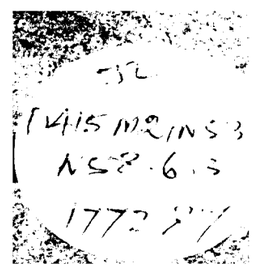
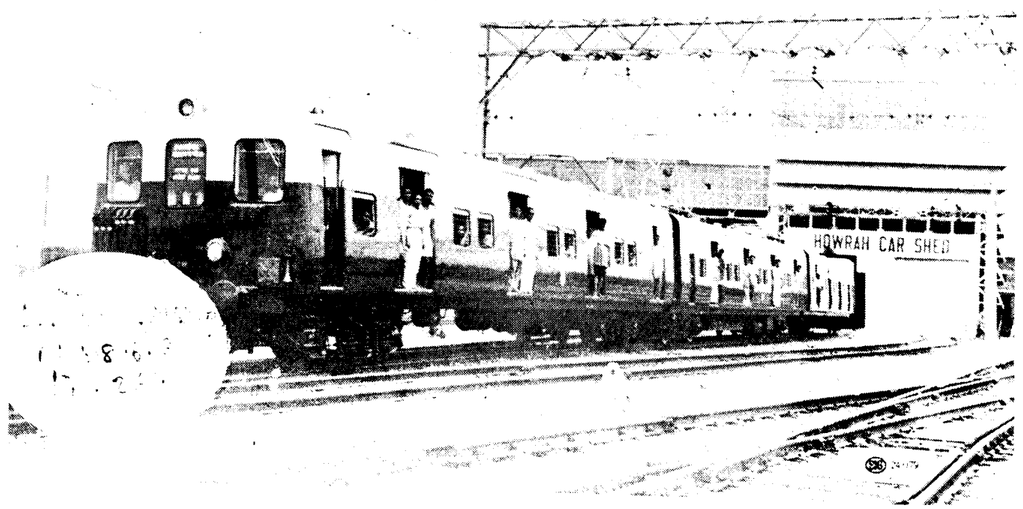


THE INDIAN RAILWAY ENGINEER

VOL. 6 NO. 3 JANUARY 1959 50 NAYE PAISE

INTEGRAL COACH FACTORY SUPPLEMENT



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INTEGRAL COACH FACTORY SUPPLEMENT

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Production Planning & Control in Integral Coach Factory

By Sri D. R. R. Sastri
Production Engineer, Integral Coach Factory, Perambur, Madras.

A study of the growth of industry will show that in the past several factories were managed by a single person who was the Salesman, the Director, the Planner and the Executive all combined in one. Then came the stage when a body of men undertook the various functions separately, but till quite recently a system was being followed where orders for manufacture were issued to workshops and the complete execution left to the shop foreman. With further growth of Industry the foreman was called upon to perform multifarious duties and it was at this stage that a separate production Planning and Control Organisation was set up to assist the foreman in the execution of the work. This Production Planning and Control Organisation is now recognised as one of the main sections of the Management for ensuring economic and efficient production.

In a commercial firm, the Production Office receives the orders for the work to be undertaken from the Sales department, and in the case of I. C. F. similar orders are received from the Railway Board. In both cases, however, the transactions are almost identical since the I. C. F. supplies passenger coaches to the open railways on a payment basis.

The function of the Production Control organisation is similar to that of the nervous system of the body. Just as impulses of the nervous system are co-ordinated with the useful physical movements for obtaining the desired activity, so also should a continuous and complex stream of impulses (directions) be given by the Production Control Office to the workshops to achieve complete and co-ordinated working. For achieving this, the Production Office is divided broadly into the Production Planning Section and the Production Control section.

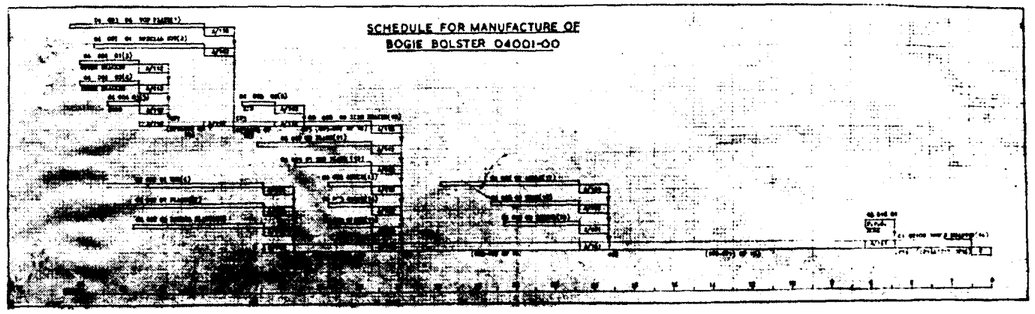
PRODUCTION PLANNING

The production of jobs in a factory can be compared to rail road working, where several trains are running on pre-determined routes at laid down schedules. Separate time tables are drawn up for mails, passengers or goods and not only are the number of stops en route different for each train but also the period of stoppage at each station varies considerably. The object in rail road control is to pass over the available track the maximum transport that it can carry within the safety limits. Exactly similar to this is the function of management in a factory i. e. it ensures that the maximum amount of work is processed through the available plant and mechinery within the regulations and limits of safety. In assisting the management to achieve this objective, Production Planning plays an important role; it having been decided by the management as to WHAT to produce, the Production Planning decides on HOW, WHERE and WHEN to produce the job. It is remembered that the results can be no better than as planned.

The Production Planning is sub-divided into other sub-sections viz. the Processes and Estimate Section the Scheduling Section and the Machine loading Section.

The Processes Section decides as to how and where to manufacture the job. For this in the I. C. F., the coach is broken down into details which are classified under groups and sub-groups, for example the bogie is classified as Group-0, under which sub-groups 01 represents axles, wheels, axle-box guides and springs: 02 – represents roller bearings with axle-box including covers etc. On the basis of this classification a list of all details required to be manufactured for coach construction is drawn up and is referred to as the List of Parts. For each such item, the method of manufacture is planned and is entered on a Scroll Sheet.

Again for indicating as to where to do the job the factory is divided into shops and sections each shop and section bearing a distinctive number. The plant and machinery in the factory is also divided into load-centres, each loadcentre representing a distinctive machine or group of machines with a particular capacity. Thus for indicating as to where the job is to be done the loadcentre and the shop section no. is also shown on the Scroll Sheet. Therefore by following the instructions contained in the Scroll Sheet each and every part required for the coach is manufactured in the proper manner and at the proper place and the



assembly completed according to the assembly scroll sheet.

The final delivery is also indicated on the Scroll itself i. e. whether the material should be delivered to another shop or section (in which case the shop or section No. is entered on the scroll.) or to stores. Here again therefore the stores is classified as the General Stores, Custody Stores, the finished parts stores and the Progress Stores.

The estimating section which is a part of the Processes Section estimates the cost of works to be undertaken for outside bodies and also works out costs of items required for coach production so as to enable a decision being taken as to whether the item should be manufactured in shops or purchased from trade.

The Scheduling section finally decides as to when to do the job. For this purpose a Master Production Schedule as shown here is drawn up. The schedule shows the date on which each batch order is to be released and completed, the period for which the materials will be in storage and finally the programme of assembly of coaches. The dates on which the various coaches are expected to be turned out of the I. C. F. can therefore be read off directly from the chart.

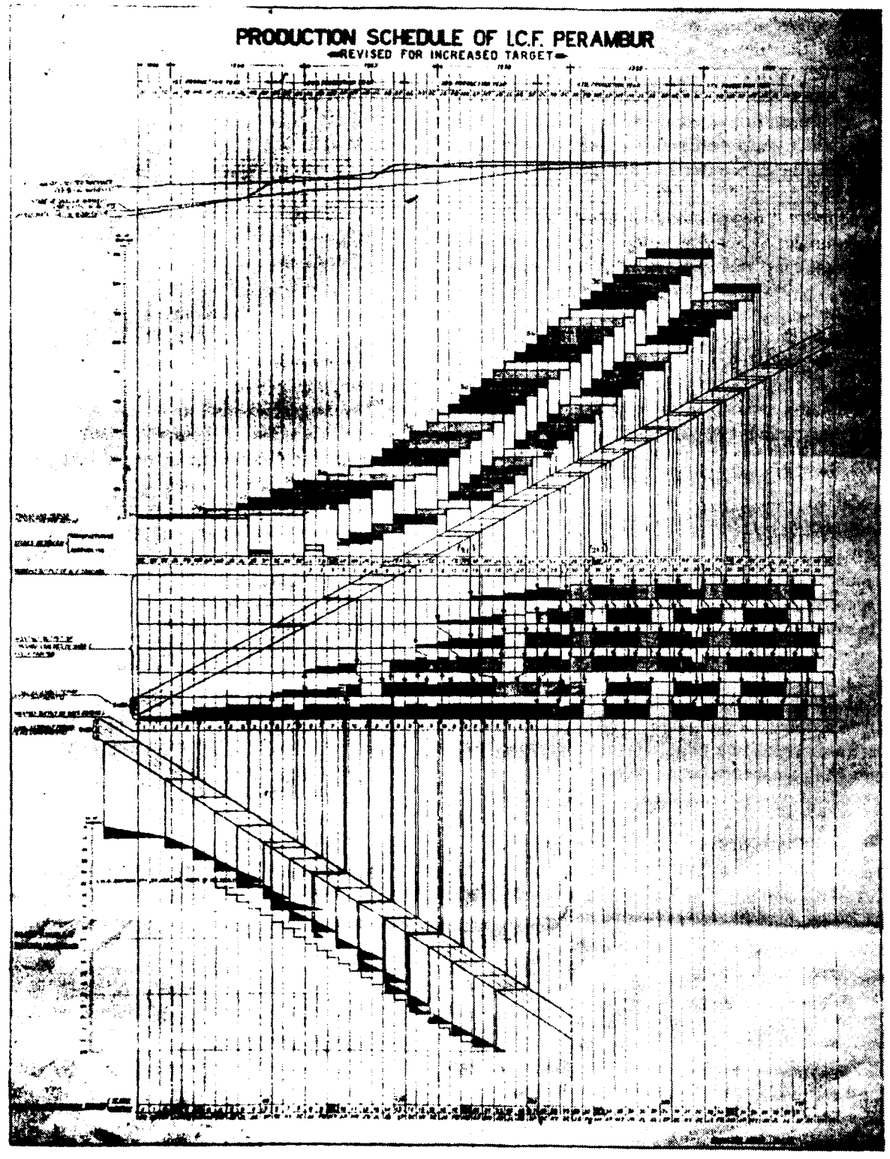
This chart after receiving administrative approval, is taken as the basis for detail scheduling. There the schedule is worked backwards from the date the coach is to be turned out to the date where each detail has to be separately taken in hand for manufacture. A sample chart as to how this is done is also shown below. It will be noticed that the period of manufacture has been divided into units, this having been done for the convenience of calculations.

The above mentioned work of the Planning Section virtually completes all that is required to be done in the planning stage, but an important part is also played by the machine loading section, which advises the Processes section as to which loadcentres will be overloaded, according to which the process may have to be at times, altered. If such a course is not possible, greater utilisation of the machinery has to be called for by working it beyond the normal hours of single shift working.

PRODUCTION CONTROL

This section is considered to be essentially a Service department to the shops and it watches the progress of each work order from the time it is issued to the time of completion. It highlights the delays and assists the shops in ironing out difficulties with the primary object of ensuring that the planned schedule is followed.

The Production Control is divided into the despatch section and the follow-up section. The despatch section releases work orders as per the pre-determined schedule and in accordance with the work order system laid down in the I. C. F. As per this system, Standing Work Orders are assigned to different repetitive works, for example, Standing Work Order 32 is meant for the manufacture of Third Class shells, Standing Work Order 33 for the manufacture of TLR shells etc. This Standing Work Order Number is followed by a three digit number which indicates the batch order. Each batch order comprises of one month's out-turn of shells and each such batch order is required to be completed within the period as given on the Master Production Schedule. The despatch section therefore issues, for the manufacture of each detail, a route card which is a reproduction of the scroll sheet, job-cards for booking of labour and material requisitions for the drawal of the correct material and to the correct quantity.



From the time the work order is thus released the follow-up section keeps a watchful eye on it and by means of documents maintained in the production office follows the progress of each job. Weekly statements of items that are likely to run behind schedule are made out and handed to the shop foreman for giving special attention. Special watch is also kept on movement of materials between one manufacturing section and another and in all cases it is endeavoured to point out delays that are likely to occur in advance

so that preventive action could be taken instead of pointing out the delays after they have actually occurred. Staff of the follow-up section are therefore in constant touch with the shops and help shop foreman to take prompt remedial action. Fortnightly meetings at which shop foremen are present are also held to discuss the difficulties and find solutions.

The Production Control therefore plays an important roll in stimulating activity where necessary in the workshops so that the planned schedule could be worked to.

OTHER CONTROLS

The Production department also assists the Works and other departments in maintaining the following important controls.

(a) *Machinery Idle Time*

Production Office issues blank idle time cards (for each machinery and plant on the shop floor) and on each occasion when the machinery or plant is enforced to idle, the card is clocked on and the reason for idle time is assigned by the Section Chargeman. The Production office and the Works together strive to keep this idle time to a minimum. Machinery breakdowns are also kept to a minimum by following the Preventive Maintenance Schedule.

(b) *Labour Utilisation*

Man hours spent per batch order are watched as each batch order is closed and increases if any from one batch to another are investigated and where avoidable leakages are discovered, suitable action is taken.

Idle time for labour is also recorded in the same way as for machinery and is carefully kept to a minimum.

(c) *Materials Control*

The Production Office is closely associated in controlling the procurement and utilisation of materials. A schedule is drawn out in consultation with the Stores department for the procurement of raw materials and in making issues to shops the requirements of each item are carefully worked out. Likely hold-ups that may occur for want of materials are also forecast and periodical meetings held with stores representatives to find means of obtaining the materials in time.

(d) *Cost Control*

The Production Office also assists the Cost Accounting department in compiling the costs by issuing completion certificates at the end of each batch order certifying the return of all production documents to the Costing department and making a review of all released materials. A system of cost code numbering viz. No. 3 for detail manufacture, No. 2 for sub-assemblies, No. 1 for major assemblies and No. 0 for installation, is also adopted, which in combination with the group and sub-group numbers of the coach form the Cost Control No., by means of which the cost of any detail or assembly can be extracted.

(e) *Overheads*

The Production Office also keeps a watchful eye on overheads which are made up of constant and variable factors. The attention of Works Managers is drawn in case a rise is noticed in any of the variable factors.

Improvements in the methods of manufacture, and ways and means of reducing both materials and man-hours are also constantly under review. A Time Study Section attached to the Production Office is fixing operational times on a scientific basis with the object of indroducing an Incentive System of payment. Also Suggestions received from staff are closely studied and wherever economies are expected the suggestions are accepted and adopted.

Through the various abovementioned functions the Production Office helps the administration of this factory to produce more coaches with increasing efficiency and decreasing costs.

At the Perambur "Integral Coach Factory"

Contributed by Helmut Jauslin, Neue Zürcher Zeitung Engineering and Industrial Editor

MADRAS—the third largest city in India with a total population of one and a half million inhabitants—is situated far in the south of the Coromandel Coast. The sea and the beach give this city its character while the center of the town reflects the typical Indian life in shining colors. The technological evolution of the past few centuries—from the rikshaw coolie bathed in perspiration to the modern air-conditioned car—mingles idyllically with the daily life of cows, donkeys, goats and dogs. Naturally, Madras also possesses a "Main Street," which is called Mountroad, and the bazaars on this road have the same fascinating effect on the passer-by as the well-lit shop windows have in America and Europe.

The harbor, from which the heavy traffic in the streets results, creates an intense and active life in Madras. The same also applies to Perambur, situated on the outskirts of Madras. The increase in railway traffic is mainly responsible for the development of Perambur. Locomotive and carriage repair shops have been working there for years, and now the latest project--the Integral Coach Factory (I. C. F.)—is being completed. This new coach factory, which represents an important milestone in the industrialization of India, is based on the decade-old experience of Swiss engineering knowledge and especially on the good cooperation between the Swiss team delegated to Perambur and the Indian staff.

A PROJECT REALIZED WITH SWISS COOPERATION

This project materialized as a result of many factors. In the early Thirties already the Swiss Car and Elevator Manufacturing Corp. Ltd., Schlieren-Zurich, in conjunction with the Swiss Federal Railways, developed a light-weight steel coach. This prototype was put into service as a trial coach as far back as 1933. It was the first time in the construction of railway coaches that the sidewalls and the roof were also used as carrying parts, resulting in a saving of as much as 30 per cent on the coach's weight. The progress in welding techniques brought further advantages in respect to the designing and the manufacturing of light-weight steel coaches. The satisfactory experience made with the new type of coaches aroused the interest of foreign companies and in 1949 resulted in the conclusion of an agreement between the Government of India Ministry of Railways, and the Swiss Car and Elevator Manufacturing Corporation Ltd., Schlieren-Zurich. The main object of this agreement was the construction of a new coach-building factory in Perambur, India, for the manufacture of modern light-weight steel coaches for broad gauge, similar to those of the Swiss Federal Railways. To introduce these coaches as quickly as possible on the Indian Railways, Schlieren, to begin with, received orders to supply complete coach bodies and later on knocked-down coaches together with jigs, fixtures and other equipment for the new factory.

The entire civil engineering work of the project was entrusted to an Indian civil engineer who proved fully capable of solving this great task. The work on the site was started in September, 1952. Thousands of Indian workmen have since then been engaged under the guidance of an engineer-in-chief, and already in May, 1953, it was possible to erect the first steel structures of the workshops. Due to the subtropical climate of Madras, the roofs of the workshops had to be provided with asbestos sheeting combined with glass louvers toward the north. Furthermore, big louvers were used on the top part of the side walls for increased ventilation. In January, 1955, the first workshop was completed and immediately afterwards the installation of the machinery and workshop equipment begun. In close continuation and according to a well calculated time-table insuring coordination between the Civil Engineering and the Mechanical and Electrical Department the rest of the workshop was set up and production started.

Simultaneously with the civil engineering work the technical training of the staff had to be started. The manufacture of light-weight steel coaches requires a thorough knowledge of modern welding techniques and up-to-date production methods. In March, 1954—one and a half years ahead of the production start—the Technical Training School attached to the I. C. F. was inaugurated. In this school qualified boys between the ages of 18 and 26 years are recruited as apprentices and given an intensive six months' basic training under the supervision of four Swiss instructors. According to the experience so far gained,

this relatively short training period seems fully sufficient to provide elementary knowledge for the different trades and to prepare the apprentices for their work in the shops.

In addition to these six-month training courses, in which an average of 200 apprentices is being trained at a time, 80 Indian engineers and specialists were delegated to the workshops of the Swiss Car and Elevator Manufacturing Corporation Ltd., Schlieren-Zurich in 1954 and 1955. These engineers and experts received a special training in the manufacture of light-weight steel coaches. Furthermore, a "Schlieren team" of 40 specialists was sent to Perambur for a contract period of three years. The installation of the machinery in the different workshops of the I. C. F. was carried out in close cooperation between the Indian engineers and workers and the Schlieren team. This team also introduced its Indian colleagues to the new production methods, modern machine tools and the new welding technique, as well as the sheet metal treatment. The majority of the team will return to Switzerland in the course of 1958.

October 2, 1955—the birthday anniversary of Mahatma Gandhi—marked the production start of the I. C. F. On this important day, the Prime Minister of India, Mr. Jawaharlal Nehru, inaugurated the first light-weight steel coach assembled in the I. C. F. from sub-assemblies delivered by Schlieren.

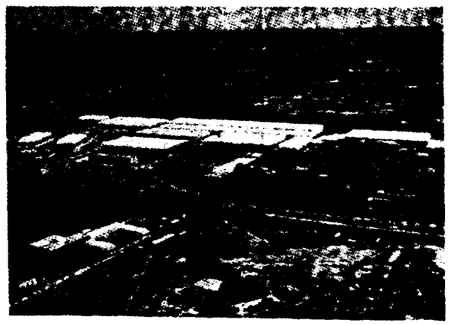


Fig. 1 Aerial view of the I.C.F. looking north.

The factory is designed to produce 350 coaches per year and when this target is achieved in 1959, a rail coach will leave the work every 6 hours. An elaborate material handling and transport system has been an important factor in the planning of the I. C. F. In adaptation to this factor as well as to the average daily temperature of 30 to 37° C, the dimensions

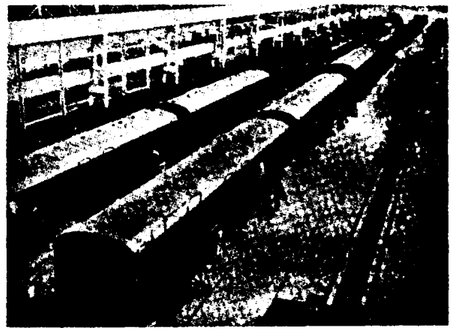


Fig. 2 Large assembly shop, showing 3 out of the 6 assembly lines. In the foreground the finishing touches are being applied to a coach shell.

of the different workshops have been reduced and as a result the layout consists of seven workshops and three warehouses.

The thin and medium steel sheets, which are the main raw material used for building the light-weight steel coaches, are stored on the western side of the factory area. The main production flow, therefore, goes from west to east through the sheet-metal shop, and from there the material moves as a sub-assembly or detail into the big assembly shop. It is then distributed to six parallel body assembly lines where the raw body shells are assembled in eight stages. The raw body shells are then moved on special trollies from the assembly shop via a traverser to the paint and finishing shop located further eastwards. The body shells are cleaned by passing through a grit-blasting plant and in continuation through another number of stations in a one-and-a-half-day rhythm. At these stations they are being painted and sprayed with asbestos and fitted with the doors, windows, draw and buffer gears and the brake equipment. The detail parts used for the assembly in this finishing shop are manufactured in the machine shop, the wheel shop, the forge and the smithy shop. Doors and windows arrive in large batches from the manufacturing belts located in a separate shop.

A separate workshop, containing the millwright section and the tool and die room is attached to the

factory, because in industrially underdeveloped countries it is of the utmost importance that repairs can be carried out at the factory itself.

All the raw materials for the buildings, roads, drainage and the steel structure for the workshops have been obtained in India. Part of the raw materials for the manufacture of light-weight steel coaches, however, must still be imported because due to numerous other projects of the second five-year plan, the steel requirements far exceed the production capacity of the country. It is, however, possible that in the course of time the light-weight steel coaches will be manufactured entirely from indigenous material and an increase of production is even contemplated for the I. C. F. The past two production years have shown great progress, inasmuch as 43 coaches were delivered during the first year instead of the 20 coaches scheduled and a total of 150 coaches were manufactured, instead of 100 during the second year which terminated on October 1, 1957. Out of these 150 coaches 63 were "made in India" completely.

The success of this project, which was realized at a total cost of 66 million Swiss francs has been greatly appreciated by the Indian Government. The I. C. F. has, therefore, been held up as an example of good international cooperation, in which the planning of all details and the technical support given by the Swiss Car and Elevator Manufacturing Corp. Ltd. as consulting engineers was not forgotten. The I. C. F. is, of course, only one of many projects undertaken by the Government of India to raise the country's standard of living, but we are happy to note the contribution made by a Swiss firm in this particular case.

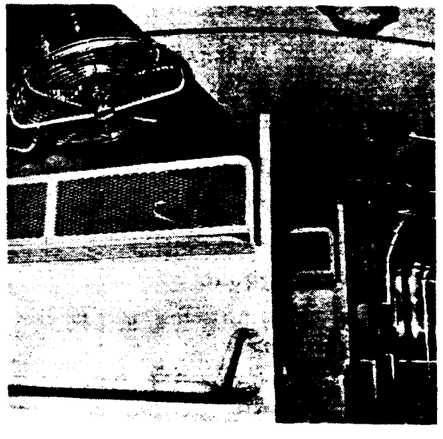
Integral Coach Factory—Furnishing Annexe

By K. M. Aiana

Dy. Chief Mechanical Engineer, (Furnishing) Integral Coach Factory, Perambur, Madras.

HOW THE IDEA OF HAVING A FURNISHING ANNEXE CAME INTO BEING

THE Integral Shells manufactured in the Integral Coach Factory, Perambur, were originally planned to be furnished in the Workshops of different Railways. Subsequently, on account of large scale expansions during the Second Five Year Plan period, which steadily increased the holdings of coaching and wagon stock on the Railways, the capacity in the Railway Workshops was required to be utilised for dealing with the increased repair load, and for building certain types of Timber coaches. Consequent to the increased production of shells, the necessity for having a separate unit for furnishing the shells turned out by the Integral Coach Factory, was keenly felt. Moreover, it was considered logically to be most economical to centralise this work and establish a factory to turn out complete coaches, ready for passenger traffic, in the shortest possible time, by mass production methods, thereby also relieving the zonal Railways of the load of furnishing the coaches themselves.



The Ministry of Railways, therefore, decided to establish a Furnishing Annexe to the existing Integral Coach Factory at Perambur, which would undertake furnishing of all the shells turned out from this Factory, for all the various types and classes of coaches as would be required. Accordingly, the Permanent Furnishing Project was sanctioned in 1956, at a cost of Rs. 3.69 crores. This Unit is being

located in close proximity to the Coach Factory connected by rail and situated south of the New Avadi Road, where 260 acres of land have been acquired, for the construction of the factory, sidings, and staff quarters. The Factory, when completed, will be of a modern design somewhat similar to the existing Coach Factory, and the standards of amenities for good working conditions have been planned on similar lines. It is anticipated that production from this Factory will be in keeping with that of the Integral Coach Factory.

In the first stage, macadam roads, compound walls, storm water drains and temporary construction sheds, in the Factory area, required for the construction organisation, have been completed A two mile long railway siding from Villivakkam Railway Station and also connecting the Integral Coach Factory, has been laid and is nearing completion. This will enable materials and stores for the construction of the workshops being brought to site direct by rail. The construction of 200 Quarters to initially house about 10% of the workers contiguous to the existing colony of the Coach Factory is also in progress.

IMMEDIATE FACILITIES FOR FURNISHING COACHES

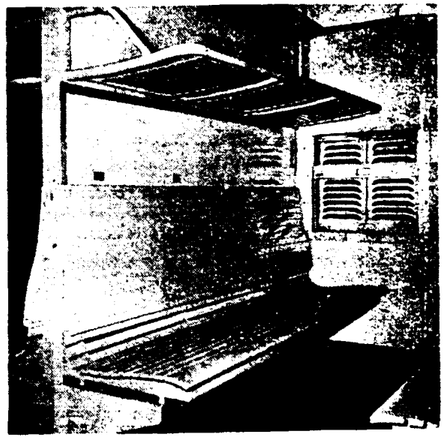
Pending construction of the permanent Furnishing Factory, it was decided by the Railway Board that the Integral Coach Factory should develop urgently furnishing capacity on a small scale, making use of covered space wherever available, in the existing Shell Factory and by use of temporary facilities. The first third class coach so furnished in the Shell Factory, was turned out and ceremoniously launched by H. E. the Governor of Madras, late Shri A. J. John, on the 21st February 1957.

TEMPORARY FURNISHING ARRANGEMENTS

In order to speed up the production of furnished coaches from the permanent Furnishing Factory, as soon as it is ready, a plan was also devised to commence furnishing production with some temporary facilities. This was to enable production staff and technique to be built up gradually, while the construction of the permanent Unit is in progress, so that the work will be switched over to the Permanent Unit, so as to attain full production, as soon as it is complete and with the least delay, instead of the production having to be phased over a period of years.

The proposals for the interim Furnishing Arrangements were accepted by the Railway Board and sanctioned and the construction of the Temporary Sheds at the site of the present Temporary furnishing Annexe, situated on the Konnur High Road, was taken in hand early in 1957, utilising some second-hand shedding materials procured from the Avadi Military Base nearby. The construction of these sheds for providing the necessary covered accommodation for the workshops to furnish the shells, storage of furnishing materials and a limited amount of ancillary work, with siding facilities and a Yard, were all completed in a very short time. Steps were also taken to make these facilities offer as comfortable working conditions, as possible, to the workers, as well as production to the maximum. The furnishing work was commenced from May 1957 as and when the sheds were getting ready and the first Third Class Coach was furnished and turned out in July 1957 and the 100th furnished Coach was launched on 19th June 1958. The strength of workshop staff of various categories is now over 650. Side by side, arrangements have also been made to recruit apprentices and impart training in the various furnishing trades, and such recruitment will continue to be made.

With these facilities it has been possible to so far furnish 193 Third Class Coaches upto the end of December 1958 and to develop capacity to turn out 15 furnished coaches per month with prospects of stepping up this figure further. In this out-turn, one prototype TLR coach (Third Class with luggage and Guard's compartments) was fully furnished and ceremoniously launched by the Hon'ble Deputy Minister for Railways Shri S. V. Ramaswamy on the 3rd January 1959. At present, there is by far the largest need for third class coaches only. But, the design for upper class coaches is also in hand and a programme for furnishing such coaches in the near future is contemplated. Consequent to the increased out-turn and with the gradual building up of the production staff



and technique, it has been possible from the first batch onwards, not only to reduce the direct man-hours per coach, but also to reduce the cost for furnishing per coach and there has been a systematic downward trend. Besides, the furnishing materials used are now fully indigenous.

SALIENT FEATURES OF A THIRD CLASS FURNISHED COACH

(i) The all-steel light weight Integral coach for third class travel is being furnished bearing in mind the latest amenity standards to be provided for the maximum comfort of the travelling public.

(ii) The layout consists of two compartments with 40 seats each and an inter-communicating door for isolation, if necessary. The seats which are of ample widths with sufficient knee room are arranged in one row of single seats along one side, and transverse long seats for 4 passengers on the other side with a passage in between.

(iii) Flat seats are being provided in order to give maximum advantages to the passengers while sitting or sleeping instead of seats with a curved profile as hitherto provided.

(iv) The floor is laid with oxychloride flooring composition to provide a hard wearing and washable surface.

(v) The sides, ends, ceilings and partitions of the coach have been fitted with suitable panelling materials. The ceiling is of white semi glose finish and the interior has been finished in light biscuit and buff colours relieved by aluminium mouldings giving a pleasing appearance.

(vi) The steel shell is suitably insulated and a central aluminium cased air duct connecting a number of roof ventilators provides for an efficient draft, and ventilation in the compartments. There are independent roof ventilators for lavatories.

(vii) 16 fans, 24 compartment lights, 4 lavatory lights and 4 blue night lights have been provided in the Coach. External embarkation lights which automatically switch on at slow speeds and during halts, have been provided.

(viii) Windows have both glass shutters and aluminium louvre shutters.

(ix) Light luggage racks, and lower luggage racks have been provided to suit the requirements of the passengers. The four seater benches and lower luggage racks above can be used for sleeping.

(x) On each half of the coach, 2 lavatories have been provided which are fitted with mirrors, shelves, towel rails, coat hooks, and other fittings of stainless steel which can be easily kept clean and hygienic. A 64 gallon capacity overhead water tank in each lavatory provides for an ample supply of water.

TARGETS AND OUT-TURN OF FURNISHED COACHES

The original and revised targets by financial years during the Second Five Year Plan period, as visualised by the setting up of the Permanent Furnishing Unit, according to schedule, and the actual out-turn of furnished coaches are given below :—

Financial year.	Year of the 2nd Five Year Plan.	Original furnishing target.	Revised target including 2nd Shift.	Actual Out-turn.
1956—57	I	Nil	Nil	2
1957—58	II	50	(72) actual.	72
1958—59	III	140	175	119 upto Dec. 58.
1959—60	IV	220	250	—
1960—61	V	335	350	—

PLANS FOR THE FUTURE

In view of the difficult ways and means position, during the Second Five Year Plan period, it will not be possible to complete the construction during this period, as previously envisaged. The construction of the Factory, as well as the procurement of machinery and plant will be rephased, based on the priority, with which the different shop structures could be taken up for construction, and completed during the Third Five Year Plan Period.

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 to a great extent to the rolling stock assets of the Indian Railways by economical production and extending to the travelling public, modern amenities and comforts. Furthermore, it is estimated that the Furnishing Unit will, initially, provide employment opportunities to 2,400 workers, and also contribute to the growth and establishment of several ancillary industries, with the impetus and encouragement, already given in the Interim stage of activities of the Temporary Furnishing annexe.

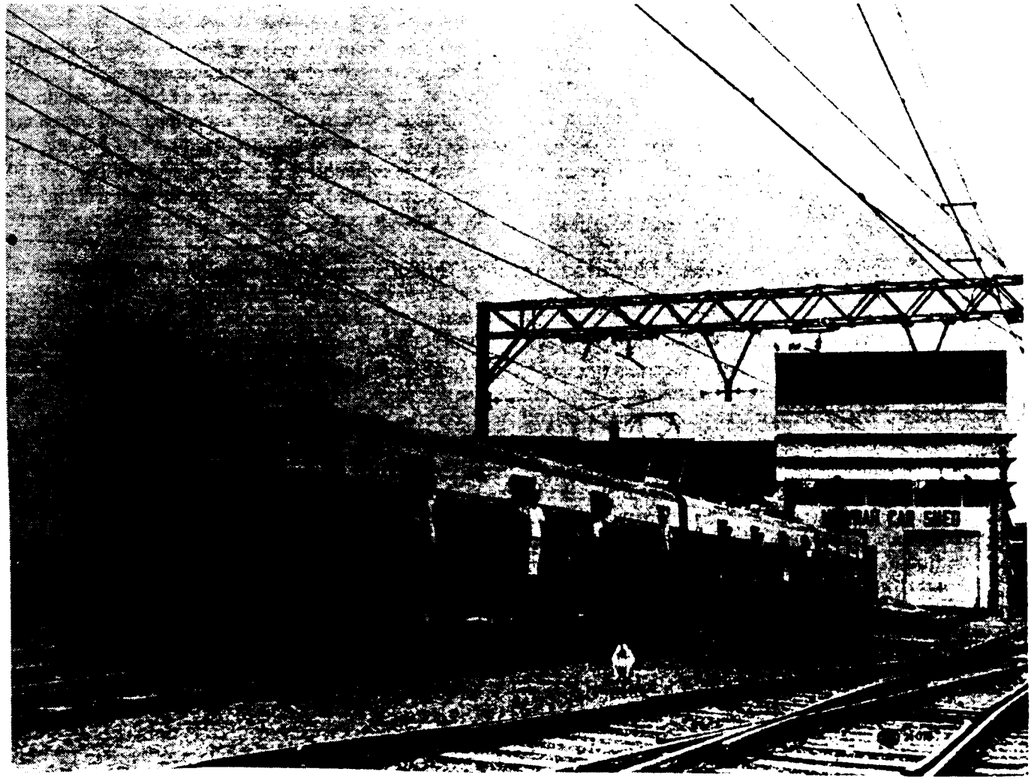
In the meanwhile, it is proposed to increase the furnishing capacity in the Temporary Furnishing Annexe and to continue obtaining assistance from some of the Zonal Railway Workshops, where coach shells turned out of the Integral Coach Factory are also being furnished, as a temporary measure, to keep pace with the increased out-turn of coach shells.

Swiss-Built Electric Multiple Unit Rolling Stock for Calcutta

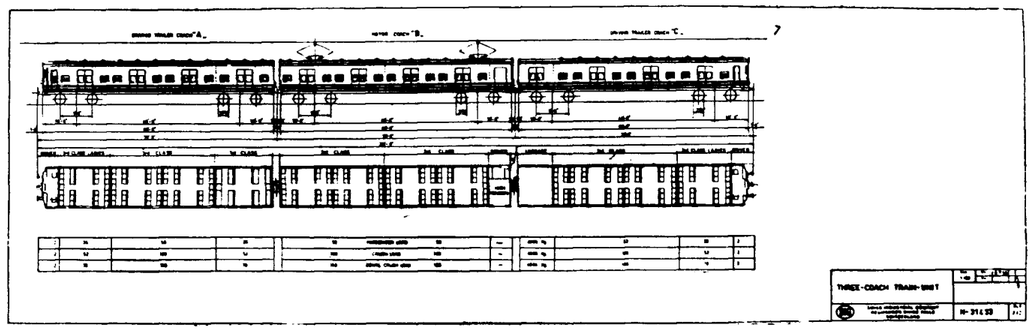
1025 h.p. Three-Coach Units for 3000-Volt d.c. Calcutta Suburban Services

A further step in the Calcutta electrification project was taken early this year with the introduction of the new E. M. U. stock on the high-tention d. c. electrified suburban lines. 16 three-coach units out of this stock, along with one spare motor-coach, were supplied by the Swiss Industrial Company (SIG), of Neuhausen Rhine Falls, on behalf of the Export Association of Swiss Railway Equipment Manufacturers, consisting of SIG; Schindler Carriage & Wagon Co. Ltd., Pratteln; Swiss Car and Elevator Manufacturing Corp. Ltd., Schlieren; Aircraft & Vehicle Works Inc., Altenrhein; Brown, Boveri & Co. Ltd., Baden; Oerlikon Engineering Co., Zurich; and Secheron Works Co., Geneva.

Of the complete order, SIG built all the motor-coaches, Schindler all the A-type trailers, and Schlieren all the C-type trailers (see accompanying diagram). The Altenrhein works supplied all the doors. The electrical equipment has been built by Brown,



General view of a three-coach unit leaving Howrah Car Shed, Calcutta.



Interior of third class compartment showing seating arrangement and fans (motor coach B/MC).

Boveri & Co. Ltd., Oerlikon Engineering Co., and Secheron Works Co.

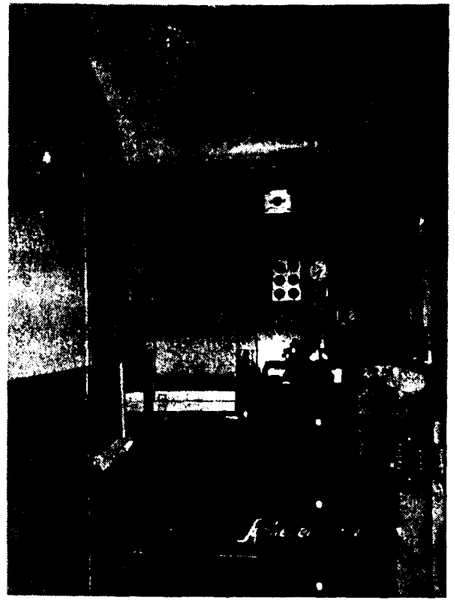
As shown on the general layout, a three-coach unit is composed of one motor-coach flanked by one control trailer on each side. A control trailer of type A/DT contains, besides the driver's compartment, two third class compartments seating 26 and 50 passengers respectively and one first class compartment seating 26. In the motor-coach, B/MC, there are two third class compartments seating 50 each, one h. t. compartment, and one auxiliary driver's cab for marshalling in yards and repair shops. A control trailer of model C/DT contains one driver's cab, two third class compartments seating 62 and 26 respectively, and a compartment for 4 tons of luggage. The trains are operated as three-coach units, with the possibility of combining up to three units into one train of nine coaches in multiple, and acceleration is 1.2 m. p. h. p. s. up to 25 m.p.h. In addition, the characteristics of the traction equipment, the layout of the control system as well as

Interior of first class compartment with seats upholstered in foam rubber lined with white cloth and artificial leather (driving trailer A/DT)

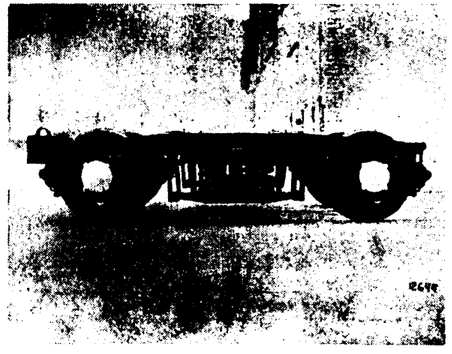
the type and arrangement of electric and mechanical couplers at the ends of the trains, enable running in multiple control with similar train units of English and German manufacture. Leading particulars are shown in the attached table.

MECHANICAL PORTION

To obtain the greatest strength and rigidity an *all-*



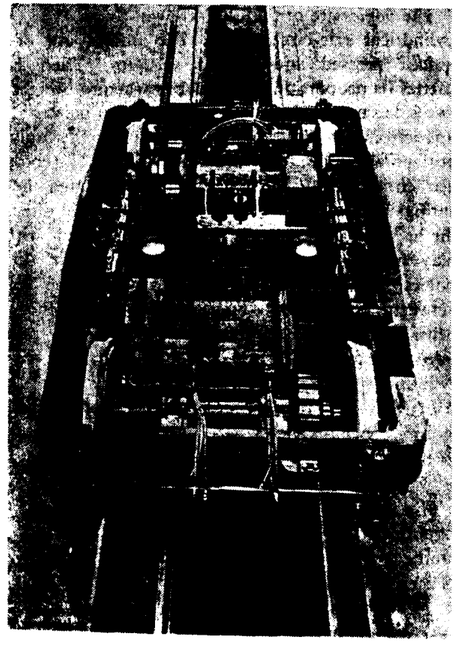
Driver's cab fitted for driving either seated or standing (driving trailers A/DT and C/DT).



Trailer bogie with all-welded frame and cylindrical axlebox guides.

welded integral stressed-skin construction was adopted for all vehicles, using pressed and bent sections for the framework, and with the 0.2 per cent copper-bearing 2.6-mm. side panel plates welded to frame members. A buffing load of 100 tons was specified as the end load to be carried. Sides, ends and roof are sprayed with asbestos insulation. The corrugated sheet steel floor is covered with cork surmounted by Ferrozell. Inner side panels, ceilings and partitions, and the semi-bulkheads near the sliding doors, are lined with durable fibre-wood boards impregnated against fire and against termites. Along the centre of the ceiling and roof is run the cable conduit, and on either side of this are several *ventilating fans* with individual operation and control mechanism. Due care has been given to effective and noiseless working of the fans in order to improve passenger comfort under severe climatic conditions. The main *lighting* circuit in each coach is supplemented by an emergency circuit having two to four lamps in each compartment fed direct by the storage battery. A three-hour feed to this emergency circuit is possible should there be a failure of the motor-generator set catering for the normal lighting.

Each side window set is a sub-assembly consisting of a light-alloy frame in which the two shutters, viz. a light-alloy louvre and a glass shutter, are guided. Both shutters open upwards. They are fully equalised and kept stable in any position. When entirely closed,



Driving bogie with nose-suspended traction motors, type TM 500.

louvre and glass shutters can be locked from inside. All window frameworks and the mouldings for the ceiling and wall linings are of light-alloy sections.

Seating in the third class compartments comprises seat and backrest boards pressed in one piece from impregnated plywood, and riveted to a frame welded up of steel tubing. The same kind of framework is used for the first class seats, but these are upholstered in foam rubber lined with white cloth and artificial leather. An *emergency alarm* is fitted in each compartment, and is operated by pulling a leather loop. A pull wire connected to the release mechanism operates a signalling device outside at the end of the coach and rings bells in each driving cabin until the signalling device has been reset.

An English Steel Corporation Majex *automatic centre coupler* at each end of the train permits the coupling of two or three triple-car sets in multiple. Alliance inter-coach centre couplers connect the three coaches of one train set. Standard side buffers are provided at the outer ends of a three-car set for use against station buffers and other vehicles.

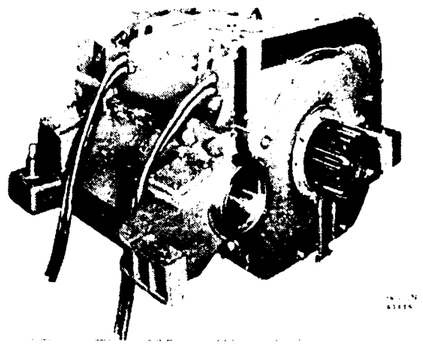
The *bogies* are of the well-known Swiss type, with cylindrical axle-box guides. The frames are of *all-welded* pressed and formed sections. Each bogie carries its proportion of the superstructure weight on two side supports carried on the bogie bolster; and apart from pivoting the bogie pivot transmits only the horizontal traction and braking forces. The bolsters are connected to the bogie frame through helical springs and swing links. In the longitudinal direction the bolsters of the trailer bogies are guided without play by two anchor links, whereas in the driving bogies this guiding is effected by friction plates between bolster and bogie transoms. Axlebox suspension consists of one pair of helical springs on each side of the axlebox; and inside these springs are the cylindrical guides and the hydraulic shock absorbers. All axleboxes are of SKF self-aligning pattern. A motor coach bogie weighs about 6½ tons without traction motors.

Braking is by the Westinghouse combined self-lapping electro-pneumatic and automatic system, with equipment obtained from England. Each bogie has its own brake apparatus consisting of an automatic brake unit with pressure-indication switch and release valve. Each motor bogie has an 8-in. dia. cylinder for each wheel, and a trailer bogie one cylinder for each wheel pair. All these cylinders have built-in automatic slack adjusters. An Oerlikon compressor furnishes the air supply for the brakes. The handbrake in the driver's cab acts only on the adjacent bogie.

Each *driver's cab* is separated from the passenger portion of the train, and can be approached only through a hinged side door. Cabs of the control trailers are fitted for driving either seated or standing, and all the functional equipment—master controller, control switches, instruments, and signal lamps—is grouped in a control panel on the left-hand side; and the driving window is equipped with an air-operated windscreen wiper. There is an auxiliary driving cabin located in the centre motor-coach, but this is for emergency and shunting use only.

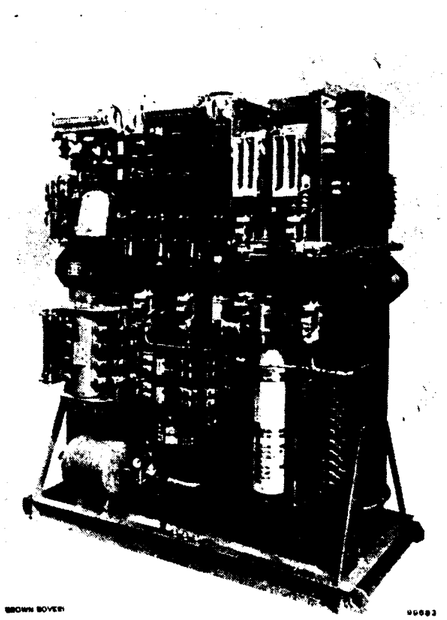
ELECTRICAL EQUIPMENT

The electrical equipment comprises four *traction motors* with an individual one-hour rating of 260 h. p. (210 h. p. continuous), which are mounted in pairs in the two bogies of the motor-coach. The two motors of each bogie are connected permanently in series. During the start, ribbon resistances are put in series with the motors and short-circuited step by step by means of electro-pneumatic contactors. Reduction gears are of non-resilient type, and the nose-suspension springs are of steel coil form.



Traction motor TM 500 with a one-hour rating of 260 h.p.

In order to ensure absolute safety in service, special care has been given to the *protective devices*. A high-speed *circuit-breaker* protects the h. t. circuits against shorts. It is designed for quick and powerful operation and cuts currents of 10,000 amp. and more at a tension of 3,600 volts in less than 0.02 sec. In case of atmospheric over-voltage, *lightning arresters* of high capacity deviate the discharge to earth. *Overload*



Apparatus panel with control equipment for traction motor circuit, overload and current limit relays.

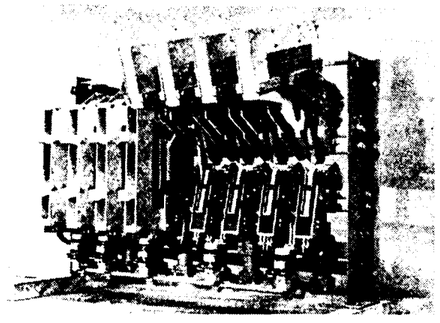
relays protect the traction motors and the 3,000-volt motor of the motor-generator set against overload. If the voltage should fail on the overhead line, a *no-current relay* disconnects the main power circuits so that the sudden come-back of the voltage cannot damage the traction motors. A *deadman device* with 2-sec. relay, combined with the handle of the master controller, trips the main power circuit and makes an emergency application of the air brakes in case of disability of the driver. Most of the *high-voltage equipment* is located in a special h. t. compartment locked with the earthing switch so that it cannot be entered until the h. t. circuits are connected to earth. In reverse, the earthing switch cannot be opened before the door of the h. t. compartment is closed. This h. t. compartment is located on the right-hand side of the motor-coach adjoining the auxiliary driver's cab, and is accessible from there through a safety door. A detachable side panel locked from the inside enables easy mounting and dismantling of the electrical equipment.

All *auxiliary and control circuits* are at a constant tension of 110 volts supplied by the generator of the *motor-generator set*. The output voltage is kept constant by means of a voltage regulator. The *alkaline battery* is designed for a nominal discharge tension of 110 volts, so that the low-voltage circuits work always at the same voltage, whether the motor-generator set is running or not. A booster connected in series with the generator provides the charging of the battery at a voltage of up to 150 volts.

A two-stage reciprocating *motor-compressor set* with a capacity of 35 cub. ft. per min. of free air supplies the necessary compressed air at a pressure of 100 lb. per sq. in. for the E. P. brake system and the pneumatic apparatus of the electrical equipment.

The main part of the *control equipment* is the *automatic starting device*. The operating of the starting contactors is controlled by a servo-controller. On his master controller the driver only chooses the position to be finally reached, namely series or parallel combination of the traction motor groups, or field weakening in parallel combination. Then the servo-controller moves step by step up to the corresponding position, and its progression is controlled by a current-limit relay providing regular tractive effort during acceleration. Any reverse movement of the handle brings the whole control gear back to the zero point. Two steps of motor field-weakening are provided, viz. 20 and 32 per cent. There are 11 traction notches in the series grouping and 9 in parallel grouping. Air-operated control switches in the control supply ascertain that the air pressure for the brakes and the electro-pneumatic equipment are always high enough during service. A set of signal lamps located on the driving desk indicates to the driver the correct working of the equipment.

Due care has been given in the *arrangement of the*



EP-Contactor group.

electric equipment in order to allow easy checking of all apparatus. The contactors, reverser, motor cut-out switch and relays are located on a frame in the middle of the h. t. compartment so that they are all easily accessible. Most of the low-voltage equipment of the motor-coach is arranged in a clear manner on the low-voltage panel in the back of the auxiliary driver's cab. Two pantographs with copper wearing strips are mounted on the roof of the motor coach.

Since a cardinal point in the design was that to ensure long intervals between overhauls, and trifling maintenance between-whiles, all mechanical parts and electrical apparatus were to well-proved design and of robust and ample construction.

MAIN TECHNICAL DATA

Nominal line voltage	2,900 d. c.
One-hour rating (at the wheel rim)	1,025 b. h. p.
Corresponding speed (full field and parallel grouping of traction motor groups)	29 m. p. h.
Corresponding tractive effort	13,200 lb.
Average starting tractive effort limited to	20,500 lb.
Maximum speed	65 m. p. h.
Motor gear ratio	21 : 65
Gauge	5 ft. 6 in.
Width over body	12 ft.
Overall height (rail to top of body)	12 ft. 6 in.
Length over buffers	211 ft.

Body of Motor Coach B/MC of fully integral tubular design.
(all-welded stressed-skin construction using corrugated steel sections for the underframe and pressed and bent steel profiles for the framework).

Distance between bogie centres	48 ft.
Wheel base of bogies	9 ft. 6 in.
Wheel diameter	37½ in.
Tare : three-coach unit	113 tons
motor-coach	51 tons
trailer coaches (2)	62 tons
Seating capacity : 1st class	26
3rd class	264
Standing passengers, approx.	290
Official crush load, capacity	380
Capacity of luggage room	4 tons

EASY DOES IT!

An 85 ton, 1320 horsepower diesel-electric locomotive was swung ashore recently in Buenos Aires Harbor, and an interesting unloading and assembling operation took place in quick time.

The locomotive's trucks were unloaded first and then the complete superstructure was lowered into place, Globe Press Service reports.

The locomotive, built by the Locomotive and Car Equipment Department of General Electric Company (U. S. A.) in Erie, Pennsylvania, was the first of 50 arriving in Buenos Aires and destined for use on the Ferrocarril Nacional General Belgrano railroad in northern Argentina.

All 50 of the locomotives ordered by the General Belgrano railroad are of the universal-type. They can can be used for freight, passenger and switching service. Hundreds of similar locomotives built by G-E are already in use in several South American republics where they are replacing obsolete steam equipment.

Metropolitan - Vickers and British Railways Modernisation

AS the first step in the £ 1500 million modernisation plan for the British Railways announced in 1955, the British Transport Commission placed orders in Deeember that year for 171 main line diesel electric locomotives. 20 of these locomotives were ordered on Metropolitan-Vickers Electrical Co. Ltd. The first locomotive was delivered to the British Transport Commission at the end of July 1958, and the last locomotive is expected to be delivered by March 1959.

The leading particulars of these locomotives are as follows :—

Track gauge	— 4′ 8½″
Wheel arrangements	— C_O—B_O
Engine Horse Power	— 1200 h.p.
Length over buffers	— 56′ 7½″
Total wheelbase	— 42′ 7″
Distance between pivot centres	— 32′ 4″
Bogie wheelbase	— 12′ 1½″ (C_O bogie)
	8′ 6″ (B_O bogie)
Overall height from rail	— 12′ 8⅜″
Overall width	— 9′ 2½″
Wheel diameter	— 39½″
Total weight in working order	— 97 tons
Fuel oil capacity (engine and boiler)	— 510 gallons.

These locomotives will be used on the London

Midland Region of British Railways. They will be based in Derby, and used on the Midland Division to haul passenger and freight trains between London (St. Pancras), Manchester and Carlisle, for Scotland, on routes serving Leicester, Nottingham, Derby, Sheffield and Leeds.

Metropolitan-Vickers Electrical Co. Ltd., are responsible for the design of the whole locomotive, and are supplying all the electrical equipment. The mechanical parts are being manufactured by Metropolitan-Vickers-Beyer Peacock Ltd., with English Steel Castings Corporation Ltd., supplying the cast steel bogies, and Davies and Metcalfe Ltd., providing the brake equipment. The diesel engines are being made by Crossley Brothers Ltd.

The following particulars regarding the main items of equipment may be of interest.

ENGINE

Crossley 2 cycle engine with 8 cylinders in Vee formation.

Cylinder bore and stroke— 10.5″ × 13.5″

Exhaust pulse pressure charged

B. S. Rating — 1200 h. p. at 625 r. p. m.

TRANSMISSION EQUIPMENT

The Metrovick main generator, directly coupled to the engine, supplies power to 5 nose-suspended axle-hung series-wound traction motors, one driving each axle.

Generator ratings	— 750 volts D. C. 1070 amps. 625 r. p. m.
	— 475 volts D. C. 1650 amps. 625 r. p. m.
Traction Motor continuous rating	— 475 volts D. C. 330 amps. 510 r. p. m.
Traction motor gear ratio	— 15/67.

CONTROL EQUIPMENT

The master controller is provided with 10 notches to control the engine speed and power. Automatic control of generator and motor field strengths is provided in order that the engine power selected shall be available over a wide range of locomotive speeds. This is achieved by the use of a servo-mechanism, which functions in response to a signal from a hydraulic pilot valve associated with the diesel engine governor, to control the electrical output of the traction generator. Hence, the total power is maintained at a constant value irrespective of changing track speeds and load conditions.

Most of the control equipment is housed in a cubicle adjacent to the driving cab at the generator end of the locomotive. The main items are the load regulators, electro-pneumatically operated contactors and reverser, auxiliary switches, relays and resistors. Deadman equipment is also fitted.

AUXILIARY EQUIPMENT

The auxiliary equipment on the locomotive includes :—

(1) Metrovick auxiliary generator, on the end of the main generator, to supply auxiliary power at 110 volts D. C.
(2) Air compressor, driven by engine, to supply compressed air at 100 lbs. per sq. inch for locomotive brakes, electro-pneumatic control gear, sanding, hooters and window wipers.
(3) Two vacuum exhausters, driven by electric motors, for train brakes.
(4) Three fans, driven by electric motors, for force ventilating the generator and traction motors.
(5) Engine ancillary equipment, comprising motor driven pumps and radiator panels with motor driven fan.
(6) Battery for starting the diesel engine, using the main generator as a motor.
(7) " Spanner " train heating boiler for steam heating the passenger coaches.

Provision is made for A. T. C. equipment to be installed later.

PERFORMANCE

Diesel engine output	— 1200 h. p.
Power for traction	— 1140 h. p.
Power for auxiliaries	— 60 h. p.
Maximum tractive effort at rail	— 50,000 lbs.
Continuous tractive effort at rail	— 25,000 lbs. at 13.5 m.p.h.
Maximum service speed	— 75 m. p. h.

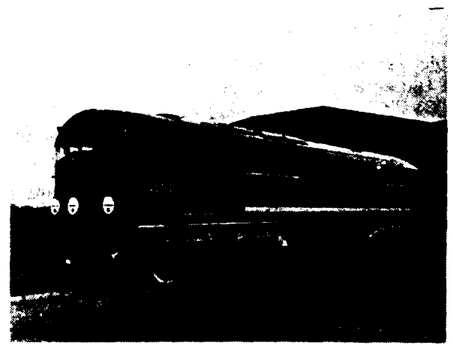


Fig. 1. The first of the twenty locomotives on order.

Fig. 2. Test run of locomotive hauling passenger stock

Fig. 1 shows the first of the 20 locomotives delivered to the British Railways, while Fig. 2 shows the locomotive on a test run, hauling passenger stock.

In addition to the 20 diesel-electric locomotives described above, Metropolitan-Vickers have just converted for the British Transport Commission, under the modernisation plan, the first locomotive to operate at 25kV 50 cycles single phase in Britain This locomotive has D. C. traction motors, fed by air-cooled glass-bulb rectifiers. Also on order are 10–3,300 H. P. locomotives and 91 electrical equipments for multiple unit trains to operate on British Railways at 25 or 6.25 kV 50 cycles single phase A. C. The locomotives will have D. C. traction motors fed from air-cooled multi-anode steel tank rectifiers, while the multiple unit train equipment motors are fed from air-cooled single anode excitrons. These equipments are designed for entirely underframe mounting, leaving the body of the coaches totally available for passenger accommodation. The first of these locomotives and multiple-unit trains are expected to be delivered to the British Transport Commission during 1959, in anticipation of the full electric services commencing in 1960.

COMMUTER SERVICE 1970

For Metropolitan commuters in the Americas, travel in 1970 will be fast, comfortable and efficient.

A system of improved and expanded commuter rail service has been predicted by General Electric (U.S.A.) transportation experts.

Improvements include automatic train operation and fare collection, escalator movement of passengers to station platforms and rail car loading direct from the platforms.

In addition, a standardized electrical system, light weight commuter cars, " park and ride " lots adjacent to outlying stations, suburban bus service to the stations, and elimination of such inefficiencies as multiple transfers at deadend downtown terminals, will highlight the modern service.

Integration of commuter rail service within the overall transportation network of a metropolitan area, say the engineers of G-E's Locomotive and Car Equipment Department at Erie, Pennsylvania, is a necessary first step leading to these advances.

The G-E planners further predict that modernization and integration of commuter rail service will save huge amounts of money that would otherwise be spent on less efficient methods of moving people in and out of cities that are becoming more and more choked with traffic. They point out that one rail line carries 40,000 people per hour, while buses carry 3,000 people per lane, and autos carry 2,000 people per expressway lane.

In addition to modernizing present commuter facilities, metropolitan transportation systems of the future will incorporate many rail rights-of-way not now used for passenger service. These may be added to the transportation network at a fraction of the cost of new rights-of-way and facilities.

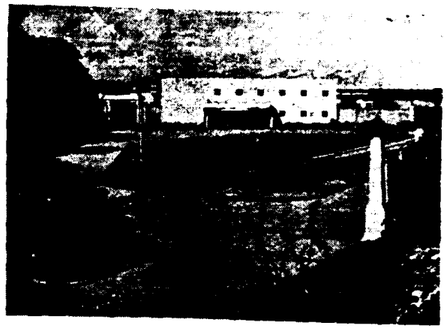
General Electric transportation engineers are convinced that *all* methods of transportation must be integrated within an area-wide system to effectively serve the booming metropolitan areas of the Americas, and eventually such areas elsewhere. They are also convinced that improved commuter rail service is the key to such an integrated system.

AESTHETICS IN INDUSTRY

By S. G. Iyer

Executive Engineer, Integral Coach Factory

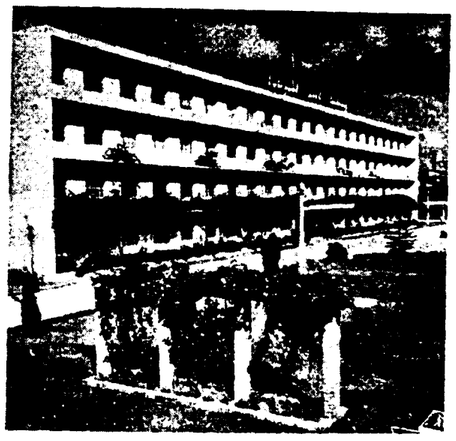
THE Indian Railways, just like other Governmental and private institutions in the country, have always had a number of workshops at various convenient points to help in the day-to-day maintenance of their locomotives, rolling stock, plant, machinery and other assets. These, perforce, had to grow from small beginnings and expand consistent with the needs of the expanding services rendered by the Railways, (very often at a much slower pace). The result was that when a lay-man or even a semi-technical man went out visiting such places, one could see a lot of sheds with corrugated iron roofs exhibiting a pathetic mixture of wear and tear. Mushroom additions were not uncommon. Although the interior of such sheds show a considerable amount of pattern and skill, yet the general impression was that there was a lot of room for improvement. Offices and stores buildings got sandwiched between sheds wherever some room could be found and it was not unusual to see materials lying about all over the place in and outside the sheds, except perhaps in front of the main offices. There was not any appreciable attempt at beautifying inside the factories. Even in the offices, the interior was anything but inviting, crammed with chairs and tables



Frontage of Main Works Entrance

and racks full of papers. Generally aesthetics was conspicuous by its absence.

With the dawn of Independence and the all-out efforts for planned progress of the country in various spheres that was sponsored by the Government, things started changing in the right direction. One of the prominent fields of progress was the planning of large industrial units from scratch, without trying to expand the existing units to take on a little more work. While on the one hand, all attempts were made to keep the expenditure within the means of the country, so as not to overtax the expanding economy, at the same time, it was definitely realised that some



Frontage of the Administrative Office.

provision for future expansion in the present planning itself will pay large dividends, since such expansions are inevitably needed quite soon and then they cost a lot more, if not originally provided for.

It was in this background that work on the construction of Chittaranjan Locomotive Works was taken up in 1948 and subsequently that on the Integral Coach Factory in 1952. This stagger of 4 years between the two projects made it possible for some of the personnel to move from Chittaranjan to Perambur and naturally while there is a marked similarity between the two units, one could see a mature finesse at Perambur.

Aesthetics and cleanliness have been given considerable importance in the Integral Coach Factory, with a view to achieve the following objects :—

(i) The mind and habits of the various grades of workers will get attuned to the surroundings in which they work and a remarkable amount of orderliness, taste and pride of production is the natural result of such association.

(ii) The pleasing appearance of the structures and the marked changes in the surroundings according to the seasonal variations provide a soothing contrast to a certain amount of inevitable monotony in mass production units.

(iii) Orderliness in habits and work result in a proper time and place for everything and go a long way to eliminate avoidable accidents.

(iv) On visitors, the external features have a subconscious influence which produces very favourable reactions even with determined critics.

Service Trenches inside Shops.

The achievement of aesthetics in this industrial unit may be broadly grouped into the following classes :—

(1) The shop structures themselves :

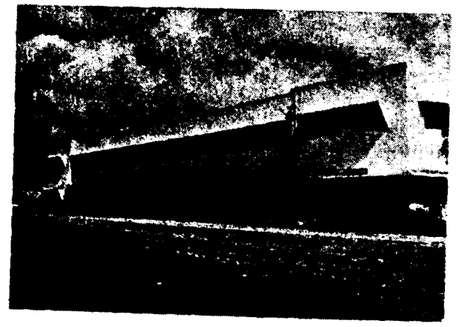
(2) The services inside the shops like water, electricity, compressed air, etc.:

(3) The ancillary buildings connected with the production unit ; and

(4) The general surroundings.

SHOP STRUCTURES

Although from considerations of keeping down capital cost on land, the site of the shops was



Frontage of Integral Coach Factory Canteen.

restricted to the area, west of the Southern Railway Loco. Works, yet the maximum advantage was taken of the land by deciding on a east-west arrangement of the different units with plenty of inter-shop space for ventilation on the Chittaranjan pattern. To ensure adequate lighting under economical means, a good deal of observations was carried out in the various factories of the country and ultimately north-light glazing in 2 planes amounting to 30% of the floor area, has been adopted. The arrangement of the shops follow the work flow from the west to the east with gantries between the shop sheds and overhead cranes for transfer of materials from shop to shop. This results in flow of production in one direction and the annoying criss-cross movements are avoided. The Main Assembly Shop, is the largest unit, 1000′ × 260′ × 53′ high. And here this uniflow is most conspicuous. This unit has rightly been termed as an " Industrial Cathedral ".

For all the shop structures, asbestos cement sheet roofing has been adopted with the roof sheeting being taken on inclined web members of the roof truss and the glazing girders with the vertical web members. The uniformity in shape and colour of the roof of the shops is itself a striking sight, when viewed either from ground or from a higher altitude. Inclined A. C. sheet louvres on the sides of the shops have produced very good ventilation and this has been further improved by arranging the northlight in two stretches with open space in between. The side covering of the shops are of 9″ brick work to a uniform height of 12′. Galvanised steel windows at

every 10′ with central hung ventilators have been provided. Below each window, a set of concrete of louvres has been introduced to induce draft and improve the ventilation. On the side walls have been located different sizes of steel rolling shutters to suit the flow of manufacture and mechanical transport. These are operated by hand or driven electrically and are very elegant in appearance.

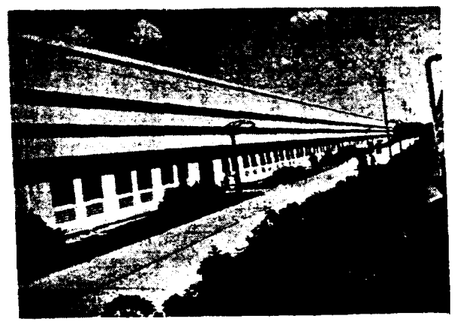
When you enter the shops, the floor is of cement concrete throughout and naturally dust-proof and clean in the extreme. This flooring extends outside the shops also, sloping away from them upto the concrete covered surface drains to take away all water from the areas. There is thus no place for dust between the shop and the drain and the apron also presents a uniform plinth to the shops.

SERVICES

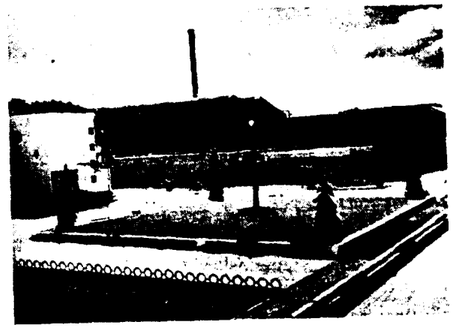
All the services have been arranged in neat trenches under the floor of the shops, the supply from the trenches to the jigs being made through ducts built into the floor. These service trenches are covered with steel chequered plates housed neatly in angle runners flush with the floors. The shops have no pipes or wires running overhead. All the machines have also their independent driving unit and pullies and beltings are completely eliminated. The improvements in the appearance and cleanliness of the shops so obtained is substantial.

ANCILLARY BUILDINGS

The most important building connected with the production is the Administrative Office, a four storeyed steel framed structure with R. C. C. floors and roofing fully air-conditioned. This has been designed to combine the austerity of an office with all conveniences required for efficient working. Equally important is the Workers' Canteen just outside the Factory premises which is a large double storeyed structure. Inside the Shop sheds, the foremen of the respective shops are housed generally on elevated cubicles from where they can command a full view of their zone of work and when they close the steel windows provided, there is absolutely no noise from the shop and they can do their table work in comparative peace. Some of the foremen are also housed in ground floor cubicles similarly sound-proofed and situated conveniently inside the shops. The lavatories intended for the workers have also been built very close the shops, but completely sanitized, so that they emit no obnoxious smell inside the shops themselves. Within an elegant double storeyed structure at the Main Entrance to the Factory are housed a First Aid Post, a Watch & Ward Post and the Welfare Offices.



General Surroundings. A view in between Shops.

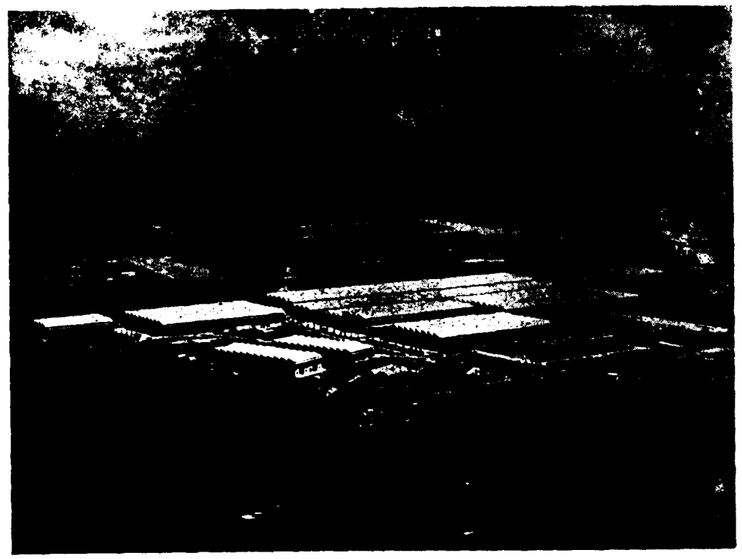


Another view of the elevated garden in front of the Main Works Entrance.

These buildings have been designed with an eye to architecture, so that they blend with the surroundings in shape, colour and treatment.

GENERAL SURROUNDINGS

The general road system for inter-shop movements is a concrete roadway running east to west between the rows of shops and also north-south into the gables These concrete roads make for the greatest amount of cleanliness as well as quick and safe movement of traffic from place to place. They can be kept scrupulously/clean and the difference that they make to the general cleanliness of the shop has to be seen, to be appreciated. The open land between the road edges and the surface drains running along the shops have been converted into two long green strips of verdent grass. The immediate effect of this is that the space does not become a dumping ground for any and every kind of unwanted rubbish. To break the monotony of a long green patch, masonry flower beds have been constructed at suitable intervals and the plants in these flower beds consist of annuals and perennials so variegated that throughout the year there are blossoms in plenty. Further between these beds are also planted bush shrubs like bogainvillaes, polyalthias, etc., which are cut and maintained to trimmed shapes. Both the flower beds and the isolated shrubs are given frequent attention to keep them in strict geometrical or artistical shapes without at the same time reducing the floral output of the plants. As a further relief, block plantations of a collection of varied types of plants are also made at the two extremities of the long road. The road junctions are made attractive by having a collection of potted plants grouped there.



An aerial view of the Integral Coach Factory.

The frontage of the two main buildings, viz., the Administrative Office and the Works Entrance and Canteen have been given special treatment. The Administrative Office garden has a long wide lawn bordered by a low hedge towards the building and sloping herbaceous border near the compound wall. Two tall pargolas at the two ends of the lawn provide vertical growth and a good screen to the whole lawn. The herbaceous border already mentioned has alternate plants in varying colour and stature, the whole area giving a most pleasing effect. In addition, the plinth of the building itself has two long flower troughs on either side of the central steps. These have a collection of lantanas in perenniel bloom. From isolated points, long strips of bogainvillaes spring up and are taken through to sprawl along the sun shades at the various floors.

The Main Works Entrance has also been treated with considerable attention. The canteen front wall also has a long green patch, but this is on a raised plinth. At the wall edge is a line of colourful plants and bogainvillaes have been taken up over the sun shades. At the far edge of the green plinth are a series of tall growing polialthias. The approach to the Canteen from the east is flanged by a sloping embankment of the Railway overbridge and this slope has been treated with boulder soling with zig-zag pits from where sprout bogainvillaes of alternating colours. These not only grow along the slopes, but also climb up the trellis work at the top of the slope and when the flowers are in bloom, the site is spectacular. On the southern side of the canteen and adjoining the compound wall of the Southern Railway Workshops, a shade garden has been developed by growing shade giving trees and providing benches for the workers to rest during the rest hours. A lilypond in the centre with water sprays playing about, keeps up the soothsomeness of the atmosphere.

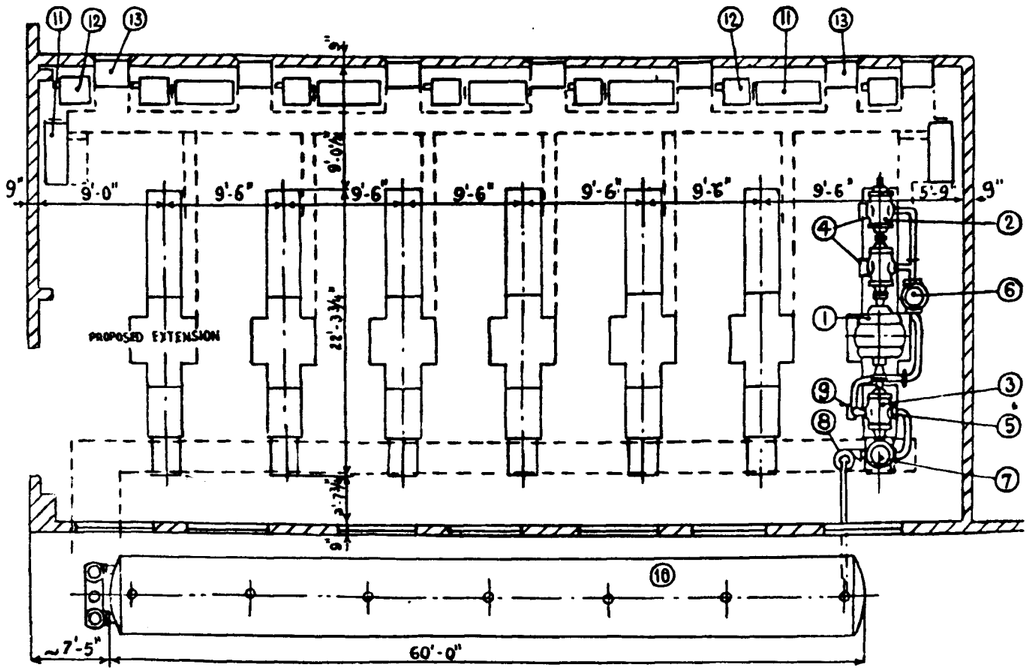
Right opposite the Main Entrance and flanked by concrete roads on either side, is a trapezoidal lawn with flower beds in all the corners and a marble statue of twins in the centre from which sprouts another water spray. The whole area is maintained

(Continued on page 28)

Automatic compressed Air Installation at Integral Coach Factory, Perambur, Madras

THE process of manufacture of coaches requires practically in all various stages and departments, compressed air in various quantities and at different pressures. As the demand of compressed air for such a large factory is fluctuating considerably, the layout of the compressor station has been given special consideration. In persuance of the general policy the most efficient and modern equipment was selected.

While planning the installation, not only the general requirements and necessary pressures had to be taken into consideration but also the location of the compressed air station, the fluctuating demand and the peculiarities of the factory in general. The installation having to operate fully automatically, the space available being limited and in order to reduce the receiver capacity to a minimum, selection of a rotary type of compressor was called for. This type offers

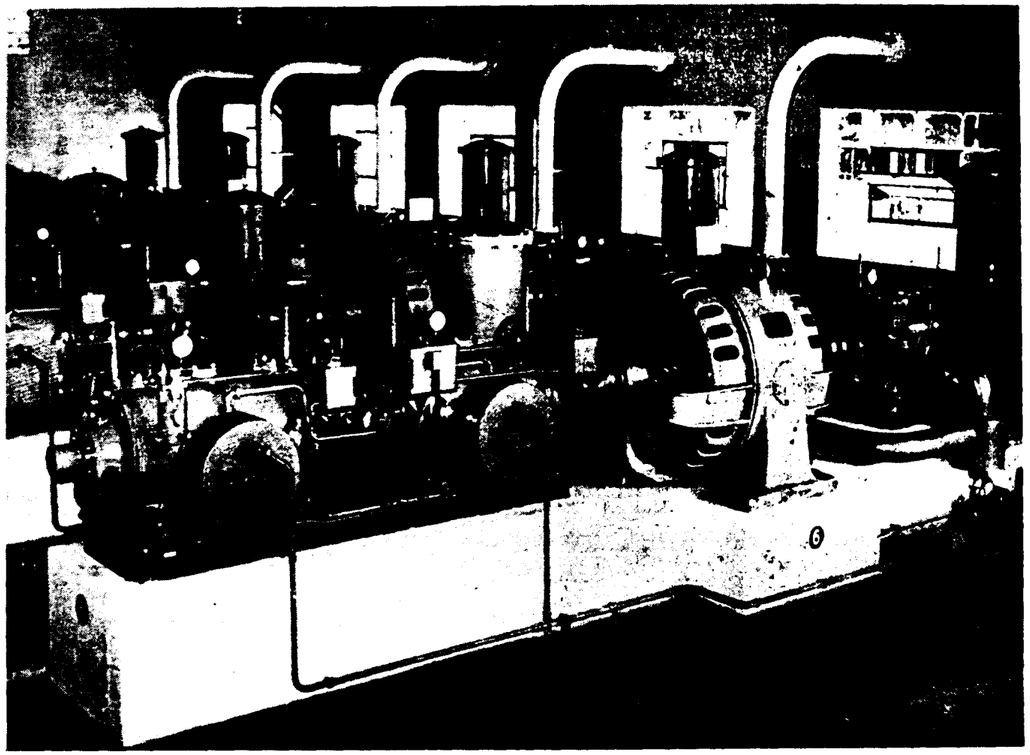


1. Electric motor
2. Compressor K 95, 1st stage
3. Compressor K 95, 2nd stage
4. Air filter & governor
5. Non-return valve
6. Intermediate cooler
7. Aftercooler
8. Condensate & oil separator
9. Condensate trap
10. Air collector
11. Rotary converter
12. Starting rheostat
13. Apparatus cubicle, ASEA.

(Continued from page 27)

particularly clean and has become extremely popular with the large body of workers inside this factory

Before concluding this article, it will not be out of place to mention that this garden has been adjudged to be the best laid Factory Garden in Madras area by the Agri-Horticultural Society, Madras, during their Annual Garden Competitions successively for the last 3 years.



considerable advantages, particularly in respect to automatic operation, continuous airflow, limited space required, light and small foundations.

The total requirement of the factory was estimated to 7100 cfm, divided for the various departments, as follows:

A)	Sheet metal shop	700 cfm.
B)	Body and Bogie shop	1300 ,,
C)	Assembly shop	400 ,,
D)	Smithy	3350 ,,
D1)	Fitter shop	350 ,,
E)	Machine shop	300 ,,
F)	Millwright Tool and Dieshop	300 ,,
J)	Window and Prototype shop	400 ,,

The working pressures were estimated to range from 85 to 120 psig. The order for the machines was subsequently placed with the Swiss Locomotive & Machine Works, Winterthur, Switzerland, through their Branch Office in Bombay.

For economy's sake and flexibility in service, 6 SLM 2-stage rotary compressors, each with a capacity of 1375 cfm. at 100 psig., running at a speed of 750 r. p. m., were selected. The twin first stages and a single second stage of the same size with mostly identical parts allow maximum interchangeability of spares.

The compressors are driven by auto-synchronous motors placed between the 2 first and second stages. This type of motors supplied by Messrs. ASEA was selected, in order to improve the power factor of the factory.

All the groups are fitted with a double automatic regulation, cutting automatically the supply of compressed air when the required pressure is reached and switching off subsequently also the electric motors. The compressors are working at full capacity and maximum efficiency only, inasmuch as they will automatically be put into service only if the pressure decreases to a preset limit.

The automatic equipment includes also the automatic

cut-in and cut-out of the cooling water. The compressors are also supplied with a centrifugal separator for the extraction of water and lubricating oil from the compressed air. The extraction of condensated water is of particular importance, especially in view of the fact that humidity at Madras is rather high.

The air is supplied from the compressors to a collector of 1870 cft. placed outside the compressor station. From this collector the air is distributed to the various departments and also to the smithy, where four additional receivers, each of 1400 cft., are provided to meet the highly variable load of the hammers.

The compressors are cooled by closed circulating system which includes forced draft cooling tower with sprayers.

In order to reduce the frictional and other losses to a minimum, sufficiently large mains have been selected, so that practically the pressure produced at the compressors is also available at the different consumer points. The mains form a ring, from which any section of the factory can be supplied in case of a local pipe defect.

Compressor Plant of 8250 cfm capacity at 100 psig installed in Integral Coach Factory, Perambur.

The compressor-station has been placed inside shop B, i. e. opposite the smithy. The photo represents the compressor-station consisting of 6 units.

RAILWAY COACH FINISHES

By Dr. G. Mukherji, G. Doraisamy & K. S. Ganesan

THE Railways in any country are one of the largest consumers of Paints and Varnishes and they need a variety of paints. The tanks carrying petrol require paints, which are good light and heat reflectors. The paints applied to bridges have little time to dry up and are subjected to corrosive effects of engine smoke and the paints for the coaches have to withstand severe conditions of weather. This paper discusses at length the finishes for the steel coaches in particular.

CHOICE OF THE FINISH

The choice of the finishes for any purpose involves the consideration of the performance desired. This, in its trail, leads us to take an account of the other factors, namely :

i) Surface and its preparation,

ii) Conditions of service to which the paint film is subjected,

iii) Method of construction of the coach,

iv) Accessibility of surface to be painted, and

v) Other factors.

SURFACE AND ITS PREPARATION

The surface on which the paint is to be applied plays an important factor. According to the Findings of the British Corrosion Committee, constituted in 1928, " the method of preparing the surface for painting is the most important factor in increasing the life of paints than attention to any other factor, since, unlike wood, there is no absorption of oil or paint into pores thereby rendering subsequent coats adherent ". In fact the life of a paint system may be increased from six months to six years by improving the conditions of surface.

The chief methods of surface preparation fall into two main types of mechanical and chemical. For the severity of service as for coaches, grit blasting to bright surface of metal for the exterior surface, which is ideal, is adopted for I. C. F. coaches. This confers a proper key for painting surface. Among the chemical treatments, phosphating is widely used in the British Railways and these essentially involve treatment at about 80°C with solutions of phosphoric acid and phosphates of either iron, manganese or zinc. The H. A. L. is designing to have granodising for the M. A. N. type of Integral Coaches to be fabricated by them. In the case of rolling stock exported abroad, the electro deposition of metal coatings is adopted by the British Railways to ensure protection of hidden parts, which are not easily accessible for maintenance. Further, the quality of material and the method of fabrication by Spot Welding, Seam Welding etc., also affect the type of surface preparation. The adopting of a particular method for surface preparation, depends on the facilities available and the conditions of service and the material used for the coach.

CONDITIONS OF SERVICE

The protective coating should be carefully designed to suit the service conditions. The case of a railway coach is unique and perhaps, in no other industry, are the demands on paint quite comparable to those put on railway carriages. A railway carriage is on its rails all through the year and is subjected to severe atmospheric conditions and fluctuations of temperature. They are subjected to wide ranges of climate conditions since they span the country, during its traverse. Intensity of sun light, condensation of moisture, fluctuations of temperature and the nature of the cycle of the above are all factors which affect the paint film and they have to be considered in detail to decide on the finish to be adopted.

Mr. Fancutt, the Paint Technologist of L. M. S. Railway, who visited India in 1937 expressed the opinion, that the most permanent colour for use throughout the Indian Continent is Red Oxide. It is durable since it absorbs the photochemical ultra-violet rays of the sun which destroy the paint film, locally available and confers mechanical strength to the paint film. It may also be noted that the Indian Railways have adopted Gulf Red for the body sides as the colour scheme.

CONSTRUCTION OF THE COACH

In steel coach construction the method of fastening the panels is significant. When riveted or fastened by

screws, considerable difficulty is experienced in stopping up and filling. However, a uniform surface is to be prepared for receiving the finish.

The all-welded integral coaches present another difficulty. The light gauge steel tends to buckle when welded and the walls have to be straightened by heating and hammering with a template. This needs an elaborate preparation of the surface, which involves a fairly long schedule for finishing the coach. The coaches of Integral Coach Factory are at present given one coat of brush filler and four thin coats of knifing stopper, which are then well sanded.

ACCESSIBILITY

This aspect plays an important part in the choice of paints. Painting and maintenance of inaccessible places is not easy, and sometimes impossible. In such cases, an increase in the cost of the material to be employed is justifiable, owing to the reduction in the frequency of painting. A case of this kind occurs in regard to interior surfaces of carriage body shells, where the first indication of failure may be the distortion of the body panel or actual perforation. Hence, the paint should be selected to ensure good protection.

It is the British practice to apply one coat of inhibitive primer followed by 3 coats of bituminous emulsions (maximum moisture 50%). This confers heat and sound insulation to some extent also. For quite inaccessible places as the cross bars under flooring and for steel structures below lavatories a fourth coat is also applied, which may be reinforced with mica.

According to the German practice, 4 coats of bituminous paints, each having a specific role are applied. The I. C. F. has at present a similar scheme for coaches produced here, as recommended by the Swiss experts. The four coats comprise of the following viz. the first coat of bituminous solution applied after removal of mill-scale and rust, the second with Red Oxide pigment, the third with short-fibred asbestos and the fourth with non-flaking aluminium and asbestos. A look into the above reveals how corrosion may be inhibited and heat and sound insulation provided to some extent. The asbestos fibre makes the film strong enough to resist usage and yet pliable enough to respond to the movement of iron. Zinc rich primers and electro-deposition of zinc are also in use by foreign railways for affording good protection to the interior of the coaches. Trials are contemplated by the Indian Railways to evaluate the performance of bituminous emulsions and zinc rich primers against the current practice of painting for interior side of coaches and their suitability for Indian conditions.

There are various factors also which affect the coach finish. The build-up of the paint film should be such as to bind the whole series of coats into one homogeneous layer so as to give a hard-wearing and weather-resisting film.

The use of a proper primer, which contributes largely to the durability of the paint system should be carefully selected and it should have inhibitive properties against corrosion. Red lead gives a comparatively good performance on a rusty surface but not on a clean rust free, scale free steel. The red oxide primer is used for the sides of the coaches and red-oxide-zinc chromate primer for the roof of the coaches in Integral Coach Factory.

From the above facts, it can be understood that the protection of railway steel coaches with a system of paints is a complicated problem and requires deep thought and research. Studies are being carried out in Indian Railways, to find the effect of various factors and to improve the system of painting, keeping pace with the development of Paint Technology.

RESEARCH PROMISES BETTER RAILWAY TRANSPORTATION

What looks like a part of a textile mill is really a part of a General Electric Company (U. S. A.) study of glass reinforced plastics for use in the electrical systems of modern railway locomotives.

The study is being conducted at G-E's Locomotive and Car Equipment Department in Erie, Pennsylvania.

Strands of pure glass are being passed through a locater screen before they are dipped in resin. The locater screen collects and bundles the individual strands together.

After they are impregnated in resin and baked in special ovens, the glass strands will be stronger than steel bands of the same weight.

According to G-E engineers, the results of this study will be used to develop better locomotive motors and generators.

PROOF OF THE PUDDING

By A. V. Sugavaneswaran, B.E.
District Controller of Stores, Integral Coach Factory, Madras

IN every family it is the housewife that has to work hard to keep the home fires burning. If the family is a big one such as a joint Hindu family or a Chinese family of the olden days the responsibility of the housewife is all the greater. She has to work hard remaining in the background all the time and run the home efficiently. It is the bread-winner of the family who comes to limelight but without the efficient housewife in the background he will not be able to play a successful part. The functions of the Stores Department in a big industrial unit are rather similar to those of a housewife. When a house is as big as that of the Integral Coach Factory the responsibilities of the housewife can be imagined.

The Stores Department had to cater to the exacting needs of the construction Engineers whose requirements were always extremely urgent. The department can look back with satisfaction on its performance in feeding the construction Engineers which has enabled them to complete the Project in record time and to schedule. But it was in the field of development of indigenous capacity to meet the needs of coach construction that the Stores Department had to play a vital role.

The integral coach has been developed by Swiss coach builders. As the watch-makers of the world the Swiss Engineers are the most precise among modern technologists and their standards are exacting. With highly industrialised Germany as the next door neighbour the Swiss coach builders had the benefit of the most advanced ideas, designs, specifications and manufactures knocking at their doors. With decades of experience in coach building Messrs. Swiss Car and Elevator Manufacturing Corporation, Schlieren-Zurich, developed the most modern integral coach in recent years. This was accepted as the standard by the Indian Railways and the Coach Factory was started for the mass production of integral coaches.

Till the advent of freedom in 1947, India remained an essentially agricultural country. Except for the textile industry which had made some progress there was hardly any major technical development in the country. After freedom the industrialisation of the country no doubt got impetus but the process had to be necessarily very slow. At the time of the commencement of the manufacture of the integral coach the position was therefore that India was far behind countries like Germany in the industrial field.

The design of the integral coach incorporated the latest manufacturing techniques, specifications and rigid tolerances to which German technologists were accustomed. It was almost impossible for the Stores Department of the Integral Coach Factory to attempt procurement to these rigid standards and tolerances in the Indian market which was accustomed to only production of commercial standards. It was a challenge to the Officers of the Stores Department of the Integral Coach Factory to develop indigenous capacity for the various items. The challenge was accepted and efforts were directed towards the development of indigenous capacity.

Steel castings offered a problem. There were only four steel castings in the integral coach but they were very important. Educational orders were placed on existing steel foundries in India which numbered only a few. The steel foundries had enough orders on hand for conventional steel castings which they had been manufacturing for some time. They were not therefore very keen to take up new castings. Further, our specifications for these castings were very rigid and it was soon found that even with considerable effort the steel foundries could not produce our requirements. We had therefore to continue importation. However, our efforts to develop indigenous capacity continued and ultimately it met with success. The newly established steel foundry in TELCO as well as one or two other firms have started manufacturing these steel castings successfully.

There were fourteen items of rubber profiles required for the integral coach. There were considerable difficulties in developing capacity for these profiles in the early stages as the rubber manufacturers in India found the tolerances as well as the shore hardness very rigid. By mutual consultations and the appreciation of each other's point of view we have been able to develop capacity in collaboration with the leading rubber manufacturers for these items.

Aluminium alloy castings also offered considerable difficulties in the early stages. It was found sand casting technique did not give satisfactory results and

die casting was almost unknown in the early stages. Fortunately several factories have sprung up in recent years for die casting of non-ferrous metals and we have been able to develop adequate capacity for our requirements.

There are a large number of aluminium extrusions numbering about 38 which are required for the integral coach. Fortunately, just when we commenced production Messrs. Indian Aluminium Co.'s extrusion presses at Alwaye also started production and we have been able to get our requirements from this Factory. There was a two-way traffic of Engineers between Alwaye and Perambur to sort out the initial difficulties in the supply of aluminium extrusions to the Integral Coach Factory; with this consultation and co-operation we have now been able to get the extrusions to our requirements from Alwaye.

Malleable casting technique is far advanced in European countries and the integral coach incorporated several items of malleable castings. Grey castings are not strong enough for the purpose and forgings or fabricated steel would be more costly. In India however the factories manufacturing malleable castings are extremely limited. It was found that we could not obtain our requirements of malleable castings in India and so we had to change over to fabrication. Simultaneously attempts continued to develop capacity for malleable castings and it is gratifying that one or two firms have been able to successfully make these castings in the past few months.

Axle box helical springs were imported in the first few instances. Our efforts to locate indigenous capacity for this item proved successful and TELCO as well as Chittaranjan Locomotive Works have offered to manufacture and supply these helical springs. Our headache did not end here. We had to find the spring steel rounds to enable these two Factories to manufacture springs. Messrs. Guest Keen Williams readily agreed to roll the rounds for us from which these Factories could make the springs. Again the problem was to get the spring steel billets from which Messrs. Guest Keen Williams could roll the rounds. We have been able to enlist the co-operation of the Ordnance Factories to supply the spring steel billets.

The integral coach is an all-welded design. As the entire shell is stressed it is very important to ensure that there is absolutely no rusting anywhere. While the exterior of the coach is always open for inspection and care can be taken to prevent corrosion, it is not so in the case of the inside of the shell. Once the panelling materials are fitted up and the entire coach is furnished and put on the line it is very difficult to know what is happening under the panels. The interior of the shell therefore has to be protected very carefully from the ravages of corrosion. Messrs. Swiss Car and Elevator Manufacturing Corporation, Schlieren, who are our Technical Advisers have found from practical experience that 'Inertol' manufactured in West Germany give excellent results and can be depended upon. Inertol paints are petroleum based and are manufactured to secret special formulae to give hundred per cent protection from corrosion. We were fortunate in this instance also to discover that a paint manufacturing firm in Calcutta had just then started manufacturing Inertol paints under a licence from the West German firm. We have been able to obtain these Inertol paints from this Indian firm from the very beginning.

Even bolts, nuts, screws, washers and pipe connections gave us considerable anxiety. Almost all the manufacturers of these items in India make them only to commercial specifications. It was found difficult to get even a single firm to make them to our specifications. In fact the position was so bad that for the first few coaches that were turned out we had to manufacture even these small items in the workshops as all the samples obtained from firms were not found up to specifications. By persistant effort and contacting a very large number of manufacturers all over India we have been successful in obtaining these materials to our specifications.

In the space of a small article like this it is only possible to give a bird's eye view of our efforts during the past four to five years in the direction of developing indigenous quality to meet the exacting standards we set to ourselves in the manufacture of integral coaches. It is not possible to describe in detail the various problems that confronted us, our tribulations, the anxious moments when hold-up to work stared us in the face, the deep understanding and co-operation that existed between the various departments in the Integral Coach Factory, the united front that was put up to face the problems and solve them and the joy of ultimate success.

They say that the proof of the pudding is in the eating. If any proof is required of the successful and efficient working of the Stores Department of the Integral Coach Factory the excellent out-turn that has been made possible by proper planning of procurement will supply the proof.

Technical Training School — Integral Coach Factory

By M. Lal
Principal, Technical School

THE Technical Training School of the Integral Coach Factory, which was started sometime before the start of production for training skilled workers for the factory, was inaugurated on the 20th March, 1954 by the then Deputy Minister for Railways, Shri O. V. Alagesan.

At the start, training was given to Trade Apprentices mainly in the three trades, Fitting, Machining and Welding. Recently these trades have been augmented by the Plumber, Carpenter and Electrical Fitter trades. Training courses have also been started for Apprentice Mechanics and Graduate Apprentices. The latest additions to the curriculum of the School are a Promotion Course for Unskilled staff and a Refresher Course for the Supervisors of the factory.

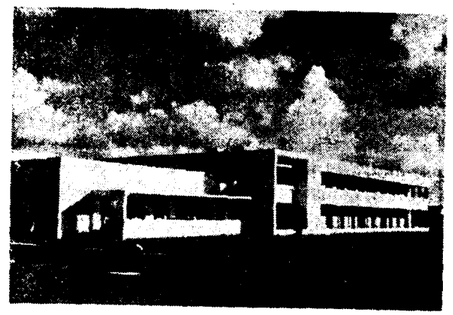
TRAINING OF TRADE APPRENTICES

The Integral Coach being of a design different from the conventional coach and the work involved in the manufacture being of a specialised nature, the administration decided at an early stage that at least 80% of the skilled artizans required for the factory should be those who have undergone a regular intensive course of training. The bulk of the skilled artizans required for the manufacture of integral coaches belong to the 3 main trades, viz. Fitting, Machining and Welding. Generally, it takes about 3½ years for a worker to become proficient in a particular trade, but in view of the limited time available before the factory went into production, a special training scheme of 18 months duration was drawn up. The scheme envisages the selection of suitable boys from those who have passed at least IV Form and undergone a minimum of 18 months practical training. The apprentices are given a training for 18 months and those found fit are absorbed as Skilled Artizans in the factory.

This phase of training is styled the intensive phase and will be replaced in due course by the conventional 3½ years course perhaps late in 1959 or in 1960, as from then on recruitment of fresh workers will be made only to meet the annual wastage.

The 18 months training is made up of 6 months of basic training in the Technical School and 12 months of further training in the Coach Factory.

Origin of the Technical School: The Technical Training School started functioning with a small Basic Training Workshop of 9,792 sq. ft. floor area and with 70 Trade Apprentices on its rolls. The Technical Training School was planned to have capacity to train 260 apprentices at a time, 100 in the fitting trade, 60 in the machinist trade and 100 in the welding trade and with that end in view it was decided that the Basic Training Workshop should be



A view of the Technical Training School.

expanded, a proper building for holding theory classes should be constructed and a hostel to hold 261 apprentices should also be built. The work was taken in hand and the plans drawn up for the School came into fruition during the year 1956-57.

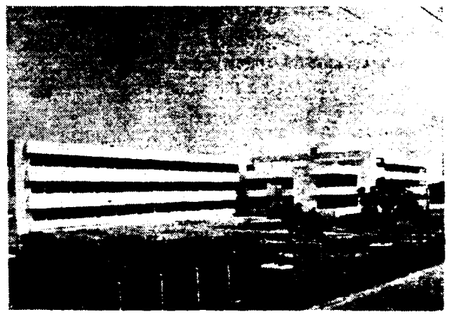
Basic Training: This training is intended to give the trainee a thorough grounding in the trade so that he is sure of the basic principles and he is in a position to derive maximum benefit from the factory training and attain the requisite skill within the 18 months training period. Advantage is taken of the basic training to create in the trainee the desirable habits for him to perform his work in a proper and methodical manner and also to become a worthy citizen of the state.

Each trainee puts in 47½ hours of work per week. The boys undergo practical training for 24 hours in a week and during the remaining 23½ hours they receive theoretical instructions, attend physical training classes and do community work.

The basic training courses start in May and November each year and during apprenticeship the trade apprentices receive a stipend of Rs. 36/- and a Dearness Allowance of Rs. 45/-, making a total of Rs. 81/-.

Practical training : Practical training is given in the Basic Training Workshop, which has a floor area of 19,600 sq. ft. and 105 machines installed in it. The B. T. Workshop consists of 3 departments, viz. Fitting, Machining and Welding. During practical training each apprentice has to work with his own hands and for that purpose he is allotted a fully equipped workplace in each department. In the fitter department, each trainee has a vice and set of tools allotted to him, in the machinist department a machine and in the welding department a welding booth with complete welding equipment. Similar arrangements have also been made for the 3 new trades, Carpenter, Plumber and Electrical Fitter. Each exercise is discussed in advance in the class room and when the trainee comes on to the shop floor he is fully aware of what he has to do, the raw materials and tools required, the sequence of operations, etc. To minimise fatigue and to avoid unnecessary waste of time, special tool cabinets with swing-out shelves have been provided for the machinist trainees.

During basic training each trainee has to complete a number of graded basic exercises starting from the simplest. The basic exercises are designed to develop the ability required to do all the skilled jobs



A view of the Apprentices' Hostel.

encountered in day to day work. To cut down the cost of training, scrap material is used for basic exercises to the extent possible and in some cases the same workpiece is used for more than 2 to 3 exercises.

In the case of fitters, besides giving training in fitting techniques, training is given in smithy and sheet metal working. In the case of the machinists, as the time available is limited, the trainees specialise in any one of the four sub-trades, viz. turning,

A view of the Interior of the Basic Training Workshop.

shaping, milling or drilling and boring. In the case of welders training is given in arc welding, gas welding, gas cutting and spot welding, a technique adopted largely in the manufacture of integral coaches. Similarly, for the Carpenters, Plumbers and Electrical Fitters, the exercises have been so planned that the apprentices will be fit to do the different types of furnishing required on the coach.

Each workpiece done by the apprentices is evaluated and marks are allotted for "Accuracy", "Finish" and special features such as fits, etc. The evaluation is done by specially trained men and the defects in workmanship or the methods employed are systematically shown to the boys.

The progress of the trainees is carefully watched and for this purpose a practical test is held every 6 weeks. This test indicates as to how much of training each apprentice has assimilated, whether he is sure of his ground and whether he is fit to go on to the next set of exercises. Corrective action is taken as indicated by the results. In the case of test jobs, marks are allotted for the working method followed, order on the work bench, time taken, planning, accuracy and finish.

During practical training, particular attention is paid to the adherence to safety regulations and the

use of safety appliances to ensure that the apprentices do not fight shy of using the safety appliances later on.

Theoretical instructions: For imparting theoretical instructions a magnificent building with well lit and well ventilated 11 class rooms, an auditorium capable of accommodating 300 persons, a Library and Laboratory has been built. The total floor area is 21,906 sq. ft. The School building is fitted with modern sanitary fittings and has been adequately furnished.

The lectures are so planned that each trainee understands the theory underlying each operation. Besides lectures on technical subjects, connected with the trade, lectures on Citizenship, Personal Hygiene are also given. Opportunity is taken to teach Hindi to those who do not know that language. Film shows are also arranged on important technical subjects.

Each apprentice has to attend physical training classes for 2 hours a week and has to become a member of the Auxiliary Cadet Corps Weekly parades are held to instil a sense of discipline in the apprentices. Time has been set apart for community work also to develop esprit-de-corps.

Theoretical tests are held once every 2 months.

Prizes: To serve as an incentive for the apprentices to give off their best, attractive prizes have been instituted for the basic training course. Two prizes (a first and a second) for General Proficiency and one prize for the practical training are awarded in all trades. A prize for proficiency in theory is awarded for all trades together.

Factory Training: During the factory training, which lasts for 12 months, the boys are first attached to experienced workers and then work independently as skilled artizans. On completion of the 18 months training they are trade tested and on being found fit absorbed as skilled artizans. The Factory Instructor attached to the Technical School follows up the progress of the boys.

Hostel: A two storeyed building with 87 rooms, 2 dining halls, 2 recreation rooms and fitted with modern sanitary fittings has been built to accommodate 261 boys. Each room is equipped to accommodate 3 boys and each boy is provided with a cot, a table, a chair, a book rack and a coat stand. The rooms are well lit and well ventilated. The hostel has a total floor area of 60,329 sq. ft. A vegetarian and a non-vegetarian mess are run on a co-operative basis, under the supervision of a Mess Committee, elected by the apprentices. The recreation and reading rooms are also managed by the apprentices themselves.

TRAINING OF APPRENTICE MECHANICS

To fill up the vacancies likely to arise in the supervisory cadre, a special Apprentice Mechanics scheme of 2 years duration (as against the conventional 5 years course) has been drawn up and was introduced in February, 1957. For this purpose a selection was made from the trade apprentices, who had completed their training with credit and who had passed S. S. L. C. and were below 25 years of age. The course commenced with 20 trainees comprising of 10 Fitters, 4 Machinists and 6 Welders. At present there are 31 boys under training. These apprentices receive advanced trade training and allied trade training in the Technical Training School and receive factory training on the floor of the shops. Whilst in the School they are given theoretical instructions to bring their knowledge upto the standard prescribed for Apprentice Mechanics in the Technical Training Committee Report. These boys also receive training in Jig and Tool Design, the Drawing and Design Office, and in the Production and Planning Office.

Later on, Diploma holders were also recruited from the open market for the post of Apprentice Machanics. The duration of their training is 2½ years. Under this course 14 Apprentice Mechanics are under training.

TRAINING OF GRADUATE APPRENTICES

A special training scheme of 2 years duration has been drawn up to train Engineering Graduates to fill up vacancies likely to arise in the intermediate stage of the supervisory set up. During training they receive a stipend of Rs. 250/- plus Rs. 70/- as Dearness Allowance per mensem. These apprentices spend 7 months in the Technical School, the major portion of the time in receiving practical training, theoretical instruction being confined only to factory administration and general subjects. They receive 16 months training in the factory of which 5 months are spent in the Jig and Tool Design Office, Drawing Office and Planning Office. The last month of their training is spent in the Technical School in undergoing a refresher course after which they are tested and absorbed as Chargemen in grade Rs. 260-350. This scheme was introduced on the 2nd April, 1957 and on date 18 apprentices are under different stages of training.

PROMOTION AND REFRESHER COURSES

After the work came into full swing in the factory, the need was felt for providing instructional courses for the Unskilled staff and for providing Refresher courses for the supervisors in the factory. These courses were started recently. For the Unskilled staff the training given is similar to the training given to the Trade Apprentices during the first 6 months of their training and consists of basic exercises in the B. T. Workshop and a series of lectures in the School. The exercises, however, are simpler and the lectures also are of a more elementary nature and are delivered in regional language. The duration of the training is 3 months.

The Refresher Course consists of lectures by Officers of the Factory on various subjects such as Production and Planning Control, Time and Motion Study, Principles of Supervision, Machine Tools, Stores Procedure, etc. These lectures are so planned that the supervisors learn what they miss in the daily rush of work and thus are helped to understand how the factory is administered. They also acquire a basic fund of knowledge on important topics, which it is hoped will be an asset in the execution of their duties.

STAINLESS STEEL AND RAILWAYS

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

AS a "glamour" material, offering at the same time a combination of mechanical, heat-resisting and corrosion-resisting properties, that are not matched by any other commercial metal, the stainless steel now occupies a very important place in product design in modern industries including railways.

Selecting materials is one of the most important aspects of the designer's job. From the technical point of view, his choice for the material should not only be based on the mechanical requirements of the product but also on its corrosion-resistance properties, since losses due to corrosion are one of the important problems constantly demanding the attention of engineers. Sales appeal by way of good appearance, easy maintenance, durability, and reliability are other equally valid technical reasons to dictate his choice.

WHAT IS STAINLESS STEEL

Stainless steels, a much more correct term for which would be "steels resistant to corrosion" are alloy steels in which chromium is the basis. All standard analyses and types of stainless steels have at least 12% chromium which imparts to them some of the characteristics of noble metals including the high degree of corrosion resistance for which they are well known. Other alloying agents are nickel, carbon, manganese, silicon, phosphorous, sulphur etc.

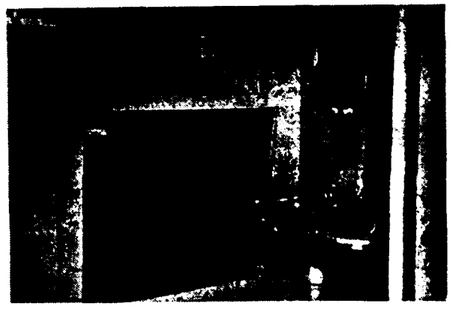
It was in or about 1913 that the excellent corrosion-resisting properties of iron-chromium alloys were first discovered by the researchers. During the same period another alloy containing chromium and nickel was developed. These two alloys were the forerunners of two fundamental classes of stainless steels, viz:, martensitic stainless steel and austentic stainless steel, the former being hardenable by heat treatment and the latter non-hardenable by heat treatment. The third basic class, the ferritic group being substantially non-hardenable, came into being shortly thereafter.

CLASSES OF STAINLESS STEEL

Although there are more than 50 standard analyses and types of stainless steels, based on their chief characteristics, they may be divided, as already indicated earlier, into three main categories — austenitic, ferritic and martensitic. These are metallurgical terms defining the microstructure of the stainless steels, and almost every alloy is grouped into one of the three classifications.

Austenitic stainless steels are chromium-nickel combinations with a basic composition of 18 per cent chromium and 8 per cent nickel and are therefore commonly known as 18–8 stainless steels. The carbon content in them does not generally exceed 0.12 per cent. They may also contain titanium, columbium, molybdenum, sulphur or phosphorous and selenium. Non-magnetic in character, these steels are soft and easily fabricated and offer excellent corrosion resistance, toughness and ductility. They are widely used for decorative purposes, and in the food and chemical industries.

Austenitic stainless steels may contain from 16 to 26 per cent of chromium and 6 to 22 per cent of nickel



Inside view of the lavatory compartment showing the use of Stainless Steel Wash Basin both from the view point of cleanability and appearance.

and by changing the analysis so as to leave 25 per cent chromium and 20 per cent nickel, such steels can have an excellent combination of scaling resistance, plus high temperature, tensile and creep strength.

Ferritic stainless steels contain from 12 to 30 per cent (usually 17 per cent) of chromium with carbon upto 0.35 per cent maximum (usually 0.15 per cent or less). They may contain small percentages of copper and molybdenum. These are magnetic and heat-treatment has little effect on their properties. Their

structures consist essentially of ferrite solid solutions. Although they do not have quite the corrosion resistance of the chromium-nickel grades when used in some corrosive environments, they are yet satisfactory for many applications and mostly used where combinations of corrosion and heat resistance are required, such as in furnace oil combustion chambers, heat exchanger flues, and related uses.

Martensitic stainless steels, as the name implies, may consist of martensite. They contain from 12 to 18 per cent of chromium and upto about 0.4 per cent (usually 0.15 per cent or less) of carbon. They may contain nickel up to 2.50 per cent, molybdenum up to 0.60 per cent, and sulphur or selenium up to 0.40 per cent. Magnetic, hard, strong, hardenable by heat treatment and a good corrosion resistance are the chief characteristics of these steels. To attain the maximum resistance to corrosion they must be hardened and tempered and an extremely wide range of mechanical properties can be obtained from them. These steels are most widely used in the form of bar, wire and forgings for general engineering purposes. They are fabricated into such products as surgical instruments, fasteners, screw machine parts, knife blades and cutlery items.

WHY STAINLESS STEELS RESIST CORROSION

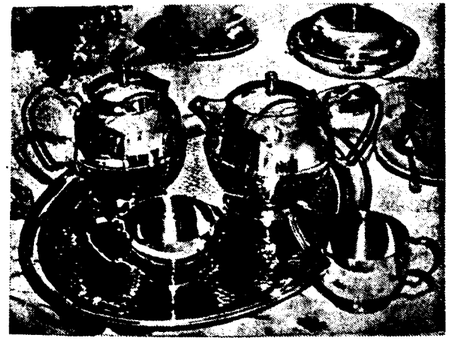
The ordinary steel, in the course of time, develops oxidized surface films or rust caused due to oxidation of the metal. Such attack of oxidation generally requires a relatively short time to develop visible effects. Although the rust film is to some extent protective, — the later stages proceed more slowly, — oxidation does not stop and it finally leads to deep corrosion and disintegration of the metal.

It is the ability of the stainless steel to readily form an oxide film which acts as an effective barrier against corrosion of the underlying metal. Stainless steels derive their capacity to form protective films mainly from the special alloying element chromium and, to a lesser extent, from nickel which is a passive and relatively noble metal.

The chemical affinity between chromium and oxygen is very strong, and as such the oxide film repairs itself instantly under oxidizing conditions. The oxide film which is although extremely thin and is practically transparent, is quite stable and very adherent and has, at the same time, the ability to reform instantly and to continue its protective action, if broken or destroyed.

ADVANTAGES OF STAINLESS STEEL

Stainless steel is about 50% stronger than ordinary mild steel. Contrasted with most other corrosion-resistant materials, its strength is very advantageous. Its stiffness is in the same range as that displayed by other steels. Where equipments must withstand corrosive attack, the use of stainless steel permits lightweight and durable construction.



Tableware made of Stainless Steel in use in Dining Car Saloons in British Railways.

When considered from the point of sales appeal, the stainless steel gives an impression of quality and reliability. By cutting out loss from tarnishing during shelf-life and display periods, stainless steel saves money in many products. The elegance of fine flat-ware, hollow-ware, etc. is complemented by the nobility of stainless steel which adds a modern note.

Design concepts and material choices usually interact. Apart from meeting functional and decorative needs, the working limitations or possibilities of the material to be selected require a careful consideration by the designer. Stainless steel meets both the aspects. Not only does it perform well in service, it also lends itself to fabrication by a wide variety of standard, economical factory processes.

Stainless steels can be work-hardened to tremendous strengths. All types of stainless steels in their annealed states have higher ultimate strengths than ordinary steel. When hardened they become stronger yet.

The 18/8 types, with 18 per cent of chromium and 8 per cent nickel, which are well known and have

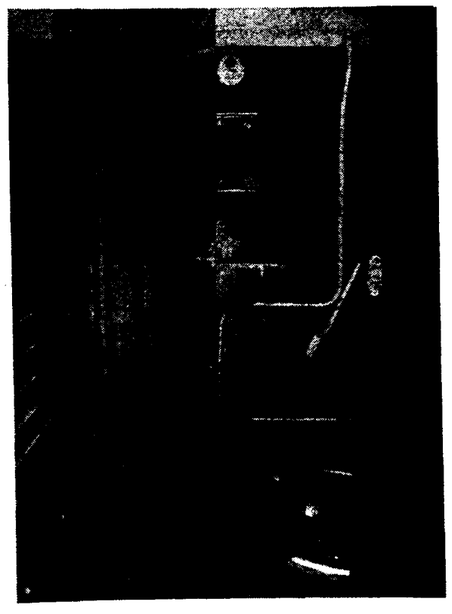
grown to be a sort of standard, attain strengths of several hundred thousand pounds per square inch when they are cold rolled or cold drawn. The 17/7 alloy, which serves almost interchangeably with the 18/8 types, displays an even greater tendency to gain strength when cold worked.

Other advantages of using stainless steel are : cleanability, ability to stand repeated scrubbing and abrasion, easy maintenance and elimination of painting cost.

STAINLESS STEELS AND RAILWAYS

In the railways, the use of stainless steel first started with the manufacture of a number of fittings to take advantage of its so many desirable special properties described before.

In the lavatories of coaches for example, where sanitation is paramount, the squat pans, wash basins, wall protectors, bottle openers are all made from stainless steel Although cleanability is the main requirement in such cases, appearance is undoubtedly



Squat Pan made of Stainless Steel is a Standard Fitting used in lavatories of Indian Railway Coaches of which one is shown.

a factor too. The impression which the stainless steel kitchenware and high-style holloware is creating in the restaurant cars is more than recognised to-day by the railway executives. The money saved in care, cleaning, repair and replacement throughout their service life, amply justifies a slight addition to cost of such items.

The hand holds aside the carriage doors are also at present being made from stainless steel tubes. These are another instance of cleanliness and safety with a bonus in beauty.

The above are the examples where stainless steel is being used by the Indian Railways. Although there exists an extensive field for the application of stainless steel in railway industry, the Indian Railways are to a considerable extent handicapped as India has no nickel and she was to depend on import for it.

In countries abroad extensive use is, however, being made of stainless steel sheet both as coach body exterior and interior panelling of shower compartments. The light fittings are another instance where the stainless steel is used with advantage. In the kitchen compartments of dining cars, stainless steel grilles are fitted at the top of the partitions. The equipment there including the oven unit is also composed mainly of stainless steel.

The first main line electric railway in Australia, which now extends 98 miles from Melbourne to Traralgon in the Gippsland District of Victoria, obtains power from the State Electricity Commission's 22,000 volt system at four supply points after its conversion to 1,500 volt direct current at 16 sub-stations and tie-stations. All these stations are connected by a 76-mile long stainless steel sheathed supervisory cable to the electrical depot at Warragul. The supervisory cable, which is suspended from the R. S. J. pillars supporting the overhead construction, is completely self-supporting by virtue of the austenitic stainless steel sheath.

In France the stainless steel body-shell for railway coaches was tried out for the first time in 1937—38 with the building of 40 motor coach bodies for the electrified main line. The trial having proved satisfactory, the French National Railways built, since the end of the last war, a considerable number of main line coaches together with all the electric motor coaches and trailers, for the suburban lines, with a stainless steel body shells.

Their 1950 passenger rolling stock programme included 200 vehicles for express trains, 36 of which were first and second class coaches built of stainless steel. This decision was based on the major benefits to be derived from the use of stainless steel. They are :

(a) inherent corrosion resistance

(b) high mechanical strength of the material resulting in the components of the coaches being made of reduced section with consequent weight reduction to about 3 to 4 tons

(c) Elimination of exterior painting thus partially offsetting the higher cost of this material

(d) A considerable saving due to the elimination of the cost of periodical repainting.

(e) Simplification in the assembly design in as much as arc welding of ordinary steel requires great care and a good deal of preparation, which is not the case with spot welding of stainless steel. Further arc welding requires considerable care and attention in order to eliminate setting up stresses which lead to distortion such as is not permissible, and may result in an unsatisfactory surface condition to take up painting. This entails a big job for levelling up which is quite unnecessary with stainless steel construction for, spot welding causes less distortion than arc welding.

(f) Resistance to weathering and fire.

Thus it will be seen stainless steel offers immense possibilities for large scale adoption in the railway industry. It is only when researchers in our country will succeed in developing alternative compositions of stainless steels, which will be without the nickel element, the railways in this country will also be able to keep pace with the modern developments that are taking place in other countries of the world, with the use of such an excellent material as the stainless steel.

Railways Adopt New Design Wagons: Order Placed

The Railway Board has placed orders with Indian manufacturers for the supply of 1,750 broad gauge new design 80-ton eight-wheeler bogie wagons, which have been accepted as the standard design for the future.

The Indian railways have traditionally been using four-wheeler wagons with a total carrying capacity of 22 tons. The new wagons will have a capacity of 55 tons, and will greatly help in running longer goods trains in India. For the time being their use will be confined to the steel belt in the eastern region.

A provision for a further lot of about 4,000 new design wagons, incorporating the latest development in wagon design, is being made in the 1959–60 rolling stock programme.

With effect from the 1960–61 rolling stock programme, the Railway Board has decided that all open wagons and 50 per cent of the covered wagons will be built as bogie wagons to the new design.

* * * *

LOCOMOTIVE COMPONENT WORKS: PROCUREMENT OF EQUIPMENT

The work on the Locomotive Component Works at Manduadih, near Banaras, is proceeding according to schedule.

The project is estimated to cost about Rs. 4.8 crores. A little less than one-third of this represents the outlay on machinery and plant, and procurement action has already been initiated on a global tender basis for nearly half of the equipment. The balance of the equipment will be procured in due course.

The construction of the technical training school, the basic training workshop and the apprentices' hostel, which is part of the project is nearing completion. The first batch of trainees have been selected and will commence their training shortly. The building of staff quarters is in progress, and tenders for the construction of the main workshop building have been invited.

The factory will mainly manufacture spare parts of standard broad and metre gauge locomotives. It is also proposed to cater for the manufacture of carriage and wagon components, as also to set up in this factory a centralised machine tool reconditioning department where specified machine tools in common use on the Indian railways will be reconditioned to extend their life, thereby saving foreign exchange by reducing imports of machine tools.

ECONOMY IN SLEEPER PROCESSING

THE wooden sleeper leads over all others; approximately 85% of all sleepers now in use being of wood. Endeavours are being made in a number of countries because of supply difficulties or other reasons, to replace the wooden sleepers by concrete ones. This, however, will only affect the overall proportion very slowly, the more so, as a not inconsiderable number of important railway countries reject the idea of concrete sleepers. This applies particularly to the United States of America, who possess about one third of the total world railway network and who use wooden sleepers exclusively. Concrete sleepers have been in use for too short a time to enable a final judgement to be made of their capabilities and economy, especially because the climatic and other conditions which have to be taken into consideration in arriving at a conclusion are too diverse.

In any case, the wooden sleeper has many economical and technical advantages, such as :—

light weight, which reduces transport and installation costs ;

great elasticity, resulting in quiet running even of fast-moving trains ;

great insulation power, which prevents interference with signalling and other electrical appliances ;

good anchoring of the sleepers in the track-bed, as points and edges of the ballast material embed themselves in the sleepers.

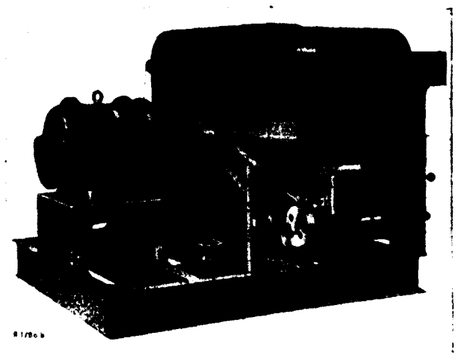
These attributes will certainly also in the future ensure a commanding position for the wooden sleeper in permanent way construction.

As further advantages of the wooden sleeper should be mentioned its easy processing and the possibility of "working it up", viz. the ferruling of old, usable sleepers either in position on the track or in sleeper processing workshops.

For reasons of economy, the processing of wooden sleepers has for some time been transferred by many railways from the track to suitable workshops, situated more or less centrally, which it has been found expedient to attach to sleeper impregnation plants.

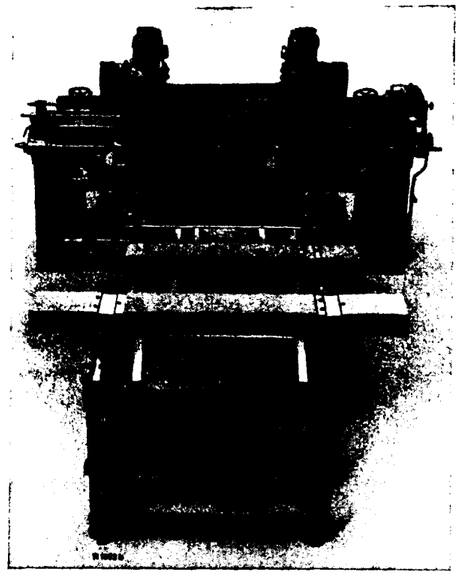
A series of machines exist for the economical production and processing of the sleepers which have proved themselves over many years with a number of important, economy-minded railway administrations. The most important of these machines are mentioned hereunder :

For the cutting-out of sleepers, there is a HIGH-EFFICIENCY CIRCULAR SLEEPER SAW which can be supplied either with electric drive or with belt-drive. Equipped with 3 saw-blades, it is capable of sawing out two sleepers simultaneously. In cases of urgency, a sleeper processing plant has succeeded in sawing out 500 softwood sleepers per hour. The machine is also suitable for the production of bridge – and other rectangular timbers, also planks, so that its uses are manysided.



High-efficiency circular sleeper saw Robel 1

The sawn sleepers, with the aid of *roller conveyors*, are then guided to a SLEEPER PLANING AND DRILLING MACHINE, the actual operation of which is restricted to the placing of the unworked sleepers onto the moving feed belt and the removal of the planed and drilled sleepers from the moving output belt. The remainder is done entirely automatically by the machine. The horizontally carried cutter heads are exchangeable, thus making possible the planing of mounting surfaces of differing widths. The drilling spindles are adjustable within wide limits, so that the most varied drill-hole diagrams can be followed. The two drill heads can be inclined to enable oblique holes, up to an incline of 1 : 20 also to be drilled.



Sleeper planing and drilling machine Robel 48

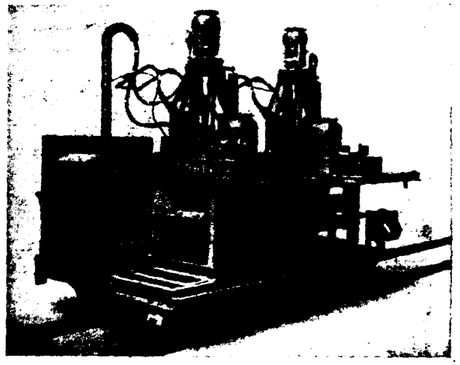
A *circular saw* at one side or one circular saw on each of the two sides of the machine can be fixed additionally in order to cut sleepers of uneven lengths to uniform length.

Further, an *impregnation hole drilling machine* can also be incorporated, which drills 4 holes into the underside of the sleepers to facilitate the absorption of the liquid in the interior of sleepers, at the same time as the holes for the sleeper bolts are being drilled from above.

Coupled or twin-sleepers can also be drilled by the machine semi-automatically. In the event of overloading of the motors or any other impediment occurring, the machine stops automatically. The moving belt has 3 speeds, for an output of 150, 200 and 300 sleepers per hour.

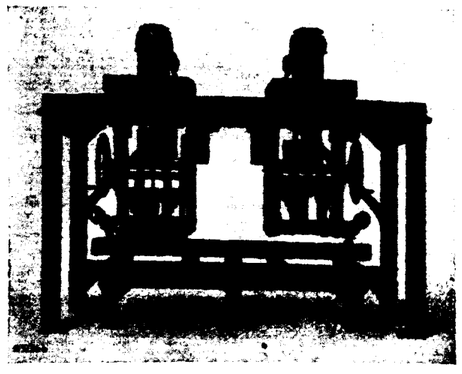
Railway administrations, whose sleeper requirements are not large enough to justify the installation of such a high capacity machine, use adzeing—and drilling machines with a capacity of up to 100 sleepers per hour. As in the bigger model, the cutter heads of this machine also, are exchangeable and the drilling spindles adjustable within wide limits, as well as being inclinable for oblique holes. The machine is

equipped with an adzeing-depth indicator. This model is also particularly suitable for the drilling of ferrule holes in old, usable sleepers.



Sleeper adzeing – and drilling – machine Robel 8.

For sleepers into which it is not intended to adze mounting surfaces for rails or base-plates, the use of MULTI-HOLE DRILLING MACHINES is recommended, the drill spindles of which are adjustable for drilling holes at varying distances from one another and can be inclined, as in the case of the combined machines. As can be seen from the illustration, the machine permits feeding and removal of the sleepers from the *front*, *left* or *right*, according to local conditions. It can also be employed for the drilling of holes for the reception of sleeper ferrules, the diameter of which is generally 32 mm. Its capacity is approximately 120-150 sleepers per hour.

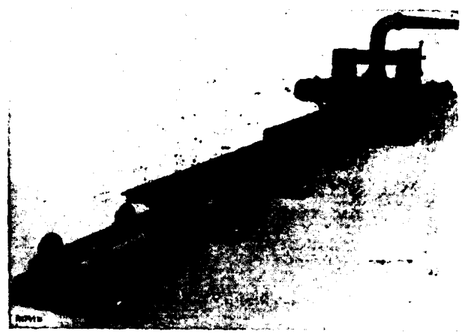


Multi-hole drilling machine Robel 34.

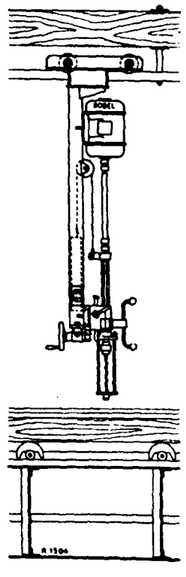
The pressing-in of the ferrules is carried out economically by a FERRULE PRESSING MACHINE

Two hydraulically operated press-pistons are provided with which the two groups of ferrules are simultaneously pressed in.

Where a completely level surface of the sleepers is essential, as in the case of switch and crossing sleepers and coupled sleepers, SWITCH-SLEEPER PLANING MACHINES are employed. For the most economical utilisation of the machine, two sleepers are placed on the planing bench one beside the other and as far as the length of the sleepers permits, also two sleepers one behind the other. The machine is also, of course, capable of planing bridge timbers



Switch–sleeper planing machine Robel 4.

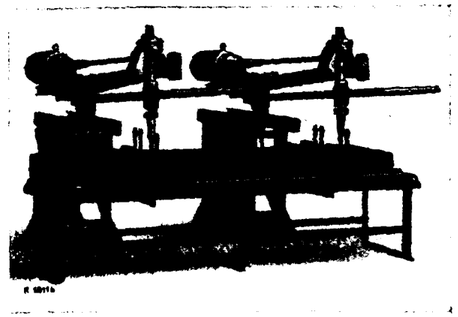


For drilling switch and points sleepers, modern workshops make use of suitable MULTI-HOLE DRILLING MACHINES or also of some *single-spindle switch-sleeper drilling machines*, suspended from an overhead guide rail and their respective templates.

This processing of the sleepers is followed by their impregnation with creosote or other wood preservative.

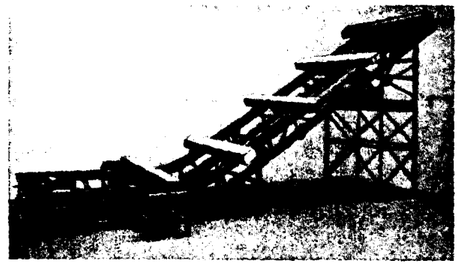
→ *Switch – and crossing sleeper drilling machine Robel 49.*

Similarly, for reasons of economy, the screwing-on of the base plates is in many cases no longer done on the track but in sleeper processing shops. For this operation, specially developed SCREWING MACHINES have proved themselves, which are usually employed in pairs, so that the bolts for the base plates canbe screwed in with one screwing machine at each end of the sleeper, simultaneously. Here also, use is made of suitable roller conveyors for the delivery of the sleepers.



Screwing machines Robel 25.

For *loading* the finished and impregnated sleepers into wagons, *conveyors* can be supplied, either as stationary or mobile models. With their aid, the loading of the sleepers can be carried out without heavy physical labour, quickly and with a minimum expenditure on wages.



Sleeper conveyor Robel 1.

In view of the steadily rising prices of almost all the materials required, the continuing rise in wages and the resultant increase in the overall cost of processing, greater economy in the work involved has become an urgent necessity. One way to achieve this economy is the replacement of expensive human labour by machines which increase productivity and work quicker and cheaper.

The machines here described, require only a minimum of maintenance and their efficiency is so outstanding, that their acquisition, even by countries with a low level of wages, is well worth while.

All these machines are products of Messrs. Robel & Co., Munich 25, Germany.

COVENTRY 1/4" STYLE 'XT' SELF-OPENING DIEHEAD

This new-type Coventry Diehead has been specially designed for use on Single-Spindle Automatics such as the Brown & Sharpe No. 00G, B. S. A. No. 48 and C. V. A. No. 8 Machines.

Besides having the notable features which have contributed for so long to the success of the well-known Coventry Diehead, the Style 'XT' Diehead is also equipped with external tripping mechanism This eliminates the possibility of the diehead's opening due to centrifugal force produced by the very rapid indexing of the turret on these high-speed machines. A particular advantage is its ability to cut short threads; the diehead can be set to trip almost immediately the dies commence cutting. The diehead is fitted with a spring-cushioned shank which provides lateral movement in both directions to compensate for the slight difference which may exist between the pitch of the thread and the forward motion provided by the feed cam. This cushion-action ensures a good start to the thread and also, with the substantial sliding dogs, provides an easy sliding movement ensuring long die life. The spring pressure can be varied.

The Coventry ¼" Style 'XT' Diehead will cut threads from 12 BA to ¼" Whitworth with appropriate dies, and as the shank is hollow, screws of any length can be cut.

The diehead uses the same dies as fitted to all ¼" size Coventry Diehead which enables the standard Die Grinding Fixture and Height Gauge to be used for regrinding. The Coventry Style 'XT' Dieheads can be used on small Capstan and Centre Lathes for which the external tripping mechanism would be ideal for cutting short threads.

Integral Coach Factory : its Performance in the Last Three Years

THE Integral Coach Factory was established at a cost of Rs. 7.35 crores in the course of the First Five-Year Plan to meet the requirements of Broad Gauge coaching stock of the Indian Railways. The capacity of the Factory was to be 350 shells for coaches per year on single shift working.

The production in the Factory was inaugurated by the Prime Minister on the 2nd October, 1955. Since then the Factory has made rapid strides. The First Five-Year Plan was mostly directed towards the increase in food production and development of river valley projects. In the core of the Second Five-Year Plan, the development of heavy industries and Railways were included. The economic growth in the country has resulted in a large increase in passenger and goods traffic on the railways. This naturally resulted in larger stocks of passenger and goods stock having to be maintained, throwing additional load on the existing railway workshops. The original intention was that the I. C. F. should produce only coach shells, and that the shells should be furnished in the different railway workshops. In 1956, it was found that the railway workshops would not be able to undertake the furnishing work. It was, therefore, decided that during the Second Five-Year Plan, the I. C. F. should be expanded—

(a) to undertake the furnishing of shells by establishing a furnishing annexe at a cost of Rs. 3.69 crores ;

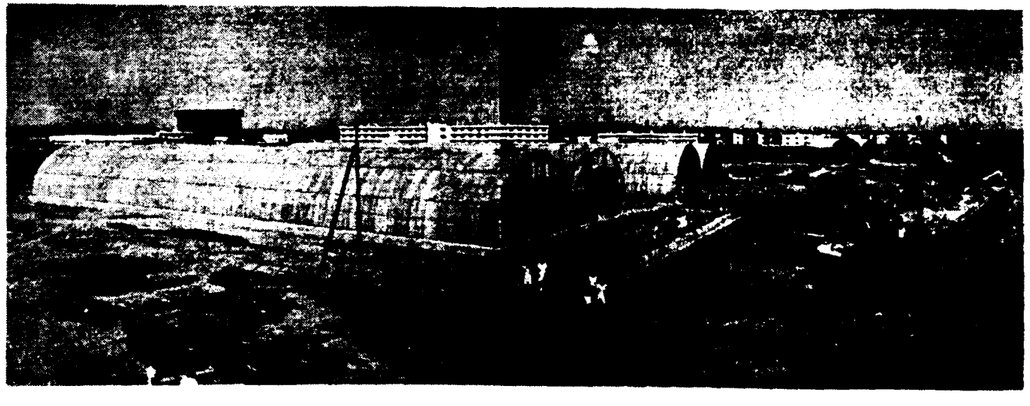
(b) to step up production, working a second shift, at a cost of about Rs. 90 lakhs.

On account of foreign exchange difficulties, work could not be progressed as originally anticipated, but the difficulties are gradually being overcome and it is earnestly hoped that before long the sanction to these two schemes would be forthcoming.

PERFORMANCE OF I. C. F.

The performance of the I. C. F. from 2nd October, 1955, when the production in the Factory was inaugurated by the Prime Minister, can be described as most satisfactory. In the very first year, against the original target of 20 and the increased target of 40, I. C. F. produced 43 shells. In the second year, against the increased target of 120, 150 shells were produced ; and in the third production year, which ended on 1st October, 1958, I. C. F. produced 308 shells against the target of 240. From June 1958, all the coaches produced are manufactured from the raw materials and certain fittings obtained from the trade. There is no more assembly of knocked-down coaches.

Though the permanent furnishing annexe is yet to materialise, furnishing of the shells has been started with temporary arrangements, and the I. C. F. is now turning out 15 coaches from the temporary furnishing unit.



A panoramic view of the Temporary Furnishing Annexe.

The performance of I. C. F. can be said to be satisfactory from the following yardsticks also :—

(1) The cost of the shell has been showing a downward tendency and from the original cost of Rs. 186 thousand it has now come down to Rs. 83 thousand. The Schlieren ex-Works price for a similar shell is approximately Rs. 107 thousand, and the imported landed cost amounted to Rs. 175 thousand.

(2) The man-hours for shell manufacture have gradually come down from 19,648 to 10,010. The present figure compares very favourably with the Schlieren man-hours.

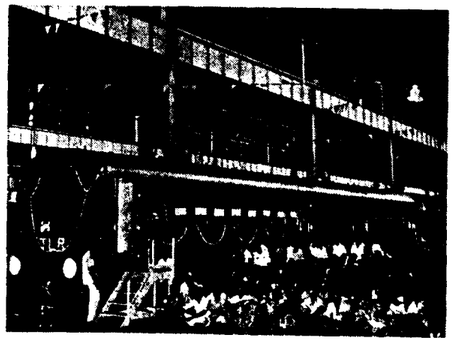
(3) The quality of the shells and coaches produced from I. C. F. compare very favourably with the imported coaches. As a matter of fact, the Swiss Experts are of the opinion that the quality of coaches produced from I. C. F. is better than the imported coaches.

TECHNICAL 'KNOW-HOW'

The technical 'know-how' in the manufacture of Integral Coaches has now been completely assimilated by the Indian engineers and the number of Swiss Experts employed has come down from the original number of 40 to 6. The remaining experts also will be leaving by early 1960. The various sections and shops are fully organised and are doing more than their fair share of work.

The Design Office has designed a new Third Class cum Luggage Van in light-weight construction and a prototype of this was launched on the 3rd January 1959 by the Deputy Minister of Railways, Shri. S. V. Ramaswamy. It establishes that now we are in a position to design other classes of coaches on light-weight construction, on our own.

An aerial view of the Staff Colony.



The first light-weight third class-cum-brake van fully designed and manufactured in the Integral Coach Factory was launched by Sri S. V. Ramaswamy, Deputy Minister for Railways on 3—1—1959. Picture shows the coach and a portion of the gathering.

TRAINED PERSONNEL

The Technical School attached to the Factory has produced the necessary trained personnel required for the increased production from the shell factory. It is now busy training men required for the Second Shift and for the furnishing unit. Courses have also been organised in the School for training Apprentice Mechanics, who, after their successful completion of apprenticeship, are absorbed in the various supervisory jobs in the shops. Refresher courses are being organised in the School and in the Shops to fit suitable and outstanding workmen in the supervisory and higher supervisory grades, more or less on the same lines as the "Training Within Industry" scheme, so popular in the Western countries.

INDIGENOUS CONTENT OF THE COACH

The raw materials, fittings, etc., in a shell cost Rs. 58,000/-. Out of this, in the first few batches, raw material worth Rs. 37,000/- had to be imported. This included steel of requisite weldable quality costing Rs. 19,000/-, the balance being other semi-finished and finished components, castings, etc. Vigorous efforts have led to the location and develop-

ment of indigenous capacity for the various items originally imported and it has been possible to bring down the imported content by as much as Rs. 10,000/-. The three rolling mills which will be going into production shortly have been contacted to meet our steel requirements, and from the enquiries so far made, no difficulty is anticipated to replace the imported steel by the products from these steel mills.

HUMAN RELATIONSHIP

We are a very happy well-knit family dedicated to the sole task of producing more and more coaches to help in the industrial growth of our country, and this patriotic spirit which is imbued in all the staff has led us to establish good human relationship. There is no class distinction in the factory, and officers, supervisors, and men mix freely to help each other, not only in their day to day tasks in the factory but also in their general well-being. These are fostered by various means. Besides a good Welfare organisation that exists to look after the welfare of the men, we have established a guardianship scheme by which each supervisor in the shops takes charge of 25 to 30 men and looks after their grievances, training, behaviour and discipline. They also go out on picnics once or twice a month, which enables them to come together and discuss their problems informally. The Works Managers along with the Welfare Officer also make a point of meeting the staff in the shops frequently to listen to their grievances and to redress them as far as possible.

A Staff Council has been also formed in which elected representatives of different categories of staff represent the grievances and suggest ways and means of improving the working conditions and production.

A 'Suggestions & Inventions' Committee invites and screens suggestions put forward by the staff. This Suggestions Committee has in the last three years received over 500 suggestions, and prizes amounting to Rs. 1700/- have been awarded to the staff for suggestions likely to improve methods or result in savings.

Besides, a Workers' Canteen is provided which supplies wholesome food at nominal rate and serves them snacks at their places of work.

STAFF COLONY

A colony with double-storeyed flats has been constructed for housing the essential staff of the Factory. The colony, situated about 3/4 mile from the factory, contains 438 quarters of various types which have been designed on the most modern lines. All quarters, including those for the lowest paid workers, have electrical and sanitary fittings. The township is provided with filtered water supply, complete underground drainage and good roads. A children's park and a playground have also been provided. The colony has an Institute attached, for the recreation of the staff, a Primary School and a Co-operative Stores.

An aerial view of the shell Factory.

A view of the Technical Training School.

STAFF BENEFIT FUND

A Staff Benefit Fund has been formed similar to those existing on the railways. A contribution of Rs. 4/- per head or a minimum of Rs. 20,000/- is made to this Staff Benefit Fund every year to encourage the various staff welfare activities. This is disbursed as follows:—

(i)	Education of staff and their children.	30%
(ii)	Recreation and amusement.	30%
(iii)	Relief of distress among families of employees.	15%
(iv)	Schemes for sickness.	10%
(v)	Miscellaneous.	15%

Besides these, a well equipped Railway Hospital is available for the I.C.F. employees. Holiday homes have also been organised where staff can go and enjoy a cheap holiday. Besides, special grants are received from the Railway Board for celebration of Independence and Republic Days and also the Railway Week in April every year.

SPORTS

It has been the policy to encourage sports in the factory, as it is felt that sports are necessary to develop team spirit and *esprit de corps*. In pursuance of this policy I. C. F. has organised an I. C. F. Sports Club. This Club has been able to build up a formidable Football and Hockey elevens representing I. C. F. In the last year the I. C. F. team won all the four major football tournaments conducted in Madras and were the winners of the semi-finals in the Inter-Railway Football Tournament. In Hockey too, we have had success in the two major Hockey tournaments in Madras. In athletics laurels have been won in events for women and the I. C. F. representative holds three Inter-Railway records. In other spheres of sports, i. e., cricket, badminton, table tennis, etc., our players are also faring well.

KEY TO SUCCESS

The key to success in the I. C. F. has been the team-spirit and enthusiasm. It has been our experience that our workman is second to none when he is given equal opportunities and facilities. The detailed planning and the instructions on methods to be employed have been mostly responsible for the good results so far obtained. We are hoping to soon finalise our Works Studies and Time Studies and introduce incentive system to further improve on our working.

From the reports and views of the numerous foreign experts who visited the factory it is established beyond doubt that the I. C. F. is one of the well-planned and well run factories in the public sector in India and the Productivity from this factory compares very favourably with the Western countries.

COACHES FOR ELECTRICS

In order to develop the manufacture of Electric Multiple Unit Coaches in India, Messrs. Jessop and Co., Calcutta, have been given an order for part manufacture of 104 Coaches. This firm is expected to develop manufacturing capacity for 50 to 60 Coaches per year. This was stated by Sri S. V. Ramaswamy, Deputy Minister of Railways, in the Rajya Sabha. The Deputy Minister further said that the manufacture of electric traction equipment for these coaches at the Heavy Electrical Project, Bhopal, was under consideration.

Asked whether coaches for electric trains were built in India or were imported from abroad, the Deputy Minister replied that these were at present being manufactured partially in India by Messrs. Jessop and Co., Calcutta. In the past these coaches had been imported.

BOOK REVIEW

Western Railway's Achievements Reviewed

THE Western Railway has successfully implemented the First Five Year Plan and is well set for fulfilment of targets for the Second Plan. Out of a total of Rs. 1125 crores for all Indian Railways, the Western Railway's allotment is Rs. 103.62 crores excluding rolling stock. The progress, in the execution of the Plan during the first two years,—the Year Book 1957-58 issued by the Western Railway states,—has been very satisfactory, with an anticipated expenditure of Rs. 47.04 crores by the end of 1957-58, which represents 45 per cent of the total allotment.

With graphs and diagrams and produced in an attractive handy size, the Western Railway Year Book gives a bird's eye view of the achievement of this Railway during the current year in every field,—Transportation, Commercial, Mechanical, Civil and Electrical Engineering, Signal and Tele-communication, Staff Welfare, Passenger Amenities and various other sections.

The Western Railway,—the Year Book mentions,—carried 359 million passengers during 1957-58 as against 305 millions in 1955-56, the end of the First Five Year Plan, and 21.3 million tons of goods during 1957-58 against 17.6 million tons in 1955-56.

The Book gives a rapid survey of important streams of traffic and steps taken to improve operation. Readers will welcome the assuring note struck in the book in outlining the important measures taken to reduce the incidence of accidents, including the new Safety Organisation set up on the Railway.

On the Suburban Section,—the book states,—the number of coaches in services has increased from 210 coaches in 1952-53 to 247 in 1957-58 and the number of trains per day from 273 in 1952-53 to 357 in 1957-58. The introduction of additional trains has relieved to an extent, overcrowding in suburban section.

The book also details the projects undertaken to create additional traffic facilities and construction of new lines during 1957-58.

In addition, the Year Book touches upon several topics of interest and importance. An intensive drive is kept up by the Railway against ticketless travel and in the year 1957-58, 12,51,562 ticketless travellers were detected and an amount of Rs. 33,85,568 was recovered. Air-conditioned travel is steadily becoming more and more popular. About 34,000 passengers availed of the 3rd class air-conditioned accommodation during the year under review.

Amenities for rail passengers are given high priority,—the Year Book maintains,—and during 1957-58 Rs. 73.67 lakhs were spent on their provision. The main object of the programme was to provide a certain minimum of the basic amenities at stations and in trains.

Staff welfare amenities also receive continuous attention from the Railways. Training of technical staff assumed paramount importance. For the staff, there are two training schools,—the Year Book mentions,—one at Udaipur for traffic, engineering and signalling staff, and the other at Ajmer for Mechanical Engineering Personnel. There is also an Engineering Technical Training School at Mhow for staff of Western & Central Railways. The Railway Protection Force have their school at Bulsar. A staff welfare organisation also functions on the Railway, with welfare centres in staff colonies. The Railway maintains 29 schools for education of staff and 54 institutions for recreational activities. In sport, the Railway acquitted itself very creditably during the current year, annexing the 'Kaul Gold Cup' for all round performance for the third year in succession. The Railway were also joint holders at Hockey with North Eastern Railway and also won the Tennis Tournament and Wrestling Championship.

The Year Book at the end contains a very useful resume of important statistics pertaining to the Railway.

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EDITORIAL NOTICE

CONTRIBUTIONS are invited from the Engineering Profession in India and abroad in the form of original articles, research write-up, Summary of papers read before Technical institutions etc. relating to Civil, Electrical, Mechanical, Signal & Interlocking and Telecommunication Engineering sections and of particular interest to the Railway Engineers. Besides, Suggestions for the technical improvement of various aspects of Railway Engineering Practice are also invited with suitable write-ups and photographs wherever possible.

Contributions are accepted on the distinct understanding that they are sent solely to the "Indian Railway Engineer". The Editor accepts no responsibility for the views and statements of the Contributors.

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Manuscripts should be typewritten, double spaced or legibly written on thick paper on one side only with sufficient margin on either side, with the sheets numbered in order. The name and full address of the author should appear on the first sheet of the contribution. The Editor cannot undertake to return unused Mss. but will make every endeavour to do so. Accepted Mss. are not returned All photographs accompanying the contribution will be retained by the Editor unless there be special reason or request for their return to the writer.

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Editor

RAILWAYS AND PUNCTUALITY

THE punctuality of railway trains loomed large in the Lokh Sabha debate in the early part of December last year, when the question of railway working was taken up.

Member after member rose to his feet and ventilated fully and freely his grievances against the late running of trains on his part of the country. Whether it was in Bombay or Calcutta or Madras the theme was uniform — the trains of to-day do not run to time at all.

The bombshell however came when reference was made to the constant and habitual late running of the Grand Trunk Express which after four years of promises of improvement in punctuality by a succession of Railway Ministers to parliament showed not the slightest sign of improvement. As a matter of fact members indicated that matters were now going from bad to worse.

Pointed references were made to the late running of the once famous Deccan Queen, the "crack" train of the Central Railway which in covering a distance of just 110 miles in either direction is as much as 50 minutes late in a 3 hours, 10 minute schedule. The writer remembers the days when these two streaks of blue and silver lightning used to roll on either into Victoria Terminus or Poona for years without fail, dead on time.

The explanations offered by the Deputy Railway Minister on this occasion were puerile and it was evident, satisfied not a single of the complaining M. Ps. The statement that constant efforts were being made for the improvement of the Grand Trunk Express during the last 4 years and that no tangible success had been obtained appeared on the face of it ridiculous, nay absurd. Further to offer excuses like repairs to tracks and the consequent slowing down of speeds, the stoppages due to signals being against, late starts and further stoppages due to the pulling of the alarm signal by passengers as being the causes of late running did not appear to carry any weight, because every one of these obstructive factors existed when this train ran to scheduled time. Not all the acrimonious remarks of our legislators were recorded in the press report but reading between the lines it was evident that feelings ran high and tempers were short. It is time the Railway Ministry sat up and took notice if the stigma of inefficiency is not to be attached to it.

Members of Parliament and educated members of the general public are aware that in drawing up a railway time table or revising one according to seasons due allowance is made for late running between certain of the smaller stations and the opportunity is afforded to drivers to make up this loss of time by an increase of speed between certain other stations, where the track is sound and there is no danger from a little acceleration. Especially in the cases where the stations are far apart or where there are gradients stiff advantage can be taken of a falling gradient to make up lost time. That the drivers of to-day are aware of these little tricks of their trade everyone knows, but it may be pertinent to ask how many of them bother their heads

or take a pride in being punctual. They carry in their pockets all the excuses, knowing fully well that inexperienced shed foremen and Mechanical Engineers will take any excuse lying down.

If this is not the case how is it that on certain Railway Divisions where the Divisional Superintendent has a reputation of alertness and coming down on staff like a ton of bricks that train punctuality figures are in the region of 90% and 95% whereas in other divisions they can hardly get over the 70% to 75% mark? It amounts to this that a "live wire" D. S. who has a reputation of firmness, tempered with justice can achieve results whereas one who takes life easy and is prepared to accept all explanations and condone faults fails every time.

Punctuality is a developed habit and is a bye-product of personal discipline and it is therefore only the highly disciplined nations of the world that observe it. It is engrained in their muscle and bone by being handed down from generation to generation.

Over the continent of Europe itself while the Latin races like the Spaniards, the Portuguese and even the French and Italian take life easy and have no value or very little value of time, the Teutons like the Germans and the British are sticklers for punctuality. Americans who are a conglomeration of heterogeneous races do observe punctuality because to them time is money and it is "the early bird that gets the first worm".

In Spain and Portugal no one worries whether a train is an hour or two hours late. Business is prepared to wait for that period. Conferences can be postponed to some other day with no better results. Passengers in railway trains in these countries who are voluble conversationalists enjoy a couple of hours longer conversation or gossip or the card players enjoy an extra two hours at their game. In France and Italy there is a little improvement in the running of trains and although the passengers do not care two hoots about punctuality they know how to enjoy their extra leisure. It is the British and the Germans who will start fussing and fuming if the train is even a few minutes late because they like to be at their appointments rather a few minutes early than one minute late.

Ancient India did not much appreciate punctuality. Our old Maharajahs and Rajahs could not be disturbed when they were taking their ease. They may have been taking an afternoon nap or enjoying a game of cards or skill or just passing their time in their harem, the answer to even the most pressing request was the Rajah Saheb is otherwise engaged and cannot be disturbed. The affairs of State could wait or could be postponed and even cancelled because here the Rajah Saheb was the final authority. Ministers of these princely State taking the cue from their masters had no fixed time for their subjects or their business which had to await their whim and fancy

Our people even to-day are not very great observers of punctuality because as a whole we are not disciplined people. Whether it is the climate or our habit of eating too much food or being fond of our bed are the causes of it we cannot say, but somehow punctuality is not in our blood as it is in the Teuton races.

It was the advent of the British that in a space of 150 years changed all our lethargic habits. Discipline and punctuality was enforced by the threats of severe punishment or the loss of the job for irregularity which was treated as a major crime.

During the British regime (which we certainly do not advocate), trains used to run to time every time and the late running of a train was an exception.

In the Railway workshops men entered the workshops on the sounding of the first buzz and were at their place of work and ready to start on the sound of the second buzz. But since the British left, discipline has been gradually declining and to-day punctuality is practically non-existent. It is a sorry spectacle to see workmen still pushing through the turn-stiles of the time office when the second buzzer is blowing. Then they will proceed to their place of work and by the time they get ready to operate their machines or their work, half to three quarter of an hour is lost. Multiplying this by two for the two half periods the loss of one and sometimes one and a half hours occurs regularly. Similarly they stop work half to three quarters of an hour before time. So that in a working day of eight and a half hours two to three hours are lost by unpunctuality. But the irony of it all is that the Executives are prepared to turn a blind eye to this state of affairs and rightly so because they fail to get the support of the Administration.

There is only one solution to this problem. Punctuality must start from the top and must infiltrate downwards. Administrative officers must give the example and enforce punctuality by firmness. Executive officers should be encouraged to practice punctuality and should be supported when they enforce discipline by inflicting punishment. Conferences and meetings must start dead on time and late comers must be made to feel that their unpunctuality will not be tolerated a second time. Drivers who are habitually late must be made an example of, so that others will be afraid. Workmen who are inclined to be frequently late should be penalised by forfeiting fifteen minutes wages each time. Further they should be warned and given a charge sheet. If one or two can be discharged for habitual unpunctuality it will have a salutary effect and boost up the morale.

Let the Railways try this out.

Railway Minister says limited resources in way of railway expansion

Shri Jagjivan Ram, Union Minister for Railways, said at Dhar, Madhya Pradesh, on November 6, 1958, that the demands for new railway lines in various States was great, but the resources were limited. He said that the railways would require at least Rs. 1,400 crores in the third Five Year Plan if they wanted to provide additional railway lines in every State of the Indian Union.

He said there were demands for expansion of railway lines in every State and in certain States they wanted priority over others. The Jammu & Kashmir and Tripura & Manipur States had demanded that they should get priority over other States in respect of construction of new lines because they did not possess even an inch of railway line at present.

Shri Jagjivan Ram said the cost of construction of railway lines per mile in the plain region of the country was about Rs. 7 lakhs and Rs. 16 to 25 lakhs in hilly and mountain areas. He said the demands for railway lines were great but resources were limited. New railway lines, especially in backward areas would be of no use unless road development programmes were taken in hand simultaneously.

RESILIENT PADS ON PERMANENT WAY

Absorption of shock in conjunction with concrete sleepers and elastic fastenings

(By a Correspondent)

WHERE flat-bottom rails are used in conjunction with concrete sleepers it has been generally recognised that there is a need for some form of resilient pad to be interposed between the two. This practice is justifiable because concrete does not satisfactorily withstand the repeated impacts which it experiences in the form of a railway sleeper. Information on this subject appears in two papers presented to the Institution of Civil Engineers, Railway Engineering Division, Session 1943–1944, entitled "Experiments on Reinforced Concrete Sleepers," by F. C. Johansen, and "Experiments on Concrete Sleepers," by F. G. Thomas, in which figures are given for estimates of the order of loads which may develop between rail and sleeper.

LOAD APPLICATIONS

Apart from these compressive loads and in view of the fact that the rail is attached to the sleeper by some form of resilient fastenings, it is of interest to know what occurs between successive compressive load applications. During the passage of a load over a rail supported on sleepers, a deflection of the rail takes place downwards beneath the load accompanied by lifting of the rail on either side of the load. This process causes the formation of a precession or bow wave, the amplitude and wave length of which is dependent upon the stiffness of the rail, the elasticity of the ballast and formation, the weight of the sleepers, and the velocity of the load. These considerations have given rise to a number of designs of rail sleeper fastenings which have met with varying degrees of success. These fastenings, by virtue of the toe load which they exert on the rail, exert an influence upon the unload part of the load/unload cycle; and as a resilient pad is sandwiched between rail and sleeper the effect is felt upon the resilient pad and influences its behaviour The rails are also subjected to high frequency vibrations during the passage of wheels and, due to its position relative to the rail, the resilient pad must be able to absorb these movements.

All elastic fastenings, whether singly or doubly elastic, that is, whether their load deflection curve is a straight line or has a change of gradient, operate about an initial deflected position which provides their working toe load. In the case of the doubly elastic fastenings their design is normally so arranged that the change in gradient of their load deflection curve occurs at this working toe load and, in practice, fastenings of this type usually utilise this fact to give an indication when being laid that the correct toe load has been reached.

In Fig. 1, two hypothetical load deflection curves have been drawn with a common load axis. The curve on the right $OA_1\ B_1$ represents that of the

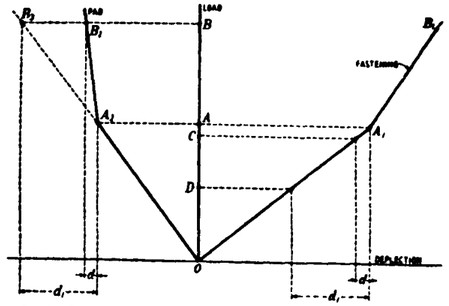


Fig. 1—Two hypothetical load deflection curves with a common load axis

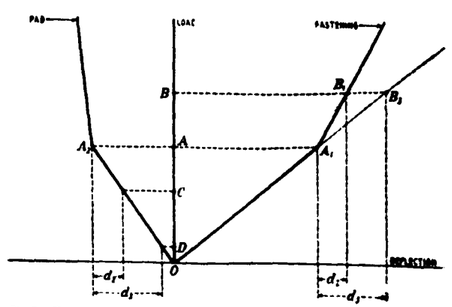


Fig. 2—Two curves as in Fig. 1., but with the rail tending to move vertically upwards as a result of the precession wave

fastening whilst the curve on the left $OA_2\ B_2$ that of the matched pad.

The fastening is designed to be pretensioned at point A_1 (OA represents the design toe load). Ideally line OA_1 should be as flat as possible so that vertical downward movements of the rail due to pad compression shall not result in large reductions in toe load. Conversely, as the rail tends to lift it must meet with an increased resistance and thus line A_1B_1 should be steep.

The load deflection curve of the pad, OA_2B_2, should be so arranged as to have a change in its gradient at point A_2 which occurs at the same pretension load as the fastening, that is at load OA. When a load is directly over the sleeper, this is added to OA and it is desirable that the resulting deflection of the pad be small so that the corresponding loss of load from the fastening is kept as small as possible. If, therefore, AB is the additional load now acting on the sleeper, the additional deflection of the pad is "d" and an equal deflection of "d" in the fastening will, from the curve, give a loss in load of AC.

If line A_2B_2 of the pad load deflection curve had, for example, been A_2B_3, the deflection of the pad under load AB would then have been d_1 and the corresponding loss in the fastening load would have been AD.

A condition could arise in which the whole of the load OA from the fastening would be released, that is, if the fastening lost contact with the rail. Assuming that the loads experienced remain sensibly constant in magnitude, the avoidance of complete loss of toe load can be effected by making the gradient of OA_1 for the fastening as small as possible and the gradient of A_2B_2 for the pad as steep as possible within reasonable bounds.

Fig. 2 shows the two hypothetical load deflection curves as before but with the rail tending to move vertically upwards as a result of the precession wave. Using the same argument as before, the application of any load AB upwards causes an increase in the fastening load of this amount which in turn causes an additional deflection of d_2. This allows the load AC on the pad to be decreased by an amount corresponding to this same deflection d_2.

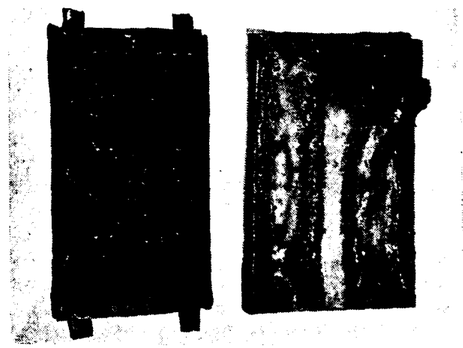
The load deflection curves for the pad and fastening are closely inter-related and as a consequence the behaviour of one cannot be divorced from that of the other.

DESIGN OF PAD AND FASTENINGS

In considering the design of both pads and fastenings if parting of components is to be avoided and excessive loss of load reduced, it is desirable that both fastening and pad should have two stage stiffness as low as possible between the range zero load to toe load, and as high as possible at loads above the toe load. There is an optimum curve for the pad OA_2B_2, which matches the fastening curve OA_1B_1. Other curves can be drawn for the pad to satisfy the criteria outlined but other considerations will again provide limitation to these.

The most convenient way of changing the gradient of the load deflection curve of a pad appears to be the method already adopted by manufacturers producing rubber resilient pads of moulding configurations into their surfaces. The physical effect of these various shaped elevations and depressions in the surface of a pad is that as a load is applied the elevations become reduced in height and the displaced rubber fills the depressions until such time as the depressions are entirely filled by displaced rubber when the stiffness becomes that of a flat sheet of rubber. In this condition, whilst some shear strain can occur at its edges, the pad is virtually behaving in bulk compression in which state its stiffness is high. Before the depressions are filled, each elevation on the surface tends to behave more in shear than in bulk compression.

After establishing an optimum curve for the pad relative to the fastening with which it is to be used, the next consideration is to decide upon the absolute



Normal design of pad (left), showing configurations compared with inadequately designed pad, after test on the same machine in identical conditions.

values of stiffness needed to cope with the order of loads expected to act upon the pad.

LOADING

Two main forms of loading normally occur under the passage of trains. They are frequently occurring on normal loads which are not of great magnitude, and higher magnitude loads which only arise occasionally. Mr. Thomas in his paper mentioned above, shows that these normal loads have a frequency of occurrence of between 20 to 50 times the frequency of occurrence of these higher magnitude or maximum loads. Concrete sleepers appear to suffer most damage from these frequently applied normal loads and these loads, therefore, dictate the choice of material and subsequent design. As a secondary consideration, the material must also be capable of withstanding occasional overloads.

These frequently occurring loads for modern heavy fast traffic are found to be of the order of 3 to 5 tons per rail for coaches and locomotives respectively. The occasional overloads may be from 10 to 22 tons respectively.

The maximum area of pad which can be employed to bear these various loads is governed by the width of the rail foot and the width of the sleeper and, because of a variety of other factors, these two dimensions remain sensibly constant in this country. The rail foot width is a constant at 5½ in. and present concrete sleeper design invariably produces a sleeper of about 8 in. width at its top. The maximum area of pad, therefore, becomes 44 sq. in. The unit loading, assuming even distribution, is therefore some 150–250 lb./sq. in. with peak loadings of the order of 1,100 lb./sq. in.

The assumption of even distribution across the pad is, however, not correct from either theoretical or practical considerations. There is some difference of opinion as to the theoretical distribution of pressure across a pad, dependent largely upon whether or not it is assumed that the rail foot is rigid compared with the rigidity of the pad. Whilst it can be shown that some deflection of the edges of the rail foot can occur under load, it is considered that such deflections as occur in the steel are negligible when compared with those occurring in the resilient pad and that the rail foot can be considered to be rigid. On this basis and insofar as rubber resilient pads are concerned, the distribution across them is parabolic. From the practical aspect, the rail acts as a continuous beam spanning sleepers and under the action of a rolling load assumes angled positions along its longitudinal axis relative to the sleepers. This rocking action leads to load concentrations towards the edges of the sleepers which are superimposed upon the parabolic distribution due to purely vertical loading. Examination of inadequately designed pads removed after service show these stress concentrations quite clearly.

It seems probable that localised pressures in the order of 500 to 2,000 lb./sq. in., at least twice as large as those previously calculated, could arise. It is desirable that these localised pressures should be eliminated and an attempt made to secure even distribution if economical use of the material and long life are to be obtained.

The opinion that the securing of even distribution of pressure over the face of a pad, with particular reference to rubber pads, is not a good practice since it applies more pressure to the edges of the pad where shear strains can occur with deleterious results to the rubber, is only valid when such configuration as the surfaces of the pad possess are completely eliminated by load. Before the elimination of these configurations, shear strain can occur at the edges of each individual configuration as well as at the edges of the whole pad and because these shear deformations are proportional to the applied vertical load, it is advantageous to reduce the high values which occur at the centre and two ends of the pad and spread the whole load uniformly. By this arrangement, whilst the sides of the pad become loaded more than they would have been without even distribution and in consequence suffer more shear deformation than before, the centre and the two ends of the pad suffer less shear deformation than before. When the configurations are eliminated by load it is a disadvantage to attempt to secure even distribution because higher loads than normal would be placed at the sides where shear deformation can now occur.

For even distribution to be obtained over the surface of the pad the stiffness of the pad over its surface must vary as the applied pressure varies. At least one design exists which has solved this problem successfully.

MATERIALS

Before selecting a suitable material for the manufacture of resilient pads, there are several requirements to be considered. A resilient pad must be capable of being rendered non-conductive for track circuiting

requirements. It must not suffer from permanent set under the various loadings described, and it must be cheap. Rubber appears to be the only material which fully satisfies all the various requirements. In the case of wood, its load deflection curve assumes a generally curved shape with very small deflections over the range of loads considered, such deflections not being completely elastic in nature. With felt, control over its elasticity is difficult whilst with cork or rubber-bonded cork, permanent set occurs and problems arise, due to absorption of water, in achieving insulating properties. Plastics appear to offer more possibilities and the production of a plastic with air entrainment and with no air leakage from its individual air cells might be the basis of a resilient pad of the future.

Rubber, however, can be made to conform with all the requirements considered and therefore would seem to be an ideal material from which resilient pads should be made.

MARKED DECLINE OF CRIME ON RAILWAYS

Shri Shah Nawaz Khan, Deputy Minister for Railways, enumerated the various steps the Railway Ministry had taken in co-operation with State Governments to put down crime on railways.

He was speaking during a two-hour discussion on a non-official motion moved by Shri Dwarka Nath Tiwari in the Lok Sabha on "the state of insecurity and danger to life and property in railway travel and protection of railway staff against police and officials who violate rules".

Shri Shah Nawaz Khan said that exaggerated pictures of these crimes had been given, although one would not deny that these crimes took place frequently. The Government had always tried to minimise them and ensure safe travel on the railways.

The Deputy Minister quoted figures to show that there had been a marked decline in cases of theft, loot, dacoity and murders as a result of the various measures taken by Government.

* * *

VOLUNTARY BLOOD DONATION FOR BLOOD TRANSFUSION SERVICE

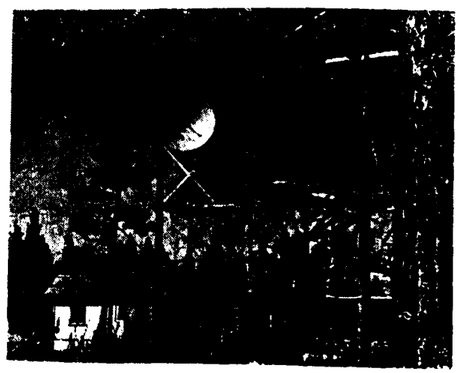
The Financial Adviser and Chief Accounts Officer of the Western Railway arranged with the St. George's Hospital voluntary blood transfusion service for a Lecture and Film Show held in his office in the new Churchgate Station Building recently. The Lecture was well attended by both the officers and staff. What is more gratifying is that in response to the appeal, 5 officers and 40 members of the staff volunteered to donate their blood.

Extension of Use of Microwave Telecommunications in the U. S. A.

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

THE Western Union Telegraph Company of the U. S. A. started a microwave radio beam system between Chicago and Pittsburgh in 1956 and the new method of communication was scheduled for completion by April 1, 1958. This installation will be the world's first commercial microwave beam system and it commenced as an experimental project between New York and Philadelphia in 1945. A permanent installation connecting New York, Washington and Pittsburgh was completed in 1948.

The recently completed Chicago to Pittsburgh microwave system has an initial capacity of 48 voice bands and can accommodate 960 two way printing telegraph circuits simultaneously. On the 510 mile route between Pittsburgh, Cincinnati and Chicago, there are 20 repeaters spaced about 25 miles apart. The towers are of modern, light weight construction. Aluminium deflectors are used at the top aligned with "bowls" at the base. The receiving and transmitting equipment is housed at the base of the towers. This permits light weight construction of the towers which are guyed. In earlier installations the equipment was placed near the top of the towers which necessitated heavy construction. Another



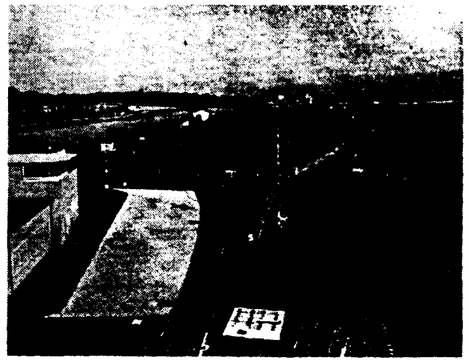
Transmitter – receiver saucer or dish used for microwave working.

Microwave – Reflecting dish or saucer at station.

project proposes the extension of this system from Chicago to St. Louis and Kansas City and also to Cleveland and Detroit. Another plan proposes extensions from Cleveland through Buffalo to New York.

This form of communication, which does not require any line wires at all, has recently been installed on the Southern Pacific Railroad of the U. S. A. The new project is expected to provide 100% service in all weathers and at the same time considerably reduce maintenance costs since over head line wires will not be required to be maintained. The project is in the vicinity of Mount Shasta (California) where heavy snow falls, up to 15 feet deep and winds of over 100 m. p. h. damage the line wires and poles every winter. The railway selected this place as a laboratory for testing out the new Microwave system and to determine if it would be feasible to carry out more extensive installation at other parts of the railway.

Microwave uses high frequency radio energy which is transmitted in a fixed direction on a line of sight basis rather than being broadcast in all directions as is the case with conventional radio. With microwave numerous different channels can be transmitted, and



General view of sorting sidings showing control tower on left.

received simultaneously so that many telephone conversations, telegraph messages and signalling control circuits can be handled. At the site selected, the railway is located in deep ravines and around mountains the distance involved being about 23 miles. The "Straight line" distance between the two stations concerned is about 15 miles but such a line would be through high mountains. The microwave, which is line of sight in open air, had to be directed up out of deep canyons and from point to point to negotiate mountains.

Starting at Dunsmuir, elevation 2235 feet, the beam goes up through a ravine 1.7 miles to a passive reflector on a mountain at 4,550 feet elevation. From this reflector, the beam is reflected at an angle of 78 degrees 45 mins. to a repeater station 7.9 miles away at Mount Shasta, elevation 3,550 feet. The direct path from this repeater station to the office at Black Butte is obstructed by a high, cone shaped mountain of volcanic cinders. To get around this mountain, the beam is directed from the repeater station, elevation 3,550 feet for 4.6 miles up to a second reflector on a mountainside at elevation 5,490 feet. From this reflector the beam goes on a direct path for 2.9 miles to the microwave terminal receiver-transmitter equipment at Black Butte Station elevation 3,900 feet which is the northern terminal of the microwave project.

In this microwave system the antennas are large metal "saucers" or "dishes". These are used at transmitter-receiver stations as a means of improving the direction and concentration of out-going "beams" and to assist in concentrating the incoming beam. The very high directivity and narrow beam width of microwave required that the "saucer" antennas and reflectors be mounted on framework or towers that have stability and resistance to deflection both laterally and horizontally.

At the repeater station at Mount Shasta there is a 100 ft. structural steel tower mounted on a suitable foundation and guyed three ways at two levels 42 ft. and 86 ft. Mounted at the top are two 10 ft. by 15 ft. reflectors which are actually almost flat, metallic sheets with a very slight concavity. Each of these reflectors is set at an angle to reflect incoming signals down to its 40 ins. diameter "saucer" fixed on the roof of the equipment house. Out-going signals are transmitted in the same manner but in the opposite direction leaving the tower reflector for the next location. The passive reflectors on the mountain ridges are identical in size and construction to those on the tower top at the repeating station except that, being on a high mountain ridge, it was only necessary to mount them 15 ft. above ground level so that the beam could not be obstructed by snowfall. The "saucers" are adjustable in two directions for beam adjustment.

At Dunsmuir the transmitter-receiver attenna is a "saucer" 10 ft. in diameter. Shortage of room at this place, due to railway tracks and the proximity of a street, meant that the "saucer" had to be mounted 30 ft. above ground level on a substantially constructed, unguyed street tower.

The basis microwave radio frequency equipment is the Motorola "Micro Package" type generally designated as model FSTM-30. The microwave radio frequency channels are frequency modulated with normal diviation of plus or minus 3 mc. In one direction the frequency is 6585 mc. between Dunsmuir

View of rail brakes or retarders.

View of operating panel for automatic marshalling of goods wagons.

and Mount Shasta station and 6745 between this station and Black Butte. In the other direction the frequency is 6625 mc. from Black Butte to Mount Shasta and 6705 mc. between Mount Shasta and Dunsmuir. The multiplexing equipment at present includes a base band order wire circuit manufactured by Motorola, and Lenkurt Type SSC carrier equipment supplied by Motorola as part of the system. The system of carrier multiplexing uses sub carrier channels approximately 5,000 cycles apart.

The microwave equipment is in duplicate at all three places. All microwave transmitters and receivers are equipped with comprehensive, fault finding circuits which initiate switch-over to standby equipment whenever a fault is detected. The present equipment has capacity for 120 channels which will ultimately be fully utilised for circuits essential to railway operation.

An interesting feature is the method adopted to counteract the effect of snow settling on the reflectors. These reflectors are fitted with electric heaters which are thermostatically controlled and come into operation when the temperature drops to 40 deg. F. The heaters on the 40 ins. reflectors are rated at 400 Watts and those on the 10 ft. reflectors at 1500 Watts.

This weather proof form of telecommunications has proved so successful that other railways in the U. S. A. have adopted it.

Even in countries where pole lines are not adversely affected by the weather, to any great extent, microwave means that construction and maintenance costs would be greatly reduced.

£ 2,500,000 INDIAN RAILWAY CONTRACT FOR BICC GROUP

The BICC Group has been awarded a contract by the Indian Railway Board for the design, supply and installation of 25 kV 50-cycle, single-phase A. C. overhead equipment. The approximate value of the contract, obtained against keen international competition, is £ 2,500,000 of which about 60% will be spent in Indian currency on locally manufactured materials and the local staff and labour costs, while about 40% will be in materials to be supplied from the United Kingdom.

The lines to be equipped are near Calcutta on the main line to Bombay on the South Eastern Railway; they lie between Tatanagar and Rourkela, together with the branch from Rajkharswan to Dongaposi. The length of track to be electrified is about 420 miles and the route links the iron ore fields in Bihar with the existing steel plant at Tatanagar and the new plant under construction at Rourkela.

The copper catenary and contact wire will, in most cases, be supported from steel masts by means of hinged cantilevers which allow along-track movement. The tension in the conductors will be kept constant by means of balance-weights, thus giving a level contact wire suitable for good current collection at high speeds.

The Indian Railways have decided to standardize their future electrifications on the 25 kV 50-cycle single phase A. C. system. Previously, lines in the Bombay district were equipped for 1,500-volt D. C. operation and in the Calcutta area lines were equipped for 3,000 volt D. C. operation. The overhead equipment for over 500 track miles of the lines in the Bombay area was designed, supplied and erected by the BICC Group who also supplied and installed the power and communications cables on the 3,000-volt D. C. system in the Calcutta area.

Work on the new contract is to begin immediately and is due to be completed in June 1960.

Electric Multiple-Unit Trains for the Calcutta Suburban System

THE suburban railway traffic between Calcutta and Burdwan which was inaugurated on December 14, 1957 by the Eastern Branch of the Indian Railways Administration has many interesting features.

The new system operates rolling stock supplied by German, British and Swiss engineering syndicates; this is made up of 64 triple unit trains and 4 spare motor coaches. Of these the West German syndicate manufactured 16 train units and one spare motor coach. Messrs. MAN Nurenberg built the mechanical engineering part, and AEG provided the electrical train equipment.

The triple train units are the first in India operated of 3000 volts D. C. All the units of each manufacture were specified to be capable of operating together in a multiple unit train.

GENERAL ENGINEERING DATA

The train comprises three short-coupled, self-contained units, the motor coach with a control trailer of each end. Up to three train units may be taken to make up a nine-unit train.

TECHNICAL FEATURES OF A MOTOR TRAIN UNIT

Track gauge	1676	mm
Length of vehicle, overall	20726	mm
Length of train unit	63398	mm
Width of vehicle, overall	3658	mm
Roof height above rail	3811	mm
Wheel base	3048	mm
Distance between king pins	14630	mm
Service weight of empty unit	120.5	tons
Number of traction motors	4	
One-hour rating of 4 motors	660	kW
Rate of acceleration of loaded train	0.54	m/s^2
Braking deceleration	0. 8	m/s^2
Top speed	100	km/h
Capacity of triple train unit, seating and standing 290 each	580	passengers
and in baggage room	41	
Capacity of 9-unit train, seating and standing 870 each	1740	passengers
and in baggage room	121	

The control trailer cab shows the driver's seat on the left, which in the seat cab is occupied by the guard. The motor coach has a driving position which is only manned during shunting, and houses the whole of the traction equipment. Braking is by compressed air.

ELECTRICAL EQUIPMENT

The four traction motors of the intermediate motor coach, Type US 8958 e, are self-ventilated, nose-suspended D. C. machines with helical gearing. The filtered cooling air for the motors is drawn from inside the coach. Two motors to one bogie are always connected in series, but are insulated against the full 3000 V contract wire voltage.

The data of each traction motor are :—

165 kW one-hour rating 125A
at 2900/2 V and 910 rav/min (90% excit.)
136 kW continuous rating, 104A
at 2900/2 V and 975 rev/min.

All high-voltage switchgear is housed in a divided-off H. V control compartment in the motor coach. A suitable door interlock to this compartment, together with an earthing isolator, prevent access until after the pantograph has been lowered and earthed. Then the H. V. switchgear will have been rendered dead.

Short-circuit protection for all H. V. circuits is by a "Gearapid" quick-acting D. C. circuit-breaker, specially designed to answer the demands of traction supply.

Trains are first set in motion by series-parallel switching of the two traction-motor groups, with bridge transition from series to parallel and motor field weakening in 2 steps. The arrangement of motor groups, disconnection of starting rheostats and motor field weakening are all effected by pneumatically

operated contractors. These are mutually interlocked to ensure a reliable switching sequence in every case. The starting current is monitored by a current-limit relay.

All the apparatus intended for the control and supervision of the traction motors is housed inside a common frame. The installation of apparatus in the H. V. compartment was greatly simplified by the supply of ready-equipped frames.

The starting rheostats are suspended from the carriage underframe. They are self-ventilating and composed of pins of chrome-nickel resistance steel to minimize the weight of the electrical equipment.

Each train unit is furnished with a single-casting machine set generating 110 volts from 3000 volts D. C. This m. g.-set is also underslung on the motor-coach frame. The motor output is 19 kW of 1550 rev/min. The generator is rated at 16 kW and supplies the control circuits, illumination and fans in the passenger departments, and the air-compressor set.

One m. g.-set is adequate in output for its own train unit, and supplies in addition the control of a 9-vehicle train and half the lighting and fan load of the train unit next to it.

The set works in parallel with a nickel-cadmium storage battery of Type StN 2316, having 72 cells with a 5-hours capacity of 155 Ah. This battery is capable of maintaining the supply to all circuits required for train operation over a period of 1½ hours.

Train illumination is by 110 V filament lamps. Should the contract-wire or the motor-generator supply fail, the battery-fed emergency lighting will automatically be switched in.

Ceiling fans for 110 volts D. C. are provided for ventilation of the passenger compartments and the drivers' stands.

All electrical apparatus is of particularly robust construction, in view of the exacting operating conditions, and is tropicalized to a high degree. As a safeguard against a tropical rain-forest atmosphere, for example, all L. V. and H. V. cables were given an additional neoprene protective sheath.

To make maintenance tasks easier, all individual apparatus and instruments are laid out to be readily accessible.

INDIAN TEAK PURCHASE MISSION

The Minister of Works, Housing and Supply, Shri K. C. Reddy, said in the Lok Sabha during question hour on September 22 that an Indian Teak Purchase Mission had visited Burma to negotiate the purchase of teak.

The members of the Mission were: (i) Shri V. N. Rajan, I. C. S., Director General of Supplies and Disposals; (ii) Shri H. D. Singh, Director, Ministry of Railways (Railway Board); (iii) Shri S. N. Ghosh, Deputy Secretary, Ministry of Finance (Supply Branch); (iv) Shri B. N. Swarup, I. A. S., Deputy Secretary, Ministry of Commerce & Industry; and (v) Shri V. Subramaniam, Deputy Director (Supplies), Directorate-General of Supplies and Disposals. The Mission also visited Thailand (Bangkok).

The Minister added that discussions were held by the team with the Burma State Timber Board for the supply of 15,000/20,000 tons of Burma Teak during 1958–59 to meet the requirements of the Railway Board and a provisional agreement reached, which awaited the final approval of the Burmese Government. The visit to Thailand was exploratory in character with a view to investigating additional sources of supply.

* * *

RAIL BUSES TO BE INTRODUCED

Shri S. V. Ramaswamy, Deputy Minister for Railways said in Coimbatore on November 7, 1958 that the Indian railways would introduce in large numbers "rail buses" to cover short distances and to meet the rather enormous road transport competition.

At least a dozen such "buses" would be made available in the Southern section and orders for them had already been placed with the Chittaranjan Workshops.

Shri Ramaswamy said that in the interest of economy, the Railways would use diesel engines as far as possible.

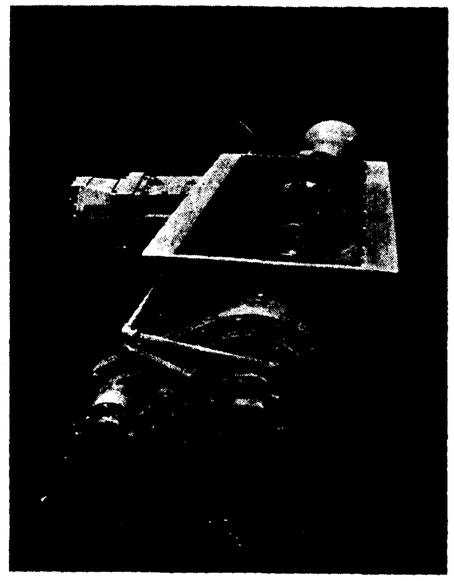
MECHANICAL STOKERS

Three B.R. 2–10–0 Class 9F Fitted

OVER the years railways have been confronted with the problem of increasing locomotive capacity and it is generally recognised that the power developed is limited by the physical effort of the fireman. Mechanical firing has received attention over a considerable period of time and has resulted in the development of several types of mechanical stoker. The fitting of stokers to locomotives is not necessarily dependent upon the size of grate but aims at obtaining maximum output from the boiler at all times regardless of the working of the locomotive and quality of fuel.

The Berkley stoker, which includes a number of novel features that have proved successful in operation in other countries, is not automatic and has to be intelligently controlled for efficient operation. It does, however, relieve the fireman of heavy physical labour. Three British Railways standard 2—10—0 Class 9 freight locomotives Nos. 92165, 92166 and 92167 recently constructed at the Crewe works of the London Midland Region have been fitted with Berkley stokers under the direction of Mr. R. C. Bond, chief mechanical engineer, British Railways Central Staff.

Footplate of Class 9F locomotive fitted with Berkley Stoker, showing the riser conduit and screw with its joint for connection to the intermediate screw. On the right are the cocks controlling the steam jets which distribute the coal in the firebox.



The tender conveyor unit, showing trough, conveyor screw, crusher, and gearbox. The stoker engine can be seen on the left.

LAYOUT

The stoker as fitted to these locomotives consists of four main units, the engine or power unit, tender conveyor unit, intermediate conduit and riser conduit. The engine, which is mounted on the tender front dragbox, provides the necessary power under all conditions to supply coal to the firebox, and can be throttled down to furnish the coal as sparingly and continuously as required. It is possible to work the engine in reverse in case of a blockage in the stoker mechanism.

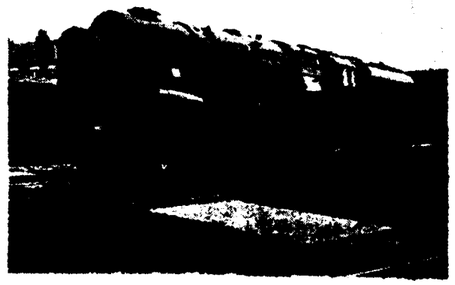
The tender conveyor unit consists of a trough, conveyor screw, crusher and gearbox. The trough is located below the coal bunker and is mounted on rollers to take care of the movement between engine and tender. The power from the engine unit is transmitted to the gearbox mounted at the rear of the conveyor unit by means of a slip shaft with universal joints. The gearbox transmits motion to the conveyor screw, which carries coal from the bunker through the crusher, where it is broken down to the correct size and is then fed into the intermediate conduit.

The intermediate conduit includes a conveyor screw enclosed in a conduit or casing, which is connected to the riser by a special ball joint. The riser conduit, which extends upward through the footplate and is secured to the back of the firebox, includes a further conveyor screw which is connected to the intermediate screw by means of a universal joint. The riser screw has a reverse flight at the extreme end and this results in the coal being levelled down and spread out prior to delivery into the firebox, thus ensuring a uniform delivery of coal over the distributor plate fitted above the hooded jet plate, and located at the underside of the firehole.

The jet plate fits in the lower portion of the mouth of the riser conduit and means are provided for easy adjustment to the proper firing angularity. The front of the jet plate has hoods above the jet orifices which allow divergence of the steam jet before meeting the coal, thus ensuring efficient distribution over the grate. The jet plate is divided into four compartments, each controlled by a separate valve located in the jet manifold and marked to indicate which section of jets the valve controls, i e. left front, right front, left back and right back.

PRESSURE GAUGES

Pressure gauges are located on a panel in the cab. In the case of the right- and left-hand gauges the black hand indicates jet pressure for the back corners and the red hand indicates jet pressure for the front of the firebox. The centre gauge shows the stoker engine



B.R. 2-10-0 Class 9F locomotive fitted with Berkley Stoker and double chimney.

pressure. The jet casting is protected from the heat of the fire by a protecting apron held in place by a removable pin.

With this form of stoker it is possible to adjust independently the coal feed and the steam jet pressures and thus obtain an even distribution of coal in the firebox under all conditions. It is possible to fire the locomotive by hand in case of failure of the stoker or when it is necessary to correct the firebed after removal of clinker, etc., and also when working the locomotive on comparatively short journeys where time would be insufficient to allow correct setting of the coal feed and jet pressures of the stoker. The three engines have been provided with double chimneys and trials will be run to determine to what extent their hauling capacity can be increased by these means. They will be based on Saltley motive power depot. The possibility of fitting mechanical stokers to other Class 9F 2—10—0 locomotives will depend on the results of the trials.

RESEARCH PROMISES BETTER RAILWAY TRANSPORTATION

What looks like a part of a textile mill is really a part of a General Electric Company (U. S. A.) study of glass reinforced plastics for use in the electrical systems of modern railway locomotives. The study is being conducted at G-E's Locomotive and Car Equipment Department in Erie, Pennsylvania. Strands of pure glass are being passed through a locater screen before they are dipped in resin. The locater screen collects and bundles the individual strands together. After they are impregnated in resin and baked in special ovens, the glass strands will be stronger than steel bands of the same weight. According to G-E engineers, the results of this study will be used to develop better locomotive motors and generators.

Comeng Railcars' Spectacular Indian Record

1360 Mile Run is World's Longest

SIX of the twenty-four 5'—6" Diesel Railcars recently supplied by Comeng to the Indian Railways ran under their own power from Madras to New Delhi, 1360 miles, on 21st September last. The entire trip was covered in one hop, only brief halts being made for re-fuelling and train examination.

The twenty-four cars have been divided equally between the Southern and Northern Railways. The Southern Railway cars are based at Cocanada, 400 miles north of Madras on a branch from the Madras-Calcutta main line. These railcars have been in revenue traffic since April 30th.

The second twelve cars, although destined for New Delhi on the Northern Railway, were also unloaded at Madras Harbour and towed 6 miles to the Southern Railway Carriage Works at Perambur for preparation and testing.

The railcars are fitted with the 3-pipe Westinghouse Air Brake System. Since the Indian Railways standard brake is vacuum and the Madras to Delhi line includes several heavy hill (" ghat ") sections, the railcars could not be hauled unbraked by steam locomotives. The decision was therefore taken to run them in two 6-car trains under their own power. Diesel stock had never previously run over much of the route, so special arrangements were made for fuelling from drums along the line.

The cars were prepared in Perambur Works and a trial 6-car set was run to Trivellore, 18 miles and back, approximately one week before the Delhi departure. Following this, one railcar was sent to the Stores Yard at Perambur, to be loaded with all portable spare parts shipped to Madras and destined for the Northern Railway Depot at New Delhi.

In order to provide living and dining accommodation on route for the Engineers accompanying the train, a saloon coach was incorporated in the diesel rake. This car was fitted with the usual vacuum brakes on normal steam stock, and was therefore temporarily piped for automatic emergency air brake and marshalled between the fifth and sixth railcars, thereby providing continuous automatic air brakes throughout the train and consequent safety in the event of a coupling parting. The sixth, or last, railcar's engines were in operation in order to compress air for braking, but their transmissions were isolated, because the saloon was not fitted with multiple unit train control wires. The train was thus operated, to all intents and purposes, as a five car diesel set pulling two trailers. The all-up weight of the seven-car train was approximately 330 tons and the power available for traction, 2,000 H. P. The rake was run trailing-end-first over the four miles from Perambur Works to Rayapuram Terminus, Madras, where all fuel and water tanks were topped up and the entire train washed and polished. A special headboard featuring the Australian Map was carried on the front railcar.

The railcar set left Madras at 2-00 p. m. on Sunday 21st September, running on a special path to the timing of the Madras-New Delhi Deluxe Janata Express, the fastest train on the Madras-Delhi run. The booked speed was 55 m. p. h. The normal Grand Trunk route was followed via Vijayawada, Kazipet (reverse), Balharshah, Wardha (reverse), Nagpur, Bhopal, Jhansi, Itrasi, Gwalior and Agra to New Delhi. The first fuelling point was Vijayawada, 268 miles from Madras. The railcars were refuelled by Burmah-Shell staff from 44 gallon barrel by means of hand pumps. At this station the southern Railway staff handed over to Central men for the rest of the journey to New Delhi.

The next fuelling point was Warangal, 136 miles on, where all tanks were manually topped-up from 4 gallon tins for the long run to Nagpur. At Kazipet, 4 miles past Warangal, the train was halted for reversal. This operation was greatly simplified by running the first four railcars around the railcar-saloon-railcar set, and cutting the transmission of the diesel on each side of the saloon in or out as required. The Kazipet-Wardha section had been cut at several points and severely damaged at many others due to flooding the previous month. Because of Engineering Department speed restrictions some time was lost on this section. From Wardha to Nagpur, the Delhi route is over the main East-West Bombay-Calcutta Line. Since this is double-track, advantage was therefore taken to run at speeds up to 70 m. p. h. and make up time lost on the previous section. At Nagpur, the railcars were refuelled from the Central

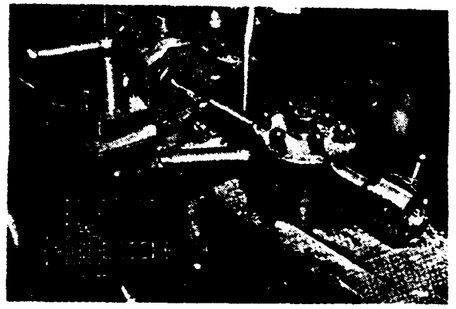


Fig. 3 Tooling arrangement on a Herbert No. 1 Capstan Lathe for the production of adjustable valve plungers, in one operation, from brass bar.
The thread diameter is turned with a special shell-type cutter carried on the turret and the head is formed, in one cut, from the rear toolpost on the cross slide. A Coventry Style C.H.S. Diehead is used to cut the 2 B.A. thread.

Fig. 4. Banjo bolts are produced on a Herbert No. 2D Capstan Lathe from hexagon mild-steel bar. The machine is fitted with a hand-operated dead length bar chuck which imparts no end movement to the work when the chuck is closed and enables the full capacity of the machine spindle to be used.
All the external diameters are produced by a single form tool held in the rear toolpost. The component is then centred, drilled and threaded from the hexagon turret and parted-off from the square turret.

The cable, one end of which is anchored, passes over two sets of sheaves. One set is fixed in the centre of the hoist and the other set is carried by twin piston rods which pass either side of the fixed sheaves.

When one trigger of the control valve is depressed, compressed air enters the cylinder and forces the piston towards the centre of the hoist, thereby pushing the sheaves carried by the piston rods away from the fixed set of sheaves at the centre. This separation of the two sets of sheaves causes the cable to be drawn into the cylinder a distance equal to the piston stroke multiplied by the number of sheaves employed.

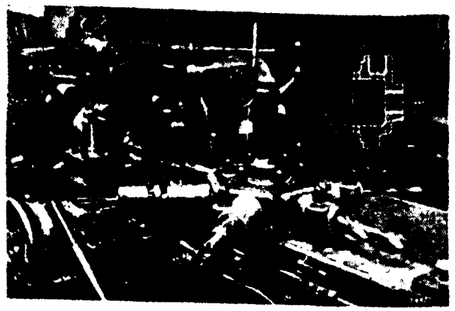


Fig. 5. A Herbert No. 4 Capstan Lathe, fitted with a Pratt Independent 4-jaw chuck, is used to machine gun-metal end covers as indicated by heavy lines on the drawing.
The two bores are machined from the hexagon turret, the $\frac{3}{4}$" B.S.F. thread being cut with a Herbert Ground-thread tap held in a Herbert Tap and Die Holder as shown. The three front faces are machined with tools held in the square turret and the 3" diameter spigot is size turned from the hexagon turret with a tool held in a standard knee turning tool holder. Herbert light-alloy tool holders are used throughout, thereby reducing fatigue and lessening wear on turret indexing and locating mechanisms.

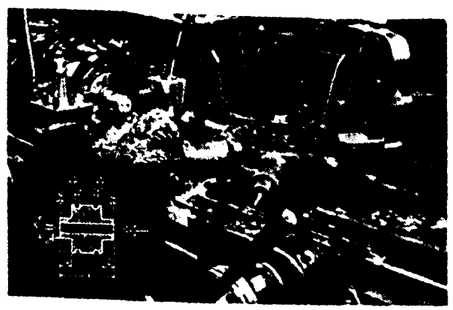


Fig. 6. Pistons for the $1\frac{1}{4}$" cushion-type air cylinders are produced from aluminium bar, in one operation, on a Herbert No. 4 Capstan Lathe with a hand-operated dead-length bar chuck.
A roller-bearing live centre, mounted in a standard knee turning tool holder, supports the work while the two $\frac{3}{4}$" diameter bosses and the 0.174" wide grooves are formed from the cross slide. The $\frac{3}{4}$" diameter is drilled, bored and reamed from the hexagon turret and a tool held in a standard knee turning tool holder is used to size turn the O.D. The reamer is mounted in a standard Herbert floating reamer holder as shown.
The finished component is parted-off from the square turret.

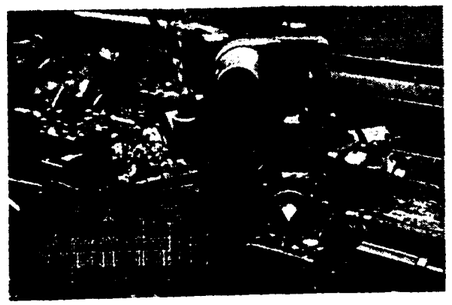


Fig. 7. The drawing shows the general outline and principal dimensions of the piston for the $\frac{1}{2}$" universal, 3-way valve. These are produced, in one operation, on a Herbert No. 4 Capstan Lathe with hand-operated dead-length bar chuck. Material used is duralumin bar.
The external diameters are simultaneously machined with a form tool held in the rear tool post on the cross slide, the work being supported during this operation by a live centre mounted on the turret. Herbert live centres employ taper roller bearings, an essential when supporting work involving high speeds and sustained heavy loading. Parting-off is performed from the square turret.

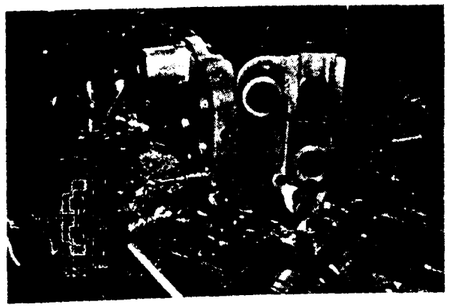
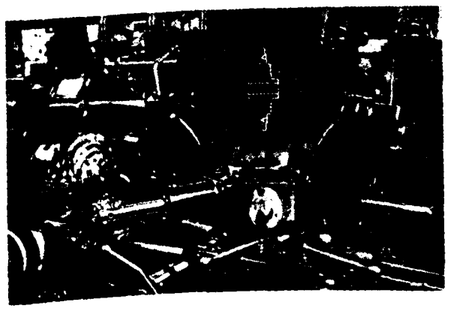


Fig. 8. Tooling arrangement on a Herbert No. 4 Capstan Lathe for performing the first operation on the diaphragm holder shown in the drawing. Material—duralumin blanks sawn from the bar.
The 2" and $\frac{5}{16}$" diameters are rough and finish machined from the hexagon turret; all other machining is performed from the cross slide.



←Fig. 11. First operation on the piston for the 10" cushion-type air cylinder. The machine is a Herbert No 7 Preoptive Combination Turret Lathe fitted with a 3-jaw chuck.
All external diameters, with the exception of the $2\frac{3}{8}$" diameter boss which is size turned from the turret, are rough and finish machined from the cross slide. The $1\frac{1}{4}$" diameter is centered, drilled, bored and reamed to size with tools held on the turret.

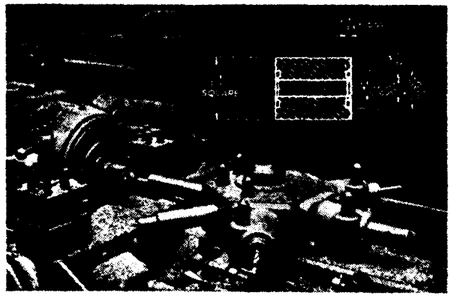


Fig. 9. Square, hard brass bar is used for the production of the valve body shown. The machine is a Herbert No.4 Capstan Lathe fitted with a hand-operated dead-length bar chuck.
Tools arranged around the hexagon turret enable the following operations to be performed: Feed out to stop, centre end, drill through, form recess, bore and ream $\frac{3}{8}$" diameter to size.
The front face is then machined from the square turret and the component parted-off from the rear toolpost.

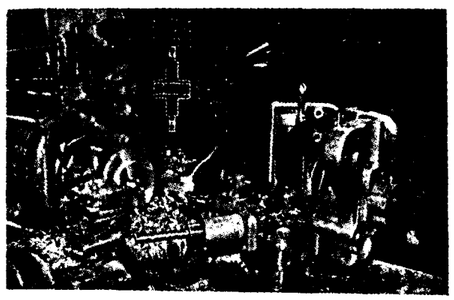


Fig. 10. First operation on the piston for the 8" cushion-type air cylinder. The machine is a Herbert No. 4 Senior Capstan Lathe fitted with a 3-jaw chuck.
All external diameters, with the exception of the $1\frac{3}{4}$" diameter boss which is size turned from the turret, are rough and finish machined from the cross slide. The 1" diameter is centred, drilled, bored and reamed to size with tools held on the first four faces of the turret. Light-alloy tool holders are used throughout and the Coventry Adjustable Reamer is mounted in a Herbert floating reamer holder.

Fig. 12. Herbert Type-B Drilling Machine set up to drill a total of 480 holes around the periphery of two $1\frac{3}{16}$" diameter grooves in an air control valve.
The holes are 0.035" diameter and arranged in eight rows, four rows in each groove. Each row consists of 60 equally-spaced holes.

Fig. 14. Tooling arrangement for the second operation on the piston for a $3\frac{1}{2}$" air cylinder. The machine is a Herbert No. 4 Capstan Lathe and the component is gripped on the previously machined flange diameter.
The 2.264" and $1\frac{1}{4}$" diameters are rough machined simultaneously with tools held in a special multi-tool holder on the first turret face. The 2.264" diameter is finish formed from the rear toolpost, the $1\frac{1}{4}$" diameter is finish turned from the hexagon turret.

Fig. 13. Herbert No. 4 Capstan lathe equipped with a special face plate for size boring and facing operations on the aluminium end covers for the 6" air cylinder.
The face plate is bolted direct to the spindle flange in place of a chuck.

Depression of the other trigger allows the air to exhaust from the cylinder, the piston to return and the cable to run out lowering the load. The speed of operation depends on the amount the triggers are depressed.

Over 40 Herbert machines have been installed by the Hurst, Curzons Company for the manufacture of component parts for Martonair Cylinders and Control Valves. These include two No. 1 Capstan Lathes, seven No. 2D Capstan Lathes, eighteen No. 4 Capstan Lathes, one No. 4 Senior Capstan Lathe, one No. 7 Preoptive Combination Turret Lathe and a battery of drilling machines of various types and sizes.

Glossary of Terms Relating to Welding and Cutting of Metals

In the course of recent years considerable developments have been made in the application of welding technique. This has resulted in an increase in the number of terms used, necessitating standardization of terminology on more exact basis, so as to avoid ambiguity and confusion arising out of misinterpretation of terms. With a view to define the terms relating to welding and cutting of the metals, the ISI has published an Indian Standard Glossary of Terms Relating to Welding and Cutting of Metals (IS : 812-1957). It is hoped that this standard glossary of terms will help in fixing a more precise meaning to words which, because of their convenience, have acquired too general a significance.

In a number of cases information is available where more than one term is being used for the same purpose. Such alternate terms have been grouped together. The terms given first are recommended for use and the use of terms given in brackets is deprecated.

Methods of Improving Utilization of Motive Power

By G. T. Bevan
Locomotive & Car Equipment Department, General Electric Company (U.S.A.)
Erie, Pennsylvania.

THE greatest single contribution to the economic operation of the world's railroads during the past half century has been the development of the diesel-electric locomotive.

In the diesel-electric locomotive, railroads have available a motive power unit with inherently different characteristics than those possessed by the reciprocating steam engine. However, these advantageous characteristics must be thoroughly understood and fully utilized in order to realize maximum benefits from dieselization.

To begin with, the combination of the diesel engine and the traction generator makes constant horsepower available over a wide range of locomotive speeds. This means hauling more profitable pay loads at higher speed. This can prove so beneficial in actual operation that it permits a new approach to the problem of locomotive dispatching. Many railroads switching to diesel-electrics have found that they can double the annual locomotive mileage formerly obtained with steam engines.

This increased mileage, plus the ability of diesel-electrics to produce more gross ton miles per train hour, can lead to a reduction in the number of motive power units in service. This will, of course, lower operating costs. The net result is that diesel-electric locomotives can do one-third more work per day at approximately one-half the cost of steam locomotives for the same operation.

FULL UTILIZATION IMPORTANT

Statistics show that 50 percent of all railroad operating costs revolve around the utilization and maintenance of locomotives. Moreover, the characteristics of the motive-power in use have a large influence on the amount of rolling stock, and the number of tracks, yards and terminals required. In fact, to a large degree the entire economic life of the railroad industry depends upon the type and number of motive power units it uses in conducting its business.

In the early stages of dieselization little effort is generally required to obtain relatively high motive power utilization. Operating advantages and savings are so attractive that the diesel-electrics are worked to the fullest possible extent. Practically any assignment where these new locomotives are in use 24 hours per day shows their economic advantage over steam.

As dieselization progresses this picture changes. The new motive power can no longer be assigned exclusively to 24-hour duty; therefore, its economic advantage over the steam locomotive becomes less marked. Evidently means must be found to increase motive power utilization if the diesel-electric is to continue replacing the steam engine with the same economic results.

Motive power utilization has been greatly simplified with the recent introduction of the "universal" or road-switcher type locomotive. The construction and operating characteristics of this locomotive have been deliberately selected to make it capable of performing all three types of service: freight, passenger and switching. Operating experience in several countries has already demonstrated its success.

In addition to its flexibility, the "universal" design has other economic advantages. The initial cost of this type of locomotive is approximately 12 per cent lower than that of the road type, or commonly called "box cab" type diesel locomotive, of comparable horsepower. Maintenance costs are also lower, often by 10 to 15 percent

NEW CONCEPT NEEDED

At the outset, this new form of motive power has been generally regarded simply as a substitute for the steam locomotive. This has necessarily limited the development of the diesel-electric's potential capabilities. In many instances division terminals and territories set up for steam locomotive operation are still in use. Consequently, there is some danger that the superior performance of the diesel-electric may be hampered by boundaries established earlier to meet the limitations of steam locomotives.

The entire scheme of railroad operations—including yard and terminal facilities, track capacities, and methods of train dispatching—should be analyzed to

determine its suitability for diesel-electric operation. Only as this new type of locomotive is freed from the shackles of the steam locomotive's limitations can its potential capabilities be fully realized in terms of productivity and earning capacity.

With the advent of the "universal" or road-switcher type of locomotive, railroads have a motive power tool with which they can do a highly efficient job. Units of this type can be held in locomotive "pools", available for any service as required. For example, a single 1500-hp. road switcher locomotive unit can be used to replace a 1000-hp. yard switcher or a 1500-hp. road freight locomotive main line service, through the simple expedient of pooling the assignments and planning a cycle of operation with the purpose of using one locomotive for both jobs. Experience has indicated that, where operating conditions permit, greater motive power utilization can be obtained by operating a "pool" of road-switcher or "universal" type locomotives for all classes of service.

These economies can be further improved by arranging locomotive assignments so that all units operate on a cycle basis. Under this system, locomotives return to a common maintenance point for inspection and repairs after completing their tours of duty. The length of time and mileage they cover between inspections is determined by a routine schedule worked out by the operating department. In arranging such schedules an effort should be made to make sure that all units accumulate approximately the same mileage between inspections.

Under such a system, a locomotive might spend three days covering the thousand miles between points A and B and back. After the first thousand miles, it would be inspected. It would then spend three more days covering the thousand miles between point B and C and back. It would then be inspected and so on cycling back and forth through point B, the maintenance station. During its two three day runs on either side of point B, it would be regularly scheduled for various duties which can include passenger, freight and switching service.

This type of operation has several advantages. One of the most important has to do with terminal layovers. When locomotives are operated on a cycle system with maintenance being done at a central point, it is possible for them to be ready for reassignment to other duties in as little as ten minutes after arrival at a terminal. This means that fewer locomotives are required. Consequently, not only is the rate of return on total motive power investment higher, but operating expenses are reduced because there are fewer locomotives to maintain.

The cycle operation with its common maintenance point has resulted in a new concept of locomotive maintenance: centralized inspection and repair. This can result in further operation economies through the discontinuance of steam engine houses and associated facilities no longer required.

Utilization of locomotives is a phase of railroading that is now being recognized as a major component of economical operation. The high availability of the diesel-electric has permitted utilization that was not practical even with modern steam locomotives.

The difference between the terms availability and utilization as used of locomotives, can be seen from their definitions. Availability is the time a locomotive is available for service, expressed as a percentage of total time. For example, if a locomotive is in the shop for inspection and repairs two hours out of twenty-four, the availability is $\frac{24-2}{24}$ or 92 percent. The availability of diesel-electric varies from 86 to 95 percent. Utilization is the time a locomotive is actually in operation, expressed as a percentage of total time. For example, a locomotive is assigned to switching duty for 8 hours and then to road service for 12 hours. It is in use 20 hours out of 24, therefore, the utilization is $\frac{20}{24}$ or 83.2 percent.

One thing affecting locomotive utilization is non-revenue service. Needless to say, this should be kept to a minimum. Wherever possible, the units should be scheduled to work in revenue service when travelling to and from maintenance points. The use of diesel-electric locomotives on work trains should be avoided except in cases of absolute necessity. Maximum use should be made of off-track equipment, thus reducing the need for work trains.

High locomotive utilization is not necessarily limited to the large transcontinental railroads of the United States, which enjoy exceptionally long-haul traffic. In fact, many smaller railroads with short hauls have done an outstanding job in this respect, sometimes operating diesel-electrics over five times the daily average mileage formerly run by steam.

CONCLUSION

The combination of higher locomotive utilization resulting from the pooling and cycling of motive power, plus the centralizing of maintenance has proved to be a most effective tool. As it is intelligently applied, it will serve to bring out the potential capabilities of the diesel-electric locomotive, resulting in a corresponding improvement in efficiency and economy of operation.

STANDARDIZATION FOR SAVING STEEL

A session on Steel Economy was held as a part of the fourth Indian Standards Convention, in New Delhi. In the absence of Sir Jehangir Ghandy of Tata Iron & Steel Co. Ltd., Jamshedpur, Shri S. L. Kumar of Indian Railways presided over this session, which was attended by about 250 delegates. Six technical papers dealing with the various aspects of achieving steel economy came up for discussion which was lively and interesting. The work so far done by the Indian Standards Institution in formulating Indian Standards for saving steel drew a lot of appreciation from the delegates. Apart from the suggestion to use alternative types of constructions with re-inforced cement concrete, the use of pre-stressed concrete was advocated. It was suggested that timber could be used to a large extent in structures. The delegates from the Forest Research Institute, Dehra Dun pointed out that instead of 3 or 4 conventional types of timber now used in the country, 89 species of timber could be used in all types of structures with spans ranging from 8 ft. to 300 ft. after proper treatment of the timber and by using improved methods of jointing. It was suggested that the sale of so called untested steel should be discouraged and as far as possible work tested and certified steel only should be put on the market. The advantages, limitations and economy of steel in the use of steel tubes and lightgauge sections in structures were brought out. Improved types of re-inforcement such as deformed and cold twisted bars for use with cement concrete were suggested. The advantages of welding instead of riveting in saving steel were enumerated and it was suggested that only trained welders should be encouraged for all welding work. It was also stressed that more and more schools for training of welders should be started and the newly published Indian Standard Specifications and Codes of Practice in the field of welding should form a part of the education curricula of the various technical Institutions in the country. Considerable stress was also laid on the need for adopting the new Indian Standards, both in the public and private sectors of the Industry to effect the desired wide spread economy in the production and utilisation of steel.

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

(Continued from IRE; October 1958—Vol. 6 No. 2)

[III]

PATTERN SHOP

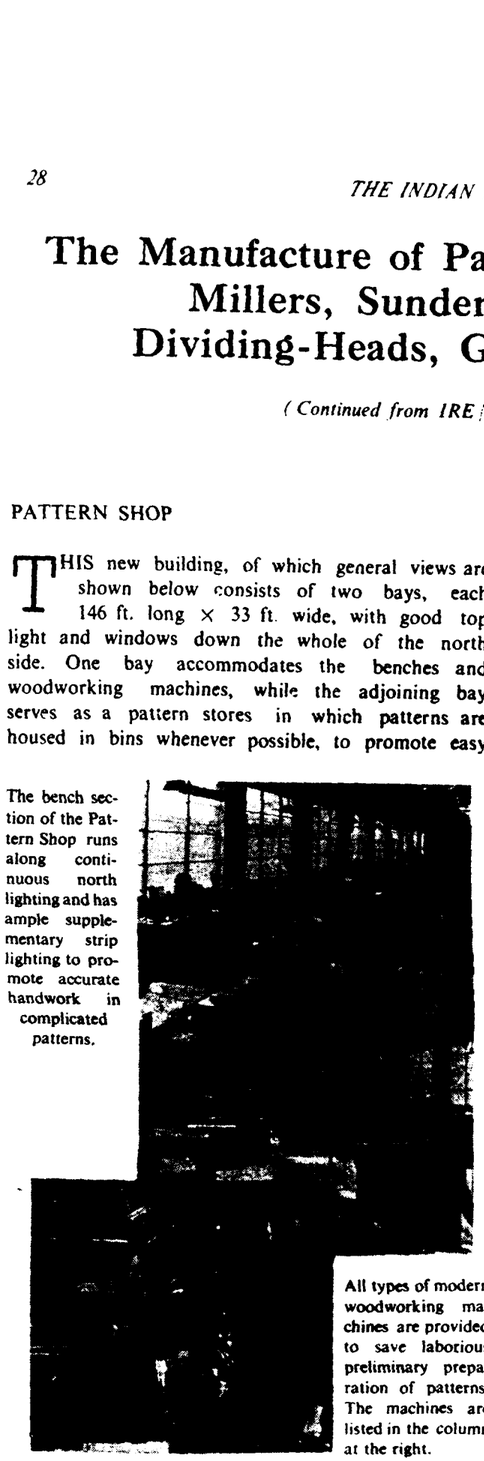
THIS new building, of which general views are shown below consists of two bays, each 146 ft. long × 33 ft. wide, with good top light and windows down the whole of the north side. One bay accommodates the benches and woodworking machines, while the adjoining bay serves as a pattern stores in which patterns are housed in bins whenever possible, to promote easy accessibility with the minimum of time spent in finding any pattern when it is required.

High quality patterns only are made, close liaison being maintained with the foundry staff with a view to establishing the most simple and practical coremaking and moulding for each job. Pattern plates are used wherever possible and the positions of gates, risers, etc., clearly marked to promote foundry production.

Equipment is the usual type of woodworking machinery consisting of modern and new machines by such leading makers as Wadkin Ltd., J. Sagar & Co., Thos. White & Sons. This includes a Wadkin junior pattern miller, disc sander, pattern shop drill, electric-head mortising machine, canting-head dimension saw, planing and thicknessing machine, band saw, circular saw, tool sharpener and patternmakers' lathes.

A most useful addition recently installed is a Parkson 'Adapta' miller which is used extensively for machining metal patterns. This machine, has a swivelling cutter head which may be firmly clamped at any angle between vertical and horizontal. Moreover, by means of a sub-head attached to the swivelling cutte head, the cutter spindle may be swivelled through a complete circle around the cutter head axis and an almost infinite variety of cuts taken with such simple cutters as right angle end mills.

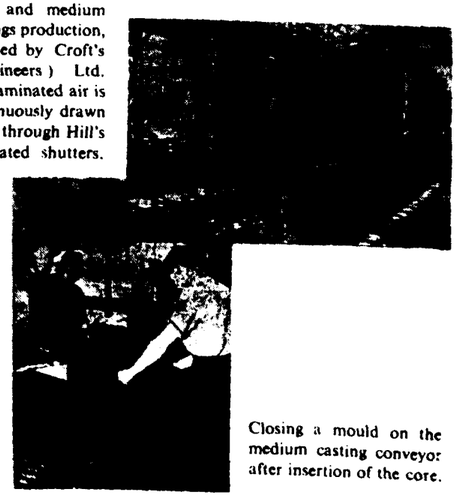
The bench section of the Pattern Shop runs along continuous north lighting and has ample supplementary strip lighting to promote accurate handwork in complicated patterns.



All types of modern woodworking machines are provided to save laborious preliminary preparation of patterns. The machines are listed in the column at the right.

End milling an awkward corner of a cast-iron pattern on a Parkson "Adapta" miller, a machine that accomplishes most intricate operations.

Mechanised bay for light and medium castings production, planned by Croft's (Engineers) Ltd. Contaminated air is continuously drawn away through Hill's ventilated shutters.



Closing a mould on the medium casting conveyor after insertion of the core.

FOUNDRY

From the accompanying illustrations it will be seen that the foundry is a clean structure having abundant natural top lighting. This is due mainly to the fact that the building is unusually tall, having roof glazing fitted with Hill's ventilated shutters. The latter, by daily adjustment to suit prevailing weather conditions, effectively clear the foundry air of fumes, dust and heat.

One section of the floor is reserved for hand moulding for the larger machine castings, while the remainder—a lofty bay 130 ft. long × 60 ft. wide—has been planned and equipped for mechanised medium and light casting production by Crofts (Engineers) Ltd., the parent company. The two conveyor tracks (one for small and the other for medium moulding boxes) which are seen in the general view, are both served by easy-working mono-rail systems. Each track has two Coleman-Wallwork moulding machines at the loading points, one producing the top halves and one the bottom halves of the moulds. When the two halves come together the cores are inserted, and the halves closed and clamped.

Light casting conveyor loading point with Coleman-Wallwork moulding machine and transportable sand hopper.

Metal pouring is facilitated by the use of rack-and-pinion hoisting mechanism and lidded ladles which minimise glare besides conserving heat.

The conveyor tracks are used for vise parts and such machine tool parts whose quantities justify the making of pattern plates. In many cases, of course, the pattern plates carry several patterns of the same component for repetition moulding in one box. Controlled pouring of molten metal is obtained by the use of covered ladles suspended from mono-rails on ball-bearing trolleys. The ladles are fitted with rack-and-pinion hoisting machanism so that the pouring height can be adjusted to suit individual moulds.

A sand reclamation and conditioning plant has been installed, conveying sand direct to the moulding machines on the larger track by conveyor belts. A swinging arm carrying a conveyor belt feeds the sand to the large moulding boxes sited on the bumping or jolting machines. It also feeds sand to fill transportable sand hoppers for the moulding machines on the smaller track.

Excellent changing and bathing facilities are provided in completely tiled rooms, so that men before leaving the works can shed all evidence of their occupation and be ready for their normal evening recreation without having to travel home in their working clothes.

GENERAL MACHINE SHOP

Except in the smaller sizes, bar steel is fed to the machine shop from storage racks. Small diameter material is stacked in pigeon-hole racks or stand vertically, while the larger sizes are laid horizontally as shown in the illustration, each size and quality in vertical channels which are adjustable for width to suit particular sizes. The bars then lie on top of one another with little pressure against the vertical guides which determine the widths of the channels. As the channels are open at the top, bars of any

A workshop projector and a Cousin's thread measuring machine are installed to check the accuracy of work produced in this section.

A Whirlmatic Thread-Whirling machine with CO_2 cooling equipment has recently been installed and experiments are taking place to ensure full benefit from this modern method of cutting screws.

The type L3 whirling head, which has a cutting capacity up to 4 in. dia., runs at up to 1,200 r. p. m. and work speed is infinitely variable. A fully automatic working cycle makes the machine specially useful for batch production and the bed is long enough to accommodate between centres the longest screw in regular use. Liquid CO_2 cooling is employed to prolong tool life and to minimise pitch errors. The leadscrew of the machine has been corrected to very close limits.

PLAIN GRINDING

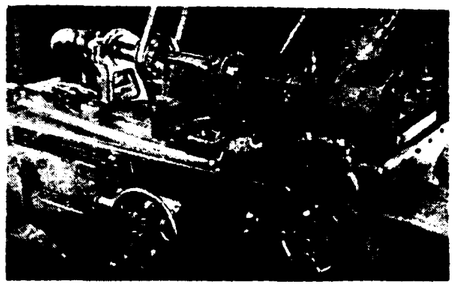
As described later in this article of the Parkinson works, a number of departments have their own special grinding facilities; but there is also a section of the general machine shop which handles most of the external and internal plain cylindrical grinding, having having for this purpose a number of machines by Brown & Sharpe, Churchill and some special purpose grinders of Parkinson design and make.

The largest machine in the section is the 14 in. swing × 96 in. Churchill Model C plain grinder. This heavy grinder is used for all the longer shafts needed for milling machine tables and gear planers, a task for which it is well suited by virtue of its inherent operational stability.

For the repetition grinding of gears a 12 in. swing Churchill Model HB7 plain internal grinder has been installed. This machine is equipped so that bores and internal or external faces can be ground at the same setting, and the workhead has swivel adjustment for grinding taper bores. Micrometer adjustment to the wheel timing device is a great asset in long runs of repetition precision work.

Recent additions to the plant include plain grinders of 10 in. swing × 18 in. to 10 in. swing × 40 in. capacity.

The need for the highest degree of concentricity between the external diameters and the internal bores of spindles for Parkson milling machines and milling attachments, and Sunderland gear planers, prompted the Company some years ago to design and build two special internal grinders in which the spindles to be ground could be mounted and driven in a manner similar to that in which they function in their respective machines. One of these grinders is illustrated below set up for a batch of miller sub-head



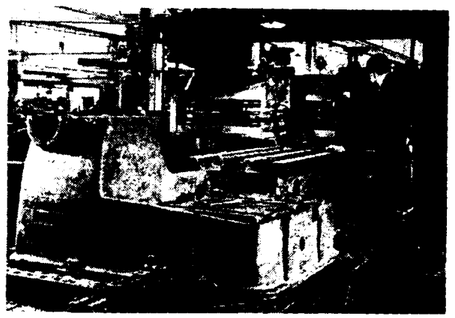
In this set-up for internal taper grinding of a miller sub-head spindle it will be noted that the spindle is mounted and driven in a manner similar to that in which it will have to function on its machine. The grinder is a special machine designed and built by Parkinson for hollow work requiring the highest degree of concentricity.

splined spindles, the work-table being swung over to give the appropriate taper of the nose bore. A flexible metallic pipe is attached to the far end of the spindle to carry dust to a dust extractor at the rear of the machine.

PLANING

With the exception of the recent addition of a 26 in. stroke Butler Super Shaper, the equipment and layout of the planing section have remained substantially unaltered for some years. This is because the importance of planing as a first operation for many cast components of machine tools had long been recognised and steps were taken to ensure the accuracy needed, coupled with speed of output and ease in operation.

The largest machine for width and height capacity is the 15 ft. × 6½ ft. × 5½ ft. Butler Spiral-Electric planer shown on next page being set up for dual planing the ways of a No. 19 Sunderland gear planer bed. Another machine much used for the larger gear planer castings is a 13 ft. × 6 ft. × 4 ft. openside planer, while the 17 ft. × 40 in. × 40 in. Stirk machine is a tandem-table model reserved primarily for milling machine columns. An interesting point about the set-up of the 12 ft. × 3½ ft. × 3½ ft. Butler planer



Machining the slideways of a No. 19 Sunderland Gear Planer bed on a 15 ft. × 6½ ft. × 5½ ft. Butler Spiral-Electric Planer using both toolboxes on the cross-slide.

These saddle plates while serving their main purpose of providing ample clamping facilities by their numerous cast bolt-holes, also protect the planer bed from damage.

Installed recently with the large planers is the 10 ft. × 5 ft. × 5 ft. Kendall & Gent plano-miller. The quantities needed of this and other components have justified the making of a special rotary fixture for supporting the work so that a number of faces in different planes can be machined without resetting. The fixture, consists essentially of a fixed base which carries interchangeable automatically-indexed revolving tables to which the work is changed. As many of the castings machined on the fixture are heavy, the weight of the table and the work is taken by compressed air while the table is easily swivelled about a central pivot from one machining position to the next. This Kendall & Gent plano-miller is fully engaged on milling machine columns, knee brackets and similar parts.

GEAR CUTTING AND GEAR GRINDING

With the exception of spiral bevels and certain wormwheels, all the gears required for the building of both milling machines and gear planers are cut in this department. Most of the gear-cutting machines installed are Sunderland gear planers, a No. 23 and a No. 25 being used for cutting double-helical gears, while the remaining machines for cutting spur and spiral gears are two No. 40, three No. 5 A, two No. 5 C and one No. 16.

The No. 5 C Sunderlands, which are for cutting spur gears only, are set up with two cutter boxes so that the "double cutting" method can be employed extensively for those spur gears which are suitable for mounting in pairs on the arbor, the technique of course stepping up production by 100 per cent.

While the gear-cutting machines are used mainly for cutting gears, shapes other than gear tooth outlines can be cut; e. g. chain sprockets, splines, ratchets etc. In actual fact a number of spline shafts are cut in the works by this method. Photograph below shows a line of three No. 5 Sunderland gear planers, the nearest two will be noted being set up for "double cutting". A valuable ancillary machine in this section is the Lang tooth rounding machine shown below which is engaged on rounding the edges of engaging gears which have to slide in and out of mesh.

"Double cutting" is usually employed as shown here when producing gears, gear tooth outlines, sprockets, etc., on these No. 5 Sunderland Gear Planers.

The edges of engaging gears which have to operate in and out of mesh are rounded on this Lang Tooth Rounding Machine.

In order to keep the department is self-contained as possible, the Sunderland spur cutters used are sharpened in the department and Parkson gear testers are available near the gear-cutting machines so that the gears can be checked as they come off the machines.

Bevel gears are cut on Heidenreich and Harbeck machines and again the gears are tested, after cutting, on Parkson bevel gear testers. The division wormwheels for Sunderland gear planers are cut on a Parkinson wormwheel generator having a capacity of 6 ft. diameter.

Hardened gears for the spindle drive of Parkson Millers and certain other hardened gears which run at relatively high speeds or where correction of distortion in hardening is important, are ground on a battery of five Maag gear grinders two of which are of the latest type. The gear grinding capacity will be

General view of the boring and milling department which has an impressive array of modern horizontal borers and radial drills.

Checking the vertical setting of a No. 2N Miller on a Pegard Borer which is also shown in bottom figure.

First operation boring and reaming of Parkson 2N Miller columns on a No. 3 Kearns Horizontal Borer.

General view of Pegard Horizontal Boring and Facing Machine with No. 3N columns and overarms for Parkson Milling Machines.

(Inset centre)—Turning the pin of a Sunderland Gear Planer crankshaft using a micro-setting universal boring and facing head.

further increased in the near future by the addition of an automatic spur gear grinding machine.

An interesting piece of equipment used in the testing of gears in this department is a special Parkson 15 in. gear tester which will accommodate gears mounted on the arbors on which they are ground. It is thus possible to test the gears while still on their arbors and, if necessary, return them to the grinding machine for further grinding or correction without disturbing the mountings.

BORING AND DRILLING

The boring and drilling department occupies the whole of the long and spacious bay. This bay, which is seen to be serviced by two overhead travelling cranes and numerous wall-type jib cranes, is equipped with various makes and sizes of modern horizontal borers, radial and other sensitive drills. Jigs, fixtures and special tools figure largely in the boring of milling machine and gear planer castings in this section, the jigs and fixtures giving uniformity in the positioning of holes relative to each other besides saving considerable setting-up time, while the special tools provided for each job promote or ensure correct sizing of the holes.

Photograph illustrates a boring fixture set-up on a No. 3 Kearns horizontal machine for Parkson 2 N miller columns, with the necessary boring bars and reamers in the foreground. At this stage the spindle hole is rough bored only and the remainder of the holes roughed and finish reamed. The spindle hole is finished on a recently installed Pegard machine.

Checking the vertical setting of the column for this operation is shown in photo (top right) and a general view of the machine with a batch of work follows in photo (bottom right). In the inset picture, a micro-setting universal boring and facing head is being adjusted for turning the pin of a Sunderland crankshaft. This pin has to drive the die which operates the cutter slides of the gear planer.

The batch production of milling machine castings lends itself admirably to the use of radial drills having multiple floor-level tables. As the castings are spaced well apart round the drill column, each may be handled independently for setting up or removal without interfering with work proceeding on the others. In the set-up the column fixing and dowel holes are being jig drilled so that the columns will be interchangeable on bases drilled from a similar jig.

SURFACE AND SLIDEWAY GRINDING

The technique of finishing by grinding (as opposed to hand scraping) the bedways of Parkson machine tools has been applied and steadily developed over the past 25 years. There is no doubt that where it can be introduced it saves considerable time by the elimination of laborious and admittedly tedious hand work, besides being entirely dependable both on the score of accuracy and in producing surfaces that function satisfactorily under sliding loads.

Of the various slideway grinders in this department two are illustrated on next page, the first being a Billeter & Klunz travelling-head grinder set up for finishing the top faces and Vs of 3 N miller knee brackets. The brackets are set level and square with dial indicators and then clamped in the fixture as shown. This machine is employed mainly on grinding knee brackets and columns. In the latter case the castings

Slideway grinding the top faces of 3N Miller knee brackets on a Billeter & Klunz travelling-head grinder. The table carrying the work is removable and stands on another table let into the floor so that tall work can be accommodated under the grinding head.

are set up with the spindle axis square with the traverse of the machine and with the grinding wheel spindle. A similar machine is engaged on finishing machine tables, cross-slides and overarms, the accuracy of grinding being held within very close limits. Tall components for grinding are readily accommodated on these machines by removing the supporting bed and placing the work on a foundation bed which is at floor level.

A number of Churchill surface, slideway and other grinders are installed, including two vertical spindle and two horizontal spindle surface grinders, a slideway grinder, ring grinder and splineshaft grinder. The slideway grinder is the 6 ft. × 2 ft. × 3 ft. model illustrated above. This, the most recent addition to the section, is used mainly for finishing the smaller

6 ft. × 2 ft. × 3 ft. Churchill Slideway Grinder finishing the undersides of circular tables. The work is driven at 15 ft. per min. from the motor seen at the left through a series of belts.

slides and gear tester beds, for which extreme accuracy is required.

The unusual set-up has been developed for grinding the undersides of circular tables, the work being continuously and slowly rotated by "reduction gear" in the form of a series of pulleys and connecting belts which give a rate of grinding feed on the table of 15 ft. per min. when finish grinding. This technique produces perfectly flat surfaces eliminating entirely any need for hand scraping. As the work is performed dry, it will be noted that an independent extraction unit is installed to draw dust away from the grinding wheel.

Flat surfaces of various milling machine parts and machine vise bodies are finished on a Naxos planer-type grinder with horizontal spindle, and a Malcus machine is used for machine vises, miller table slips, circular table bases, etc. The whole of the section is conveniently sited in one bay with ample area round each machine for the stacking and mechanical handling of work.

(To be continued)

NEW RAIL LINE IN ORISSA

The proposed Sambalpur-Titilagarh railway line is estimated to cost about Rs. 16 crores, Shri S. V. Ramaswamy, Union Deputy Minister for Railways, said in Cuttack recently.

The Deputy Minister said that to finance this scheme the United States President's Asian Economic Development Fund would allot twenty million dollars, while Japan would contribute about eight million dollars and the rest would be borne by the Central Government.

India's Biggest Steel Mills Purchase New Locomotives To Help Raise Production

India's biggest steel producers, the Tata Iron and Steel Company, Hindustan Steel (Private) Ltd., and Indian Iron and Steel Co. have purchased a total of 75 new diesel-electric industrial haulage locomotives as part of their extensive expansion programs, it was announced recently by officials of the International General Electric Company (India) Ltd.

The locomotives, which were ordered through I. G. E. India, are all manufactured at the General Electric (U. S. A.) Locomotive and Car Equipment Department in Erie, Pennsylvania. Final shipment will be completed by February, this year, G-E disclosed.

The locomotives have been purchased as part of expansion programs aimed at greatly increasing India's steel output and speeding the country's industrial development.

India must currently import several million dollars (U. S.) worth of steel each year to meet her growing needs. Greater domestic steel output will thus give India a more favourable trade balance.

The locomotives are fitted with special equipment allowing them to operate in the extreme dust, heat and humidity conditions typically encountered in steel mills.

They are used to haul ore, coke and other steel making ingredients; carry carloads of molten metal from blast furnaces to molds; transport finished steel to shipping depots, and remove waste slag to dumping areas.

G-E also builds its famed universal-type diesel electric locomotives ranging from 700 to 1980 hp, at the Erie plant. The universals are designed for all types of railway service—passenger, freight and switching no both main and branch line systems under all types of operating conditions. Over 470 have been sold for use on railways throughout the world.

The 30 industrial type diesel-electric locomotives already in use at Tata's mills include twenty 80-ton units, two 115-ton models, three 35-tonners and five 25-ton units.

In addition, about 20 other G-E diesel-electric 44-ton industrial-haulage or shunting type locomotives are in use in India. These are located at the Bhakra Dam, at the Chittaranjan Locomotive Works and on the Western and Eastern Railways.

G-E industrial haulage locomotives, similar to those being used in India, are in use in a number of South American countries, as well as in Korea, Italy and South Africa.

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ORDERS PLACED FOR CALCUTTA ELECTRIFICATION PROJECT

Orders aggregating about Rs. 10 crores in value have been placed with Italian, British and Japanese firms for the design, supply, erection and commissioning of overhead equipment for some sections of the Eastern and South Eastern Railways included in the Calcutta Electrification Project.

The three firms have agreed to employ indigenous materials and labour to the maximum extent possible.

The contract awarded to the Italian firm covers about 200 route miles on the Eastern Railway from Durgapur to Gaya and a small section on the South Eastern Railway from Asansol to Ramkanali station. The British firm has been awarded a contract for about 160 route miles on the South Eastern Railway between Tatanagar and Rourkela and a small branch line from Rajkharswan to Dongaposi. The Japanese firm will cover the South Eastern Railway section from Ramkanali to Kandra, a distance of about 76 miles.

Altogether, the three contracts will cover about 450 route miles.