomotives now currently in use in India and other countries.

It was in 1957 that the Railway Board took over

(Continued on page 43)

Problems Facing Foundries

By Railmech

AN examination of the rejected items from the Bronze Foundry shows that most of these come under the category of blow holes and porosity. Though in a majority of cases visual inspection is enough to detect such defects, it occasionally happens that items passing visual inspection fail in the hydraulic pressure test suggesting the presence of minute fissures not easily detected by the naked eye. One noticeable feature is that these defects are found in all the different types of bronze used. Wherever the material fails in hydraulic test, it is invariably found that there is a marked change in section. A chemical analysis of some of the failed specimens show that the composition in such cases is quite satisfactory while the pouring temperature as found from records is always within the specified limits. Such defects have been noticed even when cent per cent virgin metals are used instead of scrap admixture. In an endeavour to minimise the trouble, instructions were issued to be particularly careful with regard to the drying of the moulds by the blow lamp. Though this resulted in some improvement by minimising surface blow holes, the same erratic results as to pressure tightness were noticed in the various alloys, cast in the usual manner suggesting that this chronic trouble is neither peculiar to the alloy nor to any possible departure from the standard routine. The defect is common to all the classes of alloys, occurs at similar places and is more or less of the same variety showing that the present casting and melting technique is at the bottom of the whole trouble.

These classes of jobs are of the variable section type where the consensus of opinion among practical Foundrymen and research Metallurgists all over the world is that for pressure castings (especially of the variable section such as valve bodies, pumps, etc., which cannot be properly fed in the foundry) and for improved machinability Leaded Gun Metal is an alloy superior in every respect and is more easily handled in the Foundry under the most variable conditions than Lead free or low lead alloys. Success with lead free alloys requires the highest degree of skill while the leaded alloy is more or less fool proof being tolerant of a wide range of pouring temperature and feeding conditions in castings where sections vary considerably and where the design prevents adequate feeding of heavy sections.

This will be plain when it is known that lead exists as tiny globules in copper base alloys being immiscible. Having a low melting point it remains molten and is pushed towards the centre or the heavier sections of casting—the last solidifying sections which are most likely to contain porosity and seals them up. Lead therefore facilitates mass feeding by allowing the feed metal to find its way to the parts of the casting where contraction is taking place. 5% Lead seems to meet the degree of porosity most commonly present in the majority of cases.

That the actual results observed are exactly the reverse of what is expected from theoretical considerations and practical experience all over shows that the fault probably lies somewhere else and not with the mixture used.

My study of the current practice in the Foundry shows that far better and consistent results can only be achieved if the casting procedure is altered in certain important respects based on well-recognised theoretical considerations which have been of late thoroughly verified in practice by firms specialising in this work. As success depends on a thorough understanding of the fundamentals invovled, I am giving below for the benefit of all concerned the results of recent investigations which explain and confirm the past experience of foundrymen. It is suggested that some comparative trials be carried out in these directions to verify first hand the outstanding improvements in mechanical properties brought about by following these recommendations:—

THEORETICAL CONSIDERATIONS

(i) Porosity in bronze is affected by a number of interdependent variables. Recent research shows that there are 3 major sources of porosity :

(a) Shrinkage porosity—from volume changes during solidification.

(b) Gas Porosity—(a) Blow Hole porosity—from gases or air entrapped during pouring (b) Fissure Porosity—from gases present in charge or absorbed during melting.

(ii) It is difficult to produce pressure-tight bronze castings owing to (a) their long freezing range resulting in shrinkage porosity and (b) to the ease with which the molten metal absorbs gas. The long freezing range (200-300°C) throughout which perfect feeding is difficult resulting in shrinkage porosity ranging from very fine inter-granular fissures to large angular cavities. The solidification contraction is 5—7% by volume. In sand castings where the rate of heat abstraction is much lower, feeding is hindered by the growth of dendrites in the solidifying zone. The last liquid portion of the casting contracts on freezing within an intricate net work of primary dendrites which hinder the feeding necessary to compensate for such contraction. Shrinkage porosity is increased by impurities like phosphorus which lengthens the freezing range or increase the fluidity of the metal. For example the freezing range of a 10% tin bronze is extended from 140 to 300°C by 0.2% rising of a maximum of 340° at 0.5% Phosphorus.

(iii) Such a long solidification period is conducive to gas evolution. Gas porosity may occur either as blow holes or more usually as inter-dendritic cavigies and fissures often associated with shrinkage porosity. The gases dissolved in molten metal form blow holes only if in great excess or if solidification is slow. Blow hole porosity is more frequently caused by gases or vapours evolved from the mould or core surfaces, gazes from volatile mould dressing and air bubbles entrapped in solidified metal caused by excessive turbulance during pouring, especially if the casting temperature is low. The blow hole type of porosity has little effect on the working properties and reduces the mechanical properties in proportion to the area occupied by the cavities.

(iv) Fissure prosity which exerts a notch action seriously impairs strength and ductility. It is caused by evolution during solidification of gazes dissolved in the molten metal (oxygen, water vapour, hydrogen, oxides of carbon and sulphur). It is found that the greatest unsoundness is in bronze exposed to 2-4% moisture. Porosity caused by exposure of molten metal to an atmosphere which on certain days contains this percentage of moisture explains why castings are sound one day and leaks on another day when subjected to a hydraulic test.

(v) The amount of gas absorbed depends on pouring temperature, the nature of alloy. Rapid melting and prevention of excessive over-heating is thus an advantage as also decrease in pouring rate, pouring temperature and mould temperature. A slow cooling rate will favour the liberation of the maximum amount of gas, but will create large crystals in the metal. A rapid freezing rate allows little time for gases to become and with gazes held firmly in solution very sound castings are got. Hence more trouble is likely to occur through gas unsoundness when handling the heavier sand cast articles than with rapidly cooled or chill cast sections.

(vi) It is now accepted that hydrogen derived from water vapour is the chief cause of gas porosity. In coke fired furnace moisture in the air used for combustion reacts with carbon in the fuel at 850°C to form Hydrogen and Carbon Monoxide. Again all metals decompose water at red heat giving hydrogen. The use of scrap carrying hygroscopic corrosion products is a potential source of Hydrogen. The amount of hydrogen produced will depend on the amount of moisture available, temperature of sand metal interface, and composition. The concentration of water vapour at sand metal interface depends on (1) amount of water in sand depending on nature of bonding agent and temperature at which mould or core is baked; (2) permeability of sand which will determine the case with which water vapour generated can escape through sand. This depends on grain size distribution, the nature of bond and tightness of packing.

(vii) The temperature at sand metal interface will depend on pouring temperature, temperature and thermal conductivity of sand mould, bowl or core. As regards composition, phosphorus reacts with water vapour more readily.

(viii) Reaction between molten metal and the surfaces of sand moulds, cores, pouring basings, etc., (which contain chemically combined water even after baking and which the molten metal can split) gives metallic oxides and hydrogen which is in the atomic state and hence rapidly absorbed. This gives rise to inter-crystalline porosity as distinct from surface blowing or entrapping of steam bubbles which occurs when there is free moisture on moulds or cores. Surface " blowing " also occurs when the molten bronze stream impinges on a cast iron mould face raising its temperature sufficiently to permit reaction between carbon of cast iron and oxides in the metal stream. Rapid pouring and high temperature of mould or metal faciliate this reaction. Refractory dressings like French Chalk are washed away at area of impringement but volatile dressings (like fine 200 mesh charcoal mixed with equal weight of preheated volatile base, tallow and applied thinly with a hard brush) prevent direct contact between the molten bronze and cast iron. A copper faced mould (water cooled) eliminates this defect.

(ix) The harmful effects of hydrogen can be eliminated by ensuring oxidising melting conditions or the presence of active oxides in the molten metal. In the first case, the oxidising gases in the furnace atmosphere cause dissociation of water vapour to be reversible so that free hydrogen is not readily produced. Also metallic oxides are formed in the metal which remove hydrogen. It should be noted that hydrogen has greater affinity for cupric oxide than for copper and will combine with the oxide to form water vapour which is harmlessly evolved from melt and copper which is redissolved. Where it is impossible to control the concentrations of oxides necessary by furnace atmosphere alone add dry oxides of copper, nickel of manganese to the extent of 1-2% of the charge. Nickel oxide can be added for molten metal degassification when 0.2% is added and stirred into the metal in the furnace before pouring. Treatment of metals after melting has an added advantage as crucible attach by flux is minimised. It is found that the addition of cupric oxide alone does not transfer oxygen to the melt. The admixture of a flux with the oxide is necessary.

(x) An oxidising flux however is better than degassing by direct oxidation since a flux provides protection from furnace atmosphere and cleans the melt from oxide skins in addition to supplying the required oxygen. All alloys heated with oxidising media should be deoxidised before casting. Efficient deoxidation is best done by Phosphorus since it gives a fluid phosphate which separates easily from the metal and also prevents further oxygen being absorbed during pouring. Otherwise sufficient oxygen may be reabsorbed to react with the residual hydrogen and give steam porosity.

(xi) In the absence of elements with a high affinity for oxygen like Phosphorus and zinc which form insoluble oxides, hydrogen may be eliminated by oxidation of melt followed by deoxidation to remove excess oxygen added. But commercial bronzes generally contain phosphorus and or zinc which hinder this removal. It is wasteful to eliminate large amounts of phosphorus by oxidation. In such cases hydrogen can be removed by a scavenging treatment by addition to the charge at the bottom of the crucible of substances like manganese ore (2% of charge) which results in a prolonged evolution of inert gases during melting, presumably oxygen and or carbon dioxide. This has a marked degassing effect on Zinc containing bronzes even when the melting atmosphere is reducing. It is less effective when mixed with flux as it fuses and rises to the surface of melt forming a fluid slag.

(xii) Manganese ore is the ideal protection for the metal in that it provides a steady stream of oxygen during melting and when it has given up all its available oxygen, the ore comes to the surface of the molten metal and provides an efficient inert cover which is easily removed by skimming. Manganese does not go into the alloy showing that MnO_2 is not reduced to metal. This is preferable to the harmful but old established practice of using charcoal as cover during melting especially for leaded gun metals.

(xiii) The most common cause of leaky castings is the concentration of shrinkage prosity at local heat centres. In freezing, the copper rich crystals grow as tree like dendrites and the remaining liquid occupies an intricate net-work of channels between the primary dendrites. The freezing shrinkage of the liquid trapped between the dendrites is not easily fed by flow of liquid from feeders with the result that minute cavities dispersed throughout the casting instead of as a pipe in the feeder. A considerable amount of pressure tightness exists provided it is uniformly dispersed. But the prosity tends to concentrate at areas in imperfectly fed castings where solidification has been locally delayed, e. g., at junctions of sections, change of section, bosses, etc., where rate of heat abstraction changes. Such concentrations of prosity cause leakage under pressure.

6. The various defects are:

A. MISRUN
B. SHRINKAGE & DRAWS
C. SLAG
D. POROSITY
E. HARD METAL
F. SCABS
G. DISTORTION
H. ROUGH SURFACE
I. CRACKS
J. BLOW-HOLES
K. CAVITIES

The causes, remedies and visual diagnosis for each of these defects are given for the guidance of a practical workman in the following paragraphs. Many foundrymen are often in doubt when faced with a scrap casting, and very often the cure is obtained by rule-of-thumb methods, no direct approach to the trouble being made.

Appearance	*Cause*	*Remedies*
A. MISRUN May appear as:		
(1) Holes in the thin sections of a casting. Edges are smooth and well rounded; surface of metal round holes smooth and often shiny. (2) As a line, when two streams of metal have met but not fused together. Fracture may occur along this line. Casting surface may be smooth and shiny.	(1) Low pouring temperature. (2) Low fluidity. (3) Hard mould (mainly on very thin casting) (4) Core shift, causing uneven thicknesses. (5) Vent low on sand. (6) Very high moisture content. (7) Pouring practice.	(1) Provide hotter metal cupola spot; reduce heat losses in ladle by using flux coverings. (2) Increase Carbon and phosphorus. (3) Avoid excessive ramming. (4) Take extra care in positioning. (5) Increase vent by means of vent wire or by adding Silica sand in mixing. (6) Reduce moisture compatible with moulding. (7) Keep runner bush full of metal during pouring.
B. SHRINKAGE & DRAWS		
Rough cavities catering casting on heavy sections, or at the joint of change of sections. Saucer-shaped depressions on heavy sections, usually with rough edges. (See " FOUNDRY PRACTICE " No. 47, page 39, and F. P. No. 76, page 257.)	(1) Incorrect gating and feeding.	(1) Use risers to feed heavy sections and ensure that they are filled with hot metal. If using open risers, use feeding flux, if using blind risers use feeding cores. Embody chills where a heavy section or boss cannot be fed directly with a riser.

Appearance	*Cause*	*Remedies*
C. SLAG		
Similar to above. Cavities are generally more saucer-shaped and smoother. Slag may be seen before cleaning the castings.	(1) Dirty metal (2) Incorrect gating.	(1) Remove all slag from meta before pouring. Thicken slag with sand before skimming. (2) Incorporate skim gates or strainer cores in runner systems. Keep runner bush full whilst pouring.
D. POROSITY		
Castings " weep " under pressure test. Machined surfaces show cavities in thick sections or a series of pin-holes on machined skin.	(1) Wrong type of metal. (2) Running and feeding system. (3) Gassy Metal.	(1) Reduce Silicon or phosphorus content. (2) See shrinkage. (3) Degas and scavenge well.
E. HARD METAL		
Bright areas on machined faces, often at corners or edges of thinnest sections. May occur as scattered hard spots. Shows, when broken, a white fracture.	(1) Wrong type of metal. (2) High moisture content. (3) Pouring practice.	(1) Increase Silicon content by: (a) altering metal mixture; (b) by introducing Silicon into ladle. (2) Reduce moisture. (3) Avoid splashing metal down runners and risers—" plug " sprues very helpful.
F. SCABS		
Rough " warty " excretions on surface of casting, mainly on heavy sections.	(1) Uneven raming. (2) Incorrect gating. (3) Improperly dried moulds. (4) High clay content in moulding sand.	(1) Ram more evenly. (2) Gate so that an even flow is obtained over surface of mould. (3) Avoid too rapid drying and allow time for heat to penetrate through the mould. (4) Change moulding sand.
G. DISTORTION		
Casting shows swelling on surface.	(1) Uneven mould hardness due to insufficient ramming to withstand metal pressure. (2) Poor weighing practice.	(1) Ram evenly and firmly. (2) Increase weights on moulds and ensure it is distributed evenly.

Appearance	*Cause*	*Remedies*
H. ROUGH SURFACE		
Casting surface rough. (See " Foundry Practice " No. 58 page 117.)	(1) Metal penetration. (2) Low coal dust content. (3) Hard sand surface with low permeability. (4) Moulding sand too " open ".	(1) Use finer sand or use mould dressing. (2) Make additions of coal dust. (3) Open up the sand. (4) Close-up sand somewhat.
I. CRACKS		
Hair line cracks showing on casting. When broken, discolouration shows that crack was produced while casting was hot. No discolouration shows cold crack.	(1) High dry strength of sand. (2) Cores too hard. (3) Casting strains. (4) Mechanical reasons.	(1) Ram softer to allow casting to contact. (2) Reduce oil in cores. (3) Gate evenly to avoid these. Break mould to allow of free contraction. (4) Pack casting with wood or old tyres in tumbler. Take care in breaking off risers. See that risers are provided with correctly designed necks.
J. BLOW-HOLES		
Rough shaped holes occuring on the outside of the casting or in the thicker sections. May be found just below surface on machining. In severe cases, section or casting may be hollow. Cavities may be dull or bright depending on conditions under which they have formed. (See " Foundry Practice " No. 54, page 81)	(1) Low vent on moulding or core sand. (2) Hard ramming. (3) High moisture content. (4) Rusty or damp chills and chaplets (5) Very hard cores. (6) Insufficient venting in cores. (7) Incomplete baking. (8) Damp pouring ladles. (9) Too low a pouring a temperature.	(1) Increase vent by use of vent wire or open sand with additions of Silica or by use of a Coarser Silica sand. (2) Avoid excess ramming. (3) Reduce moisture to minimum consistent with workability. (4) Ensure chaplets are dry and coat chills with oil or proprietary dressing before use. (5) Reduce oil in sand. (6) Ensure vents are clear. (7) Bake until centre is dry and hard. (8) Thoroughly dry all pouring ladles. (9) Increase pouring temperature.
K. CAVITIES		
Rough cavities and pits in casting surface. If examined before cleaning the sand may often be seen.	(1) Strength of sand low. (2) Loose ramming. (3) Direct wash of metal on sand surface, e. g., cods, corners, etc. (4) Poor finish of system. (5) Displacement of sand by cores. (6) Disturbed moulds. (7) Insufficient taper on patters.	(1) Increase green bond. (2) Ram evenly. (3) Avoid direct wash with well designed runners. (4) Finish of running system should be as good as mould. Make bushes and runners with good facing sand. (5) Blow out after placing cores. (6) Place weights carefully ; avoid knocking moulds (7) Increase taper to allow clean lift.

(Courtesy: IRE—Bombay)

(Continued from page 36)

the invention for Government exploitation. Informal discussions with foreign locomotive manufacturers were held in London the same year. In 1959, the National Research Development Corporation negotiated for world exploitation of the Suri-Transmission with Messrs. MAK of West Germany. In terms of royalty proceeds the Suri-Transmission is expected to be a fairly substantial foreign exchange earner.

As early success in world exploitation of Suri-Transmission depends entirely upon speedy and successful development of the seven prototype locomotives already ordered, the Indian Railways have extended the fullest co-operation to the firm and have also undertaken to contribute towards the cost of development of the Suri-Transmission system.

The Chairman of the Railway Board said that the patent was first challenged in West Germany hotly. They had to send solicitors and conduct court proceedings before they could establish their right. Now another challenge had come from U. S. A. and the Indian Government had taken up the matter.

Mr. Karnail Singh said that no decision had yet been taken regarding the manufacture of diesel engines in India. But he would emphasise that electrification would mean high initial costs and consequently a heavy traffic to start with. So the use of diesel engines would have to be resorted to as they were doing in many parts of India. As far as steam locomotives were concerned, the steam engines had been almost perfected because of 100 years' development.

Mr. Suri joined the Indian Railways as a Special Class Apprentice in the Superior Establishment of the Mechanical and Transportation Department of the Indian Railways in 1945. In 1954 he was sent abroad on deputation with the Director-General, India Stores Department, London, as a Junior Railway Inspecting Officer. It was in 1956, while in London, that he filed an application for a patent of his invention, on which he had been privately working approximately for two years. On return from deputation abroad Mr. Suri was posted as Deputy Director (Diesels) in the newly created Diesel Department of the Research, Design and Standards Organisation of the Indian Railways.

The Railway Board has also decided to place on deputation abroad for four weeks Mr. R. K. Sethi, Joint Director (Diesels), in the Research, Designs and Standards Organisation. Mr. Sethi is one of the very few Indian Railway specialists in the field of diesels and he will be required to assist in the development of Suri-Transmission and to certify the fitness of the prototype locomotives on completion.

Mr. Suri and his senior colleague, Mr. Sethi, have together been working during the last year or two on new designs of high-powered light-weight locomotives, the like of which have not yet been known to diesel locomotive manufacturers in advanced Western countries. They have already met with a large measure of success in this direction.

DIESEL RAIL CARS — I. C. F. TO MANUFACTURE

The Integral Coach Factory, Perambur, will start manufacture of Diesel Rail Cars for use on Indian Railways, during the Third Plan period, it is learnt. The Railway Board has asked the I. C. F. to manufacture 60 Broad gauge, 120 Metre gauge and 10 Narrow gauge rail cars at an estimated cost of rupees four, three and two lakhs respectively.

The Railway Board have further instructed the Integral Coach Factory to ' go ahead ' with manufacture of prototypes. The first twelve of these would be manufactured during 1962-63. The Board is keen that manufacture of Diesel Rail Cars should be undertaken by a public sector unit, with particular reference to the type of engine to be utilised and the driving mechanism decided upon with due regard to the needs of service as also their early availability from indigenous sources.

Railway technical experts have expressed the view that while no diesel engines suitable for rail cars were now being manufactured in the country, the possibilities of one, or both of the established Indian manufacturers, whose principals already have a flat engine for diesel rail traction should take up its manufacture. To that extent, our choice of diesel engines would depend upon the rate of indigenous development.

As the prototypes have to be tested before bulk production could commence to meet the requirements during the Third Plan period, the Integral Coach

Factory have been advised to finalise the designs as early as possible.

It is further learnt that diesel engines, transmission gears and switchboard panels have to be imported and global tenders for their supply are likely to be called soon.

* * *

NEW LOCOMOTIVES FOR TISCO

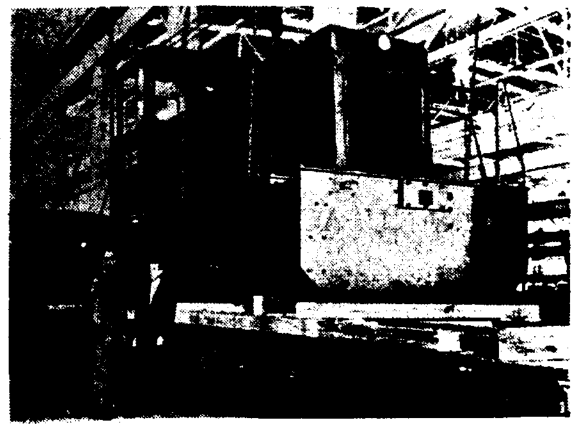
India's fast growing steel industry will gain more "muscle" this year in the form of ten new diesel-electric industrial locomotives.

The order for the locomotives by Indian Iron and Steel Company was announced recently by officials of General Electric's (U. S. A.) Locomotive & Car Equipment Department which will build the units in its Erie, Pennsylvania, plant.

Estimated cost of the order is in excess of $ 750,000, according to G—E.

The new locomotives will be used by TISCO to haul raw materials to its mills and to transport finished steel products to railheads for shipment to warehouses and to users.

Four of the new locomotives will develop 550 horsepower and the six remaining locomotives will each develop 275 horsepower.



This present order will bring the total number of General Electric industrial locomotives serving India's steel industry to 87, with 27 of these in service with Indian Iron and Steel.

Incidentally, halfway around the world from Indian Iron and Steel's mills in Burnpur, other G—E industrial locomotives are supplying vital motive power for Argentina's big new steel mill in San Nicolas. There, approximately 200 kilometers north of Buenos Aires, 420-horsepower G—E diesel-electrics are being used to haul raw materials to the mill.

* * *

SMALL TRAIN MAKES HISTORIC TRIP

A big diesel-electric railroad locomotive hauled a small two-car train on an epic making trip recently. The locomotive was the thousandth diesel-electric unit built by the General Electric Company (U. S. A.) for use by a South American railroad and it was making a special inaugural run for the benefit of railway and government officials and members of the press who jammed the two cars it was hauling.

The train consisted of the locomotive, a pullman car and diner. Departure point was the Buenos Aires terminal of the General Manuel Belgrano Railroad. The end of the ride was at the town of Del Viso, some 57 kilometers from the capital.

Members of the Argentine press, government and railway officials are shown in the Buenos Aires station of the General Belgrano Railway shortly before boarding a special inaugural two-car train hauled by the 1000th locomotive built for a South American railway by General Electric Company (U.S.A.). The 1320 horsepower diesel-electric unit is shown in the background.

The press, government and railway officials were invited on the inaugural trip by General Electric, Argentina, S. A.

Built by the G—E Locomotive & Car Equipment Department in Erie, Pennsylvania, the 1320 gross horsepower locomotive was delivered to Argentina late last year for use by the Belgrano Railroad. It was one of fifty recently ordered by Belgrano officials. General Electric's 1000th South American locomotive is of the universal-type found on several Brazilian lines, including the Paulista, Sorocabana, Santos a Jundiai, Santa Catarina and others. Out of the 1000 locomotives shipped to South America since 1915, Brazil, with 300, has received the greatest number.

IMPORTANT ANNOUNCEMENT

We have pleasure in announcing to all our Readers and Advertisers that we propose to bring out a special **International Number** devoted to "Steam, Electric and Diesel Railway Traction sometime in September 1960. This International Number will deal in all branches of "Steam, Electric and Diesel Railway Traction".

—*EDITOR*

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1	The title of the book and the contents of the title page	The Indian Railways Workshop Magaz
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3	The name of (a) the Author, (b) the Translator, and (c) the Editor of the book or any part thereof	S. H. [redacted]
4	The subject	Problems of Workshops.
5	(a) The place of printing, and (b) the place of publication	M. K. Press - Tanjore.
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I declare that the above entries are correct and true to my knowledge.

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