SOUTH RAIL NEWS.

SOUTH RAIL NEWS

PUBLISHED BY THE SOUTHERN RAILWAY

SPECIAL NUMBER

83

OCT. 2, 1955-INAUGURATION OF PRODUCTION OF

Integral Coach

by PRIME MINISTER Shri. JAWAHARLAL NEHRU

A PANORAMIC VIEW OF INTEGRAL COACH FACTORY, PERAMBUR.

PRESIDENT OF INDIA

RASHTRAPATI BHAVAN
NEW DELHI
September 13, 1955

I am glad to know that the Integral Coach Factory project, Perambur, Madras, which was initiated by the late Shri N. Gopalaswamy Ayyangar in 1952 is now about to go into production. On this happy occasion I congratulate all the workers who have helped in the successful completion of the Project within the stipulated period. I hope this creditable achievement will be an incentive to greater success when the Factory which I understand is equipped with the latest machinery goes into full production. It is a matter of pride that the Coaching Factory will be one of the largest in the world. I wish all success to it.

(Sd.) RAJENDRA PRASAD

VICE-PRESIDENT OF INDIA

NEW DELHI
September 6, 1955

I am delighted to know that the Integral Coach Factory will start production on the 2nd of October, 1955, and that the Prime Minister will inaugurate it. The inauguration takes place on the birthday of Mahatmaji whose life has been one of unceasing and dedicated work for our country. This occasion marks another step in the onward progress of our country and I hope that all those connected with the organisation whether in the superior or the subordinate grades will regard themselves as workers in a common cause.

(Sd.) S. RADHAKRISHNAN

GOVERNOR OF MADRAS

RAJ BHAVAN
GUINDY, MADRAS 22
September 16, 1955

It is a matter of great joy and satisfaction to us all that the Prime Minister has kindly consented to inaugurate production in the Integral Coach Factory, set up by the Ministry of Railways, for the manufacture of railway coaches at Perambur in the neighbourhood of the City of Madras.

The Integral Coach Factory Project was initiated by the late Shri N. Gopalaswamy Ayyangar during his term of Office as Minister for Railways and Transport, and it is regarded as one of the largest in the world. It is gratifying to note that by the successful completion of the Project, the Railways have taken yet another significant step towards the attainment of self-sufficiency in rolling stock ; and that the Factory, when in full production, will save the nation a considerable sum in foreign exchange. Railways are the country's vital links, and their contribution to our national economy and their role in the social regeneration and cultural unification of the country, cannot be over-emphasised.

It will be interesting to note that the type of coach to be manufactured in the Factory, is of a new design calculated to give the maximum comfort to the passengers, and at the same time, to minimise the casualties in case of accidents. The administration deserve to be congratulated on this great national enterprise.

The first of the 2,500 piles that support the huge columns of structures, was driven in September 1952 and, within a period of 3 years, it has been possible for the engineers to complete the work. This itself, to my mind is no small achievement ; and it speaks well of the conscious and the efficient manner in which the workers connected with the Factory have co-operated to bring about this consummation.

I send my warmest felicitations to all on this happy occasion ; and my very best wishes for continued success to the venture, and true happiness to all connected with the same that comes from duty well performed.

Sri Prakasa

MINISTER FOR
TRANSPORT & RAILWAYS

GOVERNMENT OF INDIA
NEW DELHI
September 7, 1955

The Second of October this year will have a special significance for the Indian Railways. On that day will come out of the Perambur Integral Coach Factory the first 'Integral' type of coach to be manufactured in the country. Among the many achievements to the credit of Indian Railways since Independence, the Perambur Coach Factory has an assured place. While Chittaranjan is progressively taking care of our loco requirements, we shall look to Perambur for meeting our increased needs in the matter of passenger coaches, and I am glad to note the progress this Factory is making under the guidance of its Chief Administrative Officer and with the help and co-operation of his officers and men. It is a happy thing that the Prime Minister will be inaugurating the production and I send my best wishes for the success of this important enterprise of the Indian Railways.

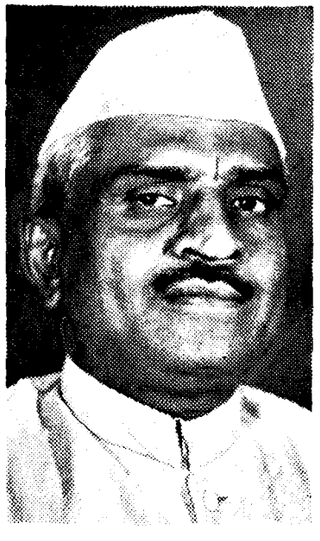
Lal Bahadur

DEPUTY MINISTER
TRANSPORT & RAILWAYS

GOVERNMENT OF INDIA
NEW DELHI
September 19, 1955

This day — 2nd October, 1955 — when our beloved Prime Minister inaugurates the Perambur Coach Factory is a Red Letter Day in the annals of Indian Railways. Perambur will be a fitting complement to Chittaranjan which is already marching from progress to progress. May all Railwaymen co-operate to make this new and glorious venture a cent per cent success.

O. V. Alagesan



MINISTER FOR LABOUR

GOVERNMENT OF INDIA
NEW DELHI
September 9, 1955

We are all happy to know that the Prime Minister is inaugurating the Production in the Integral Coach Factory, Perambur, on the 2nd October, 1955. This is yet another mile-stone in our rapid progress towards attaining self-sufficiency in our railway requirement in the matter of rolling stock. On this happy occasion I send my greetings to the workers engaged in this national enterprise and I am confident that the workers would establish happy and harmonious industrial relations between the Administration and themselves so that this national project would be a model for others to follow.

I wish all success to the Integral Coach Factory, Perambur.

(Sd.) KHANDUBHAI DESAI

MINISTER FOR
FOOD & AGRICULTURE

GOVERNMENT OF INDIA
NEW DELHI
September 8, 1955

The Integral Coach Factory is a landmark in the industrial progress of India. No large-scale industrialisation can be effected in any country without an adequate and well-integrated system of transport and in a vast country like India, no system of transport can be said to be perfect unless the locomotives, rolling-stock, etc. are manufactured inside the country. The Integral Coach Factory is thus destined to play an ever-increasing and important role as our Plans achieve their end. I am glad to know that the Prime Minister has been good enough to accept the invitation to inaugurate the production of the Factory, which throws an abundant responsibility upon those engaged in the production to fulfil the end for which this great enterprise has been set up.

(Sd.) AJIT PRASAD JAIN

CONTENTS

EDITORIAL

THE symposium pertaining to Integral Coach Factory from several officers and their points of view gives comprehensive knowledge of the data pertaining to the factory from various angles.

Articles to this special number have been contributed by the Member (Engineering), Railway Board, Chief Administrative Officer, Integral Coach Factory, Engineer-in-charge, I.C.F., Dy. Chief Mechanical Engineer, I.C.F. and several other officers, who are high grade experts in their own spheres. One can get a clear idea of the various spheres of working of the Integral Coach Factory with technical data by a cursory perusal of the various articles.

On June 1, 1951, Integral Coach Factory was officially born. Its first Headquarters were located in the Railway Retiring Rooms at Madras Egmore station. It was in September 1952 that the first pile to support the factory's huge structure was driven. From then onwards, it has been growing rapidly.

The factory has taken its name from the integral coaches it will manufacture. The integral coach will have its body and underframe integrated into a single unit all made of steel ; each coach will be seven tons lighter than the 42 ton coach which is being used at present.

Integral Coach Factory will take the Indian Railways a long way on the road to self-sufficiency in passenger coaches and also help them to fight overcrowding. Into this largest factory in Asia has gone 8,000 tons of steel, 20,000 tons of cement, 12 miles of Railway Sidings, 15 miles of water-supply pipes and 5·5 miles of roads.

Integral Coach Factory is an achievement in coach building and a step towards self-sufficiency in Indian Railway rolling stock. One cannot but commend on the vision of those who planned and sponsored the Integral Coach Factory. The Chief Administrative Officer and all officers working under him deserve all praise for their vision, capacity to look back to the past, look forward to the future, seeing relative proportions, making allowance for remote contingencies and for having successfully developed the Integral Coach Factory.

On Mahatma Gandhiji's birthday, 2nd October 1955, Prime Minister Sri Jawaharlal Nehru will press a button at Perambur Integral Coach Factory in the North-West suburb of Madras and, within a matter of seconds, India's first all-steel light-weight integral rail coach will roll ostentatiously out of the largest of the state-owned Rs. 7·3 crore Integral Coach Factory's Assembly lines.

ALL-STEEL COACH ADOPTED AS STANDARD FOR FUTURE— WHY NEW FACTORY WAS SET UP

P. C. MUKERJEE
Member, Railway Board

THE need for rehabilitating older coaches and increasing the number of coaches on the line has been felt for some time. The increase in passenger traffic since pre-war days, as reflected in the figures of passenger miles and the number of passengers originating, has been considerable. There has also been public demand for more comfortable rail travel.

To meet these urgent requirements, the Government of India decided to supplement the existing coach-building capacity in the country by setting up a large manufacturing unit under the Ministry of Railways.

The production target was fixed at 350 coaches a year. The construction of Class III coaches has been taken up in the first instance. The most modern type of coach, where the coach body and the under-frame form an integral unit, in all metal welded construction, thereby reducing the weight by about seven tons, that is, about 16 per cent, has been selected. This design affords a higher pay-load. Greater comfort in riding is provided by improvements in suspension and spring gearing. The Integral Coach Factory, at Perambur, Madras, takes its name from this integral design.

The project which is now nearing completion, with the first coach rolling out on October 2, 1955, is estimated to cost Rs. 7·4 crores. The target in the first year of production is 20 coaches, rising rapidly to 350 in five years when a coach will come off the assembly belt every six working hours.

To achieve this task we have associated with the Swiss Car and Elevator Manufacturing Corporation Ltd., Switzerland, who have been pioneers in the field of light-weight coach construction.

Indian Engineers' Work

The construction of the Factory was commenced only about three years ago. The first pile-foundation was driven in September 1952 and since then structures involving 6,500 tons of fabricated steel have been put up. The Assembly Shop which is 1,000 ft. long and 260 ft. wide is of welded construction and is, perhaps, the longest shop in India of this design. The total covered area in the factory is of the order of 850,000 sq. ft. Some idea of the engineering work involved in the factory can be had when it is stated that 1,417,000 sq. ft. of asbestos cement sheets, 271,000 sq, ft. of glazing

in the roof, 19,500 tons of cement, 9,500 tons of rolled steel and a host of other building items have been put into the structures.

It is really a matter of satisfaction that the design and erection of all these structures has been entirely in the hands of Indian engineers.

The factory, employing some 4,000 men when in full production, has been laid out adopting the unidirectional flow of movement from the raw material stage to the finished coach stage, until it is ready for furnishing. Furnishing will be undertaken for the present by railway workshops, but there are plans under consideration for this work also being done at Perambur by extending the factory or having a subsidiary of it nearby.

Mass Production Methods

Mass production methods of manufacture have been adopted for sub-assemblies. All possible steps have been taken at this early stage to avoid wasteful effort and to ensure economy in production.

The machinery and plant required has been carefully selected and obtained from eight different countries, keeping in view the advances made towards perfecting the machines required for specific jobs. There will be about 600 machine tools for operation. The very first machine, of Indian make, was installed as recently as January 20, 1955 by our Minister, Sri Lal Bahadur Shastri, and within about nine months practically all the machines have been put up.

Training of Personnel

The working of a modern factory with modern machines calls for properly trained personnel. The technique of light-weight all-metal welded construction adopting the integral design is entirely new to India. It was, therefore, arranged that the Swiss technical collaborators would put in key positions at various stages of manufacture their experts shadowed by our own men.

Under an agreement a large number of supervisors and workmen were sent to the works of our associates in Switzerland to learn the fundamentals of the job. Forty of these men have already returned and taken up positions in the production line. We have also made very rapid progress with the training of apprentices, 500 boys have been already given intensive training.

The early Timber Coach

It would be interesting to recall here that the early Class III coaches introduced in India were constructed entirely in timber, adopting truck-body design with outward opening doors. The unit consisted of a four-wheeler with a normal carrying capacity of 70 passengers. The wheel base was only 12 ft. Some coaches had two tiers, the lower carrying 70 passengers and the other 50, totalling 120. It can be imagined what little comfort was made available.

In 1874, an attempt was made to provide more accommodation by removing the seat-boards, and the passengers had to squat on the floor and travel huddled together. This led to great public agitation until in 1885 benches were restored. It was not until 1891 that latrines were provided in Class III coaches.

The design, construction and standard of amenities have gradually improved. The all-steel under-frame as developed in Europe was introduced to India in 1885 with the coach-body still in timber. The all-steel multiple coaches were imported in 1922 for the electric suburban trains in the Bombay area. In 1927, 250 all-steel coaches were imported for service on the East Indian and N. W. Railways.

In 1940 a small number of all-steel coaches were built in some of the railway workshops in India.

Standard Coach

In 1949, the Railway Board adopted the all-steel construction as the future standard and soon after an order for 100 coaches was placed on Messrs. Hindustan Aircraft Ltd., Bangalore. Simultaneously the design for an Integral type of coach was studied. and later adopted for construction at the Integral Coach Factory.

The amenities standard in the new Class III coaches far exceeds that provided in the conventional coaches. More accommodation per passenger is being given. A 70 ft. long and 10 ft. 8 inches wide bogie-coach will now seat only 80 passengers. The seats are specially designed to avoid fatigue. Lighting has been improved. Fans are provided. Lavatories are equipped with suitable fittings. The interior of the coach generally is being given a pleasing finish. Riding qualities of the coach have been improved by adopting many new features such as fitting of roller bearings to axle boxes, shock absorbers, swivelling hangers, anchor links, etc.

It is hoped our engineers and draughtsmen in the Design-Drawing Office attached to the Integral Coach Factory will further improve the coaches, providing still greater comforts consistent with economy.

TOWARDS SELF SUFFICIENCY

K. SADAGOPAN

Chief Administrative Officer, Integral Coach Factory, Perambur

SINCE the attainment of Independence, the Railway Ministry have been following a vigorous policy of attaining self-sufficiency at the earliest possible date, in the matter of Railway equipment with a view to cutting out dependence on foreign countries. So far as locomotives are concerned, the establishment of the Chittaranjan Locomotive Works and the Tata Locomotives Engineering Co. will enable us almost fully to meet requirements of locomotives not only for replacing old and worn-out locomotives, but also for providing the Indian Railways with additional locomotives, so that, with the increasing economic development of the country, in all spheres of production and distribution, the Railway transport system may fulfil its role and efficiently discharge its responsibilities.

So far as the goods wagons are concerned, Government's policy has been that the development of the requisite production capacity should be planned on the private sector. The present capacity in the country in the private sector for the manufacture of wagons is about 12 to 15,000 wagons a year. Government are constantly exploring further sources in the private sector to build up a total wagon building capacity of the order of 30,000 wagons a year.

As regards the various other items of Railway equipment, which at present are being imported for the reasons :

(i) that no indigenous capacity is available,

or

(ii) that adequate indigenous capacity has not been developed to meet our full requirements,

Government have constituted a high power Committee to suggest the steps to be taken to achieve self-sufficiency in the production of Railway equipment

to the maximum extent possible specifically covering the following points :

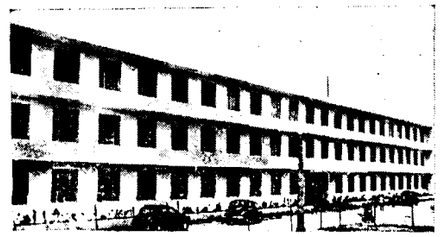
(i) to locate the idle capacity in India for the manufacture of Railway equipment for rolling stock which are at present imported ;

(ii) to suggest ways and means of expanding the existing plans and setting up new industries in India for producing items of Railway equipment which cannot at present be manufactured with the existing resources.

A panoramic view of the Factory

The Committee's investigations cover a vast range of items of Railway equipment, and it is hoped, that when the Committee's report is received, Government would be in a position to plan for complete self-sufficiency in respect of the imported items, either in the public sector or in the private sector as may be most appropriate.

So far as passenger coaches are concerned, the position at the time of Independence was that, while on the one hand we were left with a badly depleted and deteriorated coaching stock as compared with the position in 1939, just prior to the commencement of the Second World War ; on the other, we had taken on the responsibility for moving passenger traffic, which, during the war and post-war periods, had registered an enormous increase of over 150 per cent over the 1939 level of traffic, with the inevitable consequences of poor performance and overcrowding on an unprecedented scale. With a view to meeting this serious situation and affording the maximum relief possible, Government had to follow a policy of large scale importation of passenger coaches from abroad. It became also absolutely manifest that, taking *into* account all available sources of indigenous capacity for the manufacture of coaches, a large separate manufacturing unit, such as the Chittaranjan Locomotive Works, for meeting our requirements of coaches, was inescapable. Accordingly, in 1948, a decision was taken by the late Shri N. Gopalaswami Ayyangar, the then Minister for Transport and Railways, that a separate factory for



A view of the fully air-conditioned Administrative Offices

the production of Broad Gauge coaches should be established in the country.

The future B. G. Standard Type of Coach

The next question was the type of passenger coach that should be adopted as the standard. Several types of coaches were examined by the Railway Technical Chiefs and the decision was taken by Government that for the Broad Gauge, the **"light weight, all metal integral and tubular"** construction of coach design would be the best, and should be adopted as the standard. This design, which was offered by a Swiss Coach Building Firm, Messrs. Swiss Car & Elevator Manufacturing Corporation, Ltd., Schlieren, Zurich. Switzerland, was accordingly accepted by Government.

Advantages of the Integral design of Coach

The advantages of the type of coach to be built in the proposed factory at Perambur, are :

(i) The design incorporates the principles of an integral tubular construction. The tubular integral design enables the forces sustained by the coach to be borne by the entire body including the skin This design, therefore, results in the maximum economy of material for a desired strength and is therefore about 7 tons lighter than the conventional design weighing only 35 tons as against 42 tons of the present all-steel coach of the conventional type.

(ii) The design incorporates anti-telescopic end construction. This design, combined with the fact that the carriage will be of all-steel welded construction, would reduce the possibility of the carriages telescoping in the event of an accident.

(iii) The carriage is designed for improved riding by the provision of shock absorbers and coiled spring axle box suspension. The bogie trucks are of the latest all-welded Swiss design. The axle boxes are fitted with S.K.F. Roller Bearings, making for smoother movement.

(iv) The coach will be sprayed with Limpet asbestos as an insulation against heat and noise.

Location of the Factory

As regards the location of this large manufacturing unit, several alternative sites including Bangalore were considered, and it was eventually decided that this Factory should be located at Perambur, Madras. Perambur is already a big Railway Workshop centre, and sufficient Railway land was readily available for going ahead with the construction of the Factory. Railway facilities for the transport of material, etc. were available on the spot. With the location of the Factory in Madras there was also no compelling need for establishing immediately a large Colony of the size of Chittaranjan Locomotive Works for housing every worker, and consequently, the finances made available to the Railway Ministry could be put to the maximum productive use by way of the establishment of the Factory proper. In view largely of these considerations, it was decided that the Integral Coach Factory should be located at Perambur in the Madras City.

The Factory consists of ten shops with a total covered area of 8,48,600 sq. ft. and has been laid out on the most modern lines. The planning of the Factory has been such, that the raw material is received at one end of the shops and processed through the Factory in a uniflow direction and the finished coach shall roll out at the other end.

Plant and Machinery

The question of equipping the Factory with the most modern plant and machinery was taken up in time so that there might be no time-lag between the completion of the Civil Engineering Works and the installation of plant and machinery. As far as possible, machines of indigenous manufacture were ordered. But the machine tool manufacturing capacity in the country not yet having fully developed, it became inevitable to import the vast bulk of our machinery requirements from abroad. Accordingly, global tenders were called for in November 1953, and the tenders were received and finalised by March/April 1954. It is indeed a matter for special gratification that it has been possible to obtain very competitive and favourable prices and very early deliveries. The following figures give the rough break-up of the orders in West Germany, U.K., Switzerland and other countries :

Country	*No. of contracts*	*No. of machines*	
Germany ...	78	152	
Switzerland ...	31	312	(includes 260 welding sets)
England ...	23	68	(includes 25 welding outfits)
Sweden ...	3	3	
Czechoslavakia...	3	6	
France ...	1	1	
Belgium ...	1	1	
Italy ...	1	1	
Total ...	141	544	

Raw Material Procurement

Simultaneously with the procurement of plant and machinery, action was initiated for the procurement of numerous items of raw material, required for the production of the coach, both from abroad and indigenous sources. The bulk of our steel requirements has had to be imported in the first instance, but care has been taken to ensure that with the new steel plants coming into production, our entire requirements of steel are obtained from these Steel Rolling Mills.

Technical Training

The most urgent problem calling for attention in the context of the Second Five-Year Plan, is one of making nation-wide arrangements for the training of technical personnel at all levels, so that we may have technical man-power on a scale sufficient to meet the demands for the implementation of the plan. The need for properly trained skilled workers in the various technical categories was foreseen at the very early stages of this Project. In March 1954, a Technical Training School was started, and the inauguration of this School was performed by Shri O. V. Alagesan, Deputy Minister for Transport and Railways, on behalf of Shri C. Rajagopalachari, who was unable to perform the Inauguration Ceremony due to slight indisposition. Boys who have already received a basic industrial training have been recruited and given an intensive course in the particular trade for which they are most suitable, both in the School and on the Shop floor. Thus, the timely starting of the Technical Training School has enabled us to find the nucleus of skilled craftsmen to help in the starting of production in the factory, as originally planned. No pains have been spared to make the Training School a model institution and to give to the boys the best possible technical education.

The training methods have been planned with the utmost care, and due emphasis has been given to the correct practical training of the boys. For each department of training, viz. Welding, Fitting and Machining, a special Swiss Instructor is attached to give his whole-time attention to the training of the Apprentices in his charge. It is a matter for gratification that our Swiss Collaborators are very satisfied with the willingness and the capacity of the boys to pick up the technical knowledge and the skill, and there is every reason to hope that in so far as technical skill is concerned, the boys turned out of this School will compare favourably with the craftsmen in some of the industrially advanced countries of the West.

Deputation of Indians for Training in Switzerland

In establishing production of this new type of Railway passenger coach, the importance of having a sufficient number of experienced men trained abroad in the detailed processes of production need hardly be stressed. Accordingly, action was taken at an early stage of the project for the selection of suitable men in the rank of Supervisors and also in the rank of skilled workers from the Workshops of the Indian Railways, and for their deputation to Switzerland, for practical training, for varying periods from 6 to 12 months in the Works of our Collaborators, Messrs. Swiss Car & Elevator Manufacturing Corporation Ltd., Schlieren, Zurich. So far, 40 such men have received their training and returned to India, and have assumed their respective positions in the Production Organisation. 19 men are at the moment undergoing training in Switzerland.

Technical Collaboration

The integral coach being a new design of coach, in the manufacture of which our Indian Mechanical Engineers have no previous experience, it was essential that for the successful establishment of the production of this new type coach, we should acquire the 'know-how' from Engineering firms, who have considerable experience and built up a reputation for the production of this type of coach. Accordingly, a Technical Aid Agreement was entered into with a Swiss Engineering Firm—Messrs. Swiss Car & Elevator Manufacturing Corporation Ltd., Schlieren, Zurich. The main provisions of this Agreement are :

(i) The firm accept their full share of technical and executive responsibility for establishing the manufacture of the integral type of coach in the Factory.

(ii) The firm agree to supply workshop drawings and specifications for machinery and plant in connection with the construction and equipping of this Factory for the manufacture of coaches upto the agreed production targets.

(iii) The firm agree to supply technical assistance to Government by receiving in their Factory in Switzerland such technicians and Engineers as may be mutually agreed between the firm and the Government for the purpose of training them in the offices, laboratories, workshops, inspection and other departments of the firm.

(iv) The firm agree to supply whole-time technical personnel for employment in the Factory for such period or periods as may be agreed between Government and the firm.

The payment of basic fees by Government to the firm for their technical collaboration has been made contingent on the firm establishing production and achieving the production targets, from year to year, as embodied in the Agreement.

Production Targets

The following production targets have been agreed between Government and the firm :

Target for the year	*Total number of unfurnished coaches*
1st year of production ...	20
2nd do. do. ...	100
3rd do. do. ...	200
4th do. do. ...	300
5th do. do. and thereafter ...	350

Of the above numbers, the Agreement contemplates a progressive increase, vide details below, in the number of coaches to be turned out by using indigenously made parts excepting for wheels and axles and proprietary items :

Target	*Number of indigenously manufactured coaches*
2nd year of production ...	20
3rd do. do. ...	120
4th do. do. ...	280
5th do. do. and thereafter ...	350

The writer has had the rare opportunity of having been associated in the conclusion of the present Technical Aid Agreement with Messrs. Swiss Car and Elevator Manufacturing Corporation Ltd. and on the conclusion of this Agreement, the responsibility of working the technical collaboration smoothly and successfully has been placed on him. It is a matter of no small satisfaction to be able to say that so far, the Indo-Swiss Collaboration on this Project has been entirely harmonious and satisfactory, and with the experience gained so far, it could confidently be stated that the achievement of the production targets, as laid down by Government, is assured.

Salient Data

Subjoined are the salient data pertaining to this Project :

(i) Covered area in the Shops ... 8,48,600 sq.ft.

(ii) Number of Sheds ... 10

(iii) Tonnage of steel for the Project ... 9,500 tons

(iv) Length of Railway lines ... 12 miles

(v) Roads inside Shops ... 3·4 miles

(vi) Roads in Colony ... 3 miles

(vii) Houses ... 400 units

(viii) Water Supply Pipes ... 16 miles

(ix) Consumption of Cement 19,500 tons

(x) Number of machines in the Factory including Welding Sets :

(*a*) General purposes ... 549

(*b*) Special purposes ... 60

(xi) Jigs and Fixtures ... 750

(xii) Pipe Lines (Cooling Water, Oil, Compressed Air) ... 8·4 miles

(xiii) Compressors ...8,250c.ft./min.

(xiv) Number of Cranes/ Traversers :

(*a*) 20-ton Overhead Cranes ... 4

(*b*) 5-ton Overhead Cranes ... 26

(*c*) 75-ton Traversers ... 2

(xv) Number of workmen to be employed ... 4,000

(xvi) Annual output in single shift ...350 (unfurnished coaches)

(xvii) Total consumption of electrical units per annum ... 6 million units

(xviii) Total cost of the Project ... Rs. 7·35 crores

Conclusion

The successful and timely execution of a major Project of national significance is possible only when there is the most cordial team spirit, and a missionary zeal on the part of all concerned to accomplish the allotted task, viz. the Officers and staff of the Project at all levels, the steel producers, the raw material suppliers, the fabricating and building contractors, and the plant and machinery suppliers. If, on this Project, it has been possible to inaugurate production according to Schedule, this is due entirely to the effective contribution made by all the parties concerned in building up this Project and their cheerful and enthusiastic co-operation.

WORK TO BE DONE BY MECHANICAL ENGINEERS IN THE SETTING UP OF A BIG FACTORY

K. SWARUP

Deputy Chief Mechanical Engineer, Integral Coach Factory, Perambur

Introduction

SETTING up of a huge factory like the I.C.F., covering 51·5 acres of area and requiring 8,48,600 sq. ft. of covered area, is a task, which needs careful planning and thought from the time it is decided to set up such a factory. Every little detail has to be carefully considered after taking the various sequences of operations into consideration, to eliminate subsequent bottlenecks or cross-handling of material. Such studies naturally require experienced men, who would know the manufacturing operations thoroughly, and such men have to spend considerable time in working out the best possible shop layouts.

Design of the product

The product to be manufactured at the I.C.F. is the light-weight all-welded steel coach developed in the last few years in Europe, and naturally for this task Indian Mechanical Engineers did not have the complete 'Know-how', and, therefore, it was considered necessary to enter into a Technical Aid Agreement with the Swiss Car and Elevator Manufacturing Corporation, Limited, Schlieren-Zurich, Switzerland, who are the pioneers in the field of light-weight all-welded steel coaches.

Based on their 'Know-how', the job of designing a suitable Broad Gauge coach for the Indian Railways was taken in hand by the Central Standards Office as early as 1950, in conjunction with the Design Engineers specially deputed by the Swiss collaborators. At the same time, the Shop layout was undertaken, in early 1951, and Civil and Mechanical Engineers coordinated with the Swiss Specialists and Experts in working out the general layout for the factory and later the detailed layouts for individual shops.

General Shop Layout

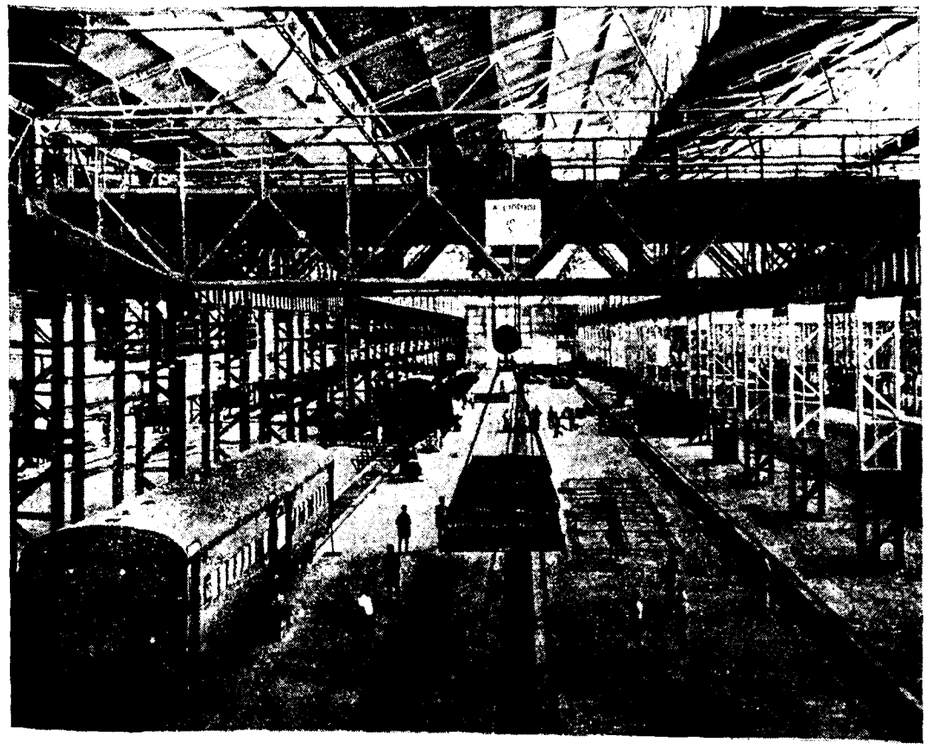
After the general layout of the factory was finalised, the task was to find a suitable site for the Project. After detailed investigations it was decided to site the Integral Coach Factory at the present site, west of the existing Southern Railway Loco Shops.

Machinery and plant

The next big task of the Mechanical Engineers was to draw up a list of plant and machinery that will be required for such a factory. This meant compilation of the time required for each operation on a particular type of machine, and as this type of coach was entirely new to India, the assistance of the Swiss Car & Elevator Manufacturing Corporation was very necessary in this matter. They very kindly placed their Operation and Planning Cards at our disposal, and from these the Swiss man-hours were worked out for a particular type of machine. The question now was to decide what will be the ratio of production of a Swiss worker to that of an Indian worker. The answer to this question was not readily available, though several experts in India and the field office of the International Labour Office in Bangalore were consulted. Detailed examinations were, therefore, made by a Swiss Team, including the author, by visits to different factories in India and this Committee was of the opinion that the ratio in the case of a machine operator may be accepted as 1 : 1·8. This question was also discussed at Geneva with the experts of the International Labour Office and they agreed that the ratio of 1 : 1·8, as worked out by this Committee, was reasonable. Accordingly the man-hours for a particular machine were worked out, and based on these man-hours the approximate requirements of the various types of machines were finalised.

The machine tool manufacturers have made great strides during and after the Second Great War, in improving the design of the machine

A view of the Main Assembly Shop where body shells are assembled on an organised belt



tools, with which it was possible to get much higher speeds and feeds. Single-purpose machine tools for specific requirements were also in the field and manufacturers were willing to design and supply other single-purpose machines that were needed. It was, therefore, necessary to have close consultations with the manufacturers in order to get the most modern machinery with labour saving devices for a plant which was going to mass-produce one particular type of coach.

In order to save time and obtain the best possible deliveries at a most competitive price, it was decided by the Government of India to call for Global Tenders in Europe. The last date for the quotations to be submitted was 20th of January, 1954.

The big task of going through 1,800 tenders to select 544 machines now started in Schlieren, Zurich. The Government of India decided to associate a Director of Finance from the Railway Board and a Mechanical Officer from the I.C.F., with the Swiss Consultants for going through these quotations and placing the orders.

The screening of 1,800 quotations was completed by this team in a record time of 2 months and 10 days, and by the 5th of April 1954, it was possible to finalise orders for 541 machine tools costing £7,88,074-3-10.

Although the orders are distributed over 76 firms in 8 different countries, 10 firms in Europe have secured a large proportion of the orders, each one obtaining orders amounting to more than £20,000.

Installation of Machinery and Plant

It was considered most advisable to leave the task of inspecting these machines, to the Experts of Messrs. Swiss Car & Elevator Manufacturing Corporation, in order to ensure that machines were suitable in every respect. By now all the machines have been received in the I.C.F. and most of them erected. The first Kirloskar 8½″ centre lathe was installed by the Railway Minister in the Machine Shop on the 20th January 1955, and during the 8 months such rapid strides have been made as to nearly complete the installation of most of the machinery and plant.

Jigs and Fixtures

While going through the operation and planning cards, the question of doing the various jobs on jigs and fixtures in order to ensure the interchangeability was given thorough consideration. It was also considered essential that, to expedite assembly and welding work, suitable jigs should be designed in order to ensure that the assembly belt functioned without interruptions. 675 jigs had to be designed, out of which 583 are being manufactured by Schlieren and the remaining 92, in India.

The big Assembly Jig on which the sides, ends and roofs are assembled on to the trough floor of the body shell, weighs 11·65 tons and has a platform to work on the outside upto a height of 8′-5½″ and there is a provision for putting up one platform inside at a height of 7′-10½″ for enabling the workers to spot weld the sides, the roofs and ends from inside. The Roof Assembly Jig, weighs 8·75 tons and has a platform 3′ high all round the jig, where the welders stand while the jig moves round at a slow speed to enable roof sheets being tack-welded after they are held in position on the carlines and cantrails.

D.C. Welding Sets

D.C. welding sets have been preferred as it is our considered opinion that for welding thin sheets it is much more economical and more efficient. The claims of the A.C. welding sets were given full consideration before coming to the above conditions.

Double-Acting Hammers

For our Smithy Shop we have selected Double-Acting Beche Hammers on account of the soil conditions existing in Perambur and because of the better control obtainable in these hammers. For our Machine Shop we have selected Alfred Herberts Turret Lathes No. 9-B for bar work and Boehringers' Turret Lathes for fixed chuck work.

Individual Shop Layouts

The sequence of operations and the best methods of obtaining an uninterrupted flow of manufacture were carefully studied before finalising the layouts. The so-called "Jobbing Layout" was chosen for the production, according to which the details and partly the sub-assemblies are manufactured in separate sheet-metal, smithy, fitter and machine shops. From here they proceed through the sub-assembly stores to the assembly lines. 2,800 doors per year and 14,700 windows per year are required for the 350 coach body shells to be produced, and therefore for the window and door shops it was decided to manufacture them in special departments according to the so-called 'Line Layout'. Here the single machine tools and jigs are arranged directly according to the requirements of the flow of production, that is, where the layout places the machine along the line of travel of the produced part. This layout is considered to be the best solution for an economic manufacture of parts to be manufactured in large series.

In accordance with the above principles and taking into consideration the machinery and plant, ordered, the following shops have been planned in order to get the uninterrupted flow of material to the assembly lines on which the coach body shell will move from one position to the other until it is finalised on the last position in the Main Assembly Shop.

Shop "A"—Sheet Metal Shop

Covered area : 1,00,000 sq. ft.

Northern 2 Bays : Details for side walls, end constructions, roofs and underframes (processing of thin sheets).

Middle Bay : Welding of side walls, end constructions and roof sub-assemblies.

Southern 2 Bays : Manufacture of details and welding of sub-assemblies for underframes, bogie frames and bolsters (processing of plates and heavier sheet sections), manufacture of door details.

The thin sheets are stored in the nearby sheet metal store 'K'. For heavier sections storage space is provided in the open gantry lane between Shop "A" and "K". The details and sub-assemblies manufactured in Shop "A" will be used finally in the assembly lines of Shop "B" for bodies and bogies.

Shop "B"—Body and Bogie Building Shop

Covered area : 2,60,000 sq. ft.

The two northern bays are especially wide (80′) and high, being foreseen to take the 6 main assembly lines for the bodies. Work processes from west to east. It has been foreseen to install a test station for leakage tests for roofs on the west side of each hall. Each assembly line begins with 2 assembly stations for roofs, followed by a spare space which is intended especially for the storing of assembled roofs. The under frames will be assembled in the next two stations. Then follows a store for assembled underframes, side wall sub-assemblies and end wall sub-assemblies. The assembly of the body shells is on the following three stations. Finally, at the end of each assembly line, there are two stations for finalising work and for the inspection. The body shells finally leave Shop "B" by the east side on diplory rollers in raw, unpainted condition to be shifted over by means of a traverser to Shop "C" for further finishing.

The bogie assembly lines and wheel shop are housed in the southern two bays of standard size, i.e. 50′ width. The bogie assembly lines receive the necessary details and sub-assemblies partly from the neighbouring Shops

"A", "D" and "E" (Sheet Metal, Smithy, Fitters and Machine Shops) and the wheel sets from the nearby wheel shop bay. They are completely painted and ready to be fitted under the body shells in the adjoining shop "C".

The part of the south bay which is not fully taken up by the wheel shop is to be used as a storage place for details and sub-assemblies.

Shop "C"—Assembly Shop

Covered area : 96,800 sq. ft.

The grit blasting plant is located in the north bay exactly opposite shop "B". All bare body shells leaving shop "B" must pass through this plant. Immediately after the outer cleaning in the grit blasting plant, the shells are coated with the necessary rust-preventing paint on the in and outside. Subsequently, the shells pass through the specific stations in Shop "C", where they will receive the inside spray-asbestos insulation and the supplementary inside painting on the underframe, as well as further outside coatings on side walls, end constructions and roof. Then follows the fitting of the brake equipment, transfer from the service trucks to the actual bogie and the mounting of doors, windows, draw gears and roof ventilators. The last station in Shop "C" is the Inspection, after which the coaches are ready for delivery.

Shop "D"—Smithy and Fitters' Shop

Covered area : 86,400 sq. ft.

The western part of the Shop "D" will house the smithy. Raw materials for forged parts are kept directly outside the smithy in an open stores space equipped with a gantry crane. Raw material cutting, furnaces, hammers and presses are being placed in position which permit most economical production. A grit blasting equipment, which will be in the north bay of Shop "D" will serve for cleaning the forged parts and the details manufactured in the fitters' shop.

Both south bays on the east part of Shop "D" have a mezzanine floor which is primarily used as store room for doors and windows. The anodising plant, nickel plating and chromium plating plant are to be installed in the lean-to on the south front of Shop "D".

Shop "E"—Machine Shop

Covered area : 1,00,000 sq. ft.

The Machine Shop has been split up into several sections according to the type of machine put in these sections. In all 89 machines have been installed in the Machine Shop. In the middle of the Shop, a Tool Crib has been organised, equipped with the necessary tool grinding machines for the sharpening of tools. A Fitter and Welding section is provided in the north bay for fitter work on parts manufactured in this shop. Inspection department as well as storage space for semi-finished parts is provided.

Shop "F"—Millwright Shop

Covered area : 28,000 sq. ft.

This shop will house an actual repair and maintenance section and a Tool Room, both departments equipped with the necessary machine tools and installations.

Shop "J"—Window and Prototype Shop

Covered area : 80,000 sq. ft.

The north bay will be reserved for the electrical repair shop and for a sub-assembly store. In the two middle bays the manufacture of complete window sets will take place. A further bay is reserved for the prototype bay. The carpenters' shop, which will serve the maintenance requirements, will be installed in the western part of the bay.

Tool Cribs

Tool Cribs have been designed for the issue of the tools to the workers. For these tool cribs special tool cabinets with a centre locking device

have been devised and based on the Swiss experience, Godrej have been able to manufacture them in India. For transport of material from Stores to individual shops, 6 Stacatruc fork lift trucks and 6 Lister trucks have been provided.

During the erection stage we found these Stacatruc fork lift trucks very useful in handling the machines and in erecting the heavy parts.

Mechanical Organisation

The Mechanical organisation has been carefully worked out and every possible care has been taken so that the 'Know-how' is obtained by the Indian Officers, Supervisors and men at all levels. An Indian is attached as a counterpart to a Swiss expert and they have to work together in close co-operation to establish the production. It is proposed that in the initial stages the Swiss will organise the first assembly line and after it has been organised it will be handed over to the Indian counterparts and the workmen to maintain the scheduled outturn, under the general supervision of the Swiss Superintendents. The Swiss experts will now be switched to organize the second and subsequent assembly lines with the help of Indians, until such time as the Indians have picked up the complete 'Know-how'.

Manning of the Factory

In order to form the nucleus for the Indian Supervisory and Skilled staff, a Technical Training School was started very much in advance of the Factory going into production. It was foreseen that it will be necessary for our Indian Supervisors and Skilled workmen to be sent to Schlieren for training purposes, and have accordingly sent 63 men in four different batches, to Schlieren for training varying from six months to twelve months. Steps were also taken to select and train suitable Indians under training abroad, and a Committee consisting of the Railway Adviser and the Chief Inspecting Officer in London was formed to select suitable candidates. We have also recruited suitable supervisory staff from the open market, through the agency of the Railway Service Commission in Madras.

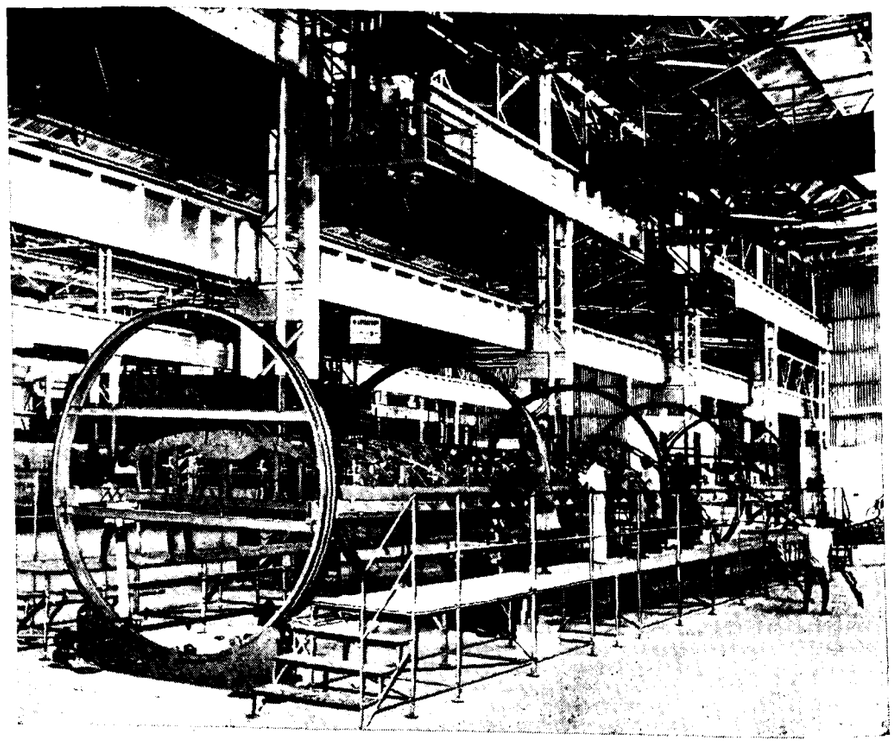
It was however found difficult to get suitable supervisory technical men from the open market with the requisite technical experience and therefore we had to adopt a scheme for training of supervisory personnel. We have recruited 24 improver or probationary chargemen and are giving them an intensified training for a period of 6 to 9 months, to fit in these men on our rolls.

To meet the requirements of the experienced men, various Railway Workshops were inspected by Officers from the Integral Coach Factory and suitable persons selected for absorption. These men, along with the Swiss Experts and Specialists, are now playing an important role in the establishment of production in the I.C.F.

Production Schedule

A production schedule has been worked out for the achievement of the production targets in the I.C.F., based on the production targets as laid down in the Supplemental Agreement of 1953. The various dates for establishing production in the Paint and Finishing Shop, in the Assembly Shop, in the Detail Manufacture Shop, have had to be worked out and are being adhered to rigidly.

On the basis of the start of production in the various Shops, the raw material procurement had also to be drawn up. Here the difficulty was that most of the material required was according to the DIN specification to which our Swiss Consultants and Experts were accustomed and on which they gained sufficient experience. The initial difficulties in this regard have been overcome and all the Government



Roof Assembly Jig for Assembly of Roof 70′ x 10′ 8″

of India Offices, particularly D.G., I.S.D. and D.G.S. & D., and the industry have co-operated in this matter fully.

Locating Indigenous Capacity

For many of the imported items, a separate section has been established in the Machanical Engineering Drawing Office for working out the indigenous products. Their **modus operandi** is to locate a suitable firm, who can produce the components required of the suitable standard and to place an Educational Order on them. After supply of these components they are subjected to rigorous tests before final acceptance. In this way it has been possible to already substitute 90 items from the imported list of 163 items. Efforts will continue until all the items have been located through indigenous sources.

Drawing and Design Office

A modern Drawing Office has also been planned with the most modern equipment in a very well-lit corner of the Administrative Office. The Factory will be now producing only third class coaches according to a design which has been worked out by our Swiss experts in conjunction with the Central Standards Office of the Railway Board. Our Design Drawing Office will be able to design, in light-weight construction, other types of coaches that are required for use on the Indian Railways. Provision has also been made for a Prototype Bay in the Shops where the newly designed types will be worked out and fully tried before finalising the designs. Other research work will also be done in this Bay as may be directed from the Central Standards Office or from the Railway Board from time to time.

Technical Society

A Technical Society has also been formed where lectures by Swiss Experts and Indian Mechanical Engineers are arranged on various technical matters, once a month and after the paper has been read out it is thrown open for discussions. It has proved very useful to bring the Swiss and the Indian Mechanical Engineers together and has been found very helpful in broadening the outlook of the Indian Mechanical Engineers.

Production Office

A proper production office is also being established for the planning of 600 different components and sub-assemblies that go to make the coach body shell. Expert staff will be employed for time and motion studies on the actual shop floors. This production office will also have a suitable section for job costing each batch order processed through the manufacturing shops. This office will also be responsible for seeing that the various components and sub-assemblies are in the right place at the right time for the belt to proceed without any interruptions.

The Task

The present assignment for the Mechanical Department of the Integral Coach Factory is to produce 350 light-weight all-welded steel construction body shells by 1959-60. The quality and the quantum of work produced by our Apprentices in the first Assembly Line which has already been established, and the co-operation that is obtaining at different levels, encourage the hope that we should be able to achieve the production targets without much difficulty.

THE STORY OF THE CONSTRUCTION OF THE PROJECT

O. S. MURTHY,
B.A., B.E. (HONS.), A.M.I. Struct. E.,
Indian Railway Service of Engineers,
Engineer-in-Charge,
Integral Coach Factory, Perambur

TO an Engineer, recounting the story of the construction of a Project of the magnitute of the Integral Coach Factory is very fascinating. For, in doing so, he lives once again through the early days of planning and design, through the days of intense activity when thousands of workers bent all their energies towards a common purpose, through the anxious time when the work was held up due to shortage of material or other impediments, and finally through the exhilarating period when a giant factory takes its final form to fulfil the purpose for which it was designed.

With the decision of the Ministry of Railways to locate the Integral Coach Factory at Perambur, a team of Engineers under the able leadership of Shri M. Ganapati of Chittaranjan reputation, took the field in May 1951 for site investigations and preparing designs and drawings. The final sanction to the Project as a whole was received in September 1952, and the stage was set for the construction organisation to go ahead in full swing.

The assignment to the Engineers was the construction of a Factory with a covered accommodation of approximately 8·2 lakh sq. ft. with all the necessary services and ancillaries, such as, roads, water supply drainage, railway sidings, canteens, bathing places, Administrative office, etc., as also the construction of a well laid out modern Staff Colony of 400 houses for the essential workers of the Factory with all amenities, like, children's playgrounds, parks, club houses, water-borne sewage, electricity and water supply.

Foundation Problems

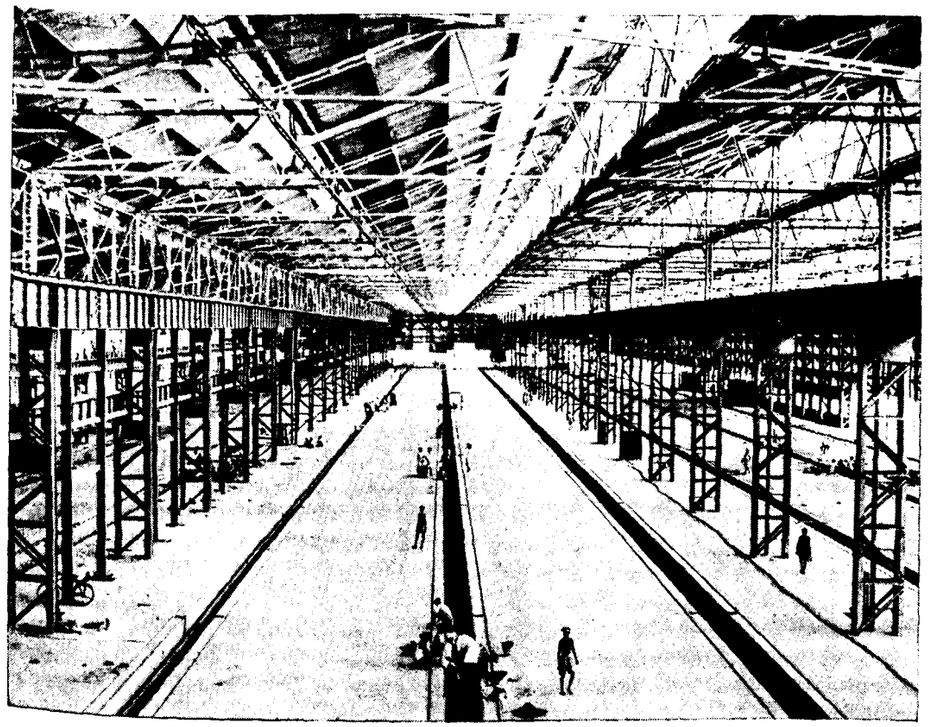
Considering the heavy loads and bending moments which the columns of the Shops would have to bear, the first work done by the investigating team was to make a thorough study of the soil conditions at site, both by direct loading tests and by the principles of soil mechanics. Undisturbed samples of soil upto a depth of 40 ft. were taken and several bore holes upto a depth of 60 ft. put down to ascertain the nature of the strata. These investigations revealed that this soil was highly compressible and was made up of overlaying silt. It was therefore decided that the foundations for all the columns would have to be on groups of piles with R.C.C. caps. Reinforced concrete raft foundations were ruled out, because of the fact that the sizes of these rafts would interfere with the machine layout and would restrict working space between the columns.

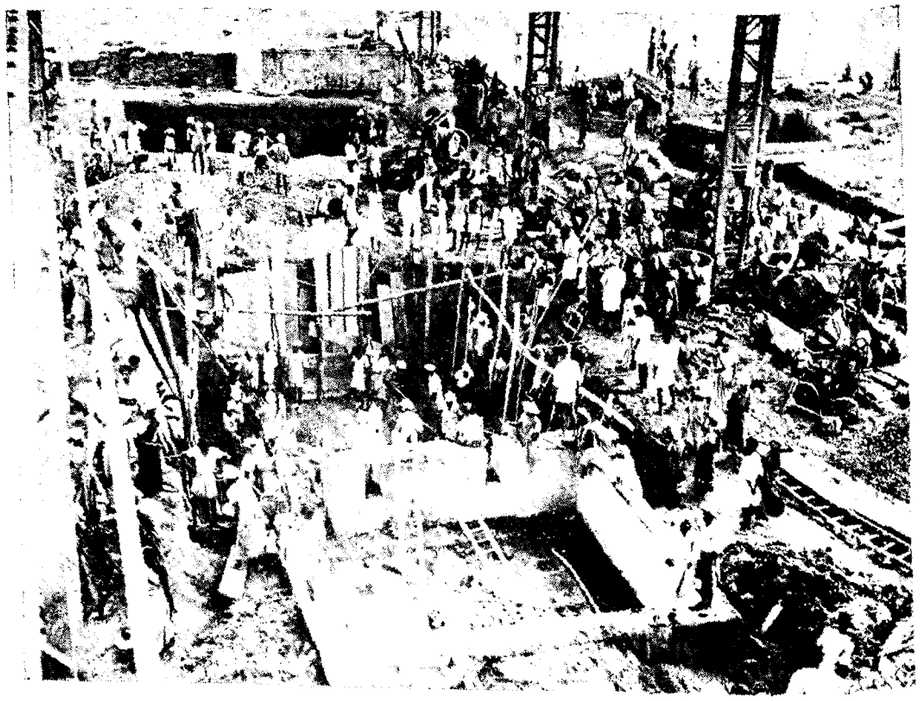
The Shops

The general arrangement of the shops follows the work-flow. Designs had to be made for 10 Shops, and before undertaking the work, the requirements of the Mechanical Engineers were ascertained in respect of several details, such as, width of bays, heights of crane operation, sizes of openings, etc. In the rational design of a Factory, the Civil Engineer can contribute towards the efficiency of production. With bad planning and unsatisfactory detailing, the Civil Engineer's work can be a great hindrance and impediment to the flow of production in the years to come, while by forethought and good planning, he can directly assist in increasing the efficiency of production.

The lighting and ventilation of the shops were carefully planned, and after careful consideration, the percentage of glass in the roof was decided at 30 per cent. In deciding the width of bays, the experience gained at Chittaranjan, where the bays are 40 ft. in width, was of great assistance. It was found that with a 40 ft. wide bay, it was difficult to arrange three rows of machines, while it was too wide for two rows of machines. Therefore, a 50 ft. wide bay has been standardised for the Integral Coach Factory in

Interior of the Main Assembly Shop—A modern Industrial Cathedral, 1,000 ft. long and 260 ft. wide—Clean, dustless, concrete floor for the Shop with all services carried underground in drenches—A special feature of workshops





Heavy foundations for the Beche Smithy Hammers being done under difficult subsoil conditions. The foundations rest on groups of 25 piles

order that a third row of machines could be installed if future demand arises.

One noteworthy feature of the general layout is that there are 3 overhead gantry cranes 80 ft. nominal span, covering the space between the shops. The handling of the raw material stored under these gantries as also the movement of components and sub-assemblies from one shop to another, is made easy, thus minimising manual effort.

As soon as the layouts of the main designs of the structures were completed, orders for the steel work were placed with structural fabricators in the various parts of the country, viz., Madras, Bombay and Calcutta. Simultaneously, action was taken for collecting the large quantity of stores, such as, 14,17,000 sq. ft. of asbestos cement sheets, 2,71,000 sq. ft. of glazing for the roof, 19,500 tons of cement, 200 tons of site rivets, bolts, nuts and galvanised fittings, 9,500 tons of rolled steel, and a host of other building material.

The total quantity of fabricated steel required was of the order of 6,400 tons. In our country, where steel is in great shortage, the rolling programme of a particular section has to be arranged and co-ordinated with the total outstandings of that section with the producers. An uneconomical tonnage of section will not be put through the rolling mills. Thus, it is not unusual for a period of nearly 12 months and more to elapse before the collection of steel by the fabricators at their works. It may perhaps be possible in the construction of small

sheds and in putting through minor schemes that a certain amount of wastage of steel could be countenanced by using uneconomical sections or lengths available in the market. The alternative of outright import of completely fabricated steel, as has been done in the case of some of the industrial enterprises, such as, Trombay, would have meant loss of work to Indian fabricators and spending of foreign currency. In the construction of the Integral Coach Factory, it has been the policy to harness as much of indigenous talent and enterprise as possible.

The chasing and programming of rolling of steel, its movement from the steel producers to the fabricators yards, the processing of the steel through the fabricators workshops and its final despatch to site of work, has had to receive the constant and anxious attention of the Engineers at site.

The unfortunate lock-out in the year 1953 in the Steel Works at Burnpur caused a delay of nearly 6 months in the collection of the sections required. Even so, with the arrival of steelwork at site, the erection was organised vigorously and at one stage as much as 700 tons per month were being erected

While this steel was being fabricated in the various workshops in the country, the site was got ready to receive the huge columns of the structures. The first pile was driven in September 1952, and commencing from that date, 2,460 numbers of 16″ dia. of R.C.C. piles cast **in situ**, have been driven to a depth of about 40 ft.

Some Engineering Features of the Workshops

Of the 6,500 tons of fabricated steel, 2,550 tons is of welded construction. Steelwork in the whole of the Main Assembly and Sheet Metal Shops belongs to the latter category.

The Main Assembly Shop, which is 1,000 ft. long and 260 ft. wide with a height of 55 ft. to the ridge, is a magnificent structure which may truly be termed an " Industrial Cathedral ". Four 20-ton cranes at a height of 33 ft. and several 5-ton cranes assist in the manufacture operations. This Shop has been planned with two 80 ft. bays and two 50 ft. bays, running the full length of 1,000 ft.

The method of fabrication adopted in the case of the Main Assembly Shop and the Sheet Metal Shop, is somewhat unusual in our country. At any rate, it is presumed, that these two shops comprise the biggest single job where a combination of shop and site welding has been exploited to advantage. The objective of easier fabrication methods and economy in the use of steel have been achieved by specifying all component units, such as, columns, roof girders, glazing girders, L type rakers, 5-ton gantry girders, side framing units, etc., as of welded construction, partly done in the shop and partly at site. The field connections are bolted and this has ensured quickness of erection. A fully rigid design for large spans would involve heavy site welding and put up the cost of the structure.

All columns less than 40 ft. in length and all 5-ton gantry girders were fully shop welded and despatched. For those columns in the 80 ft. bays of the Main Assembly Shop, which are 53 ft. long, the roof leg and the bottom shaft were despatched separately. On arrival at site, the two were assembled, checked, for alignment, held in a jig and finally welded. The attachment of the jig to the roof leg and crane shaft was through location bolt holes already drilled in the Shop.

The main roof girders of 80 ft. and 50 ft. span and the 40 ft. glazing girders were fabricated partly in the shops and partly at site. The shop work consisted of fabricating the top and bottom chords in part lengths. These units, as also the web members of the girders, were despatched to site with all the gussets welded and

provided with ½" pilot location holes. The assembly of the components at site was done on a steel staging platform with accurately positioned fixtures to hold the members in alignment and prevent distortion. The joints in the girders were then tack welded and the length and alignment checked before being welded fully.

For the erection of the steelwork for the Main Assembly Shop, a 5-ton Scotch Derrick with 110 ft. jig was provided by the Administration and made mobile by mounting it on trollies running on Railway tracks specially laid for the purpose.

In the design of the Shops, standardization has been kept prominently in view. All units, such as the roof girders, glazing girders, side framing and other details, are common to all shops. This has meant lower fabrication costs. The crane spans have also been standardized.

After detailed investigation, the percentage of glass in the northlight roof of the shops, has been fixed at 30 per cent of the floor area. In order to improve ventilation, the glass is arranged in two stretches with an intervening space between. The roof is of Asbestos "big-six" sheets. In the side walls, concrete louvre openings have been provided in all the Shops. All these features, it is hoped, would keep the shops cool.

Considering the poor soil conditions, a heavy type of concrete floor has been adopted in all the Shops. It consists of 6" of stone soling with 3" metal rolled and consolidated with a 10-ton roller. Over the sub-grade is laid 6" of graded concrete with 1" thick wearing surface.

All the services, such as, compressed air, water-supply, electrical and telephone cables, etc., are carried in trenches laid in the floor and covered over with steel chequered plates. This feature, as compared with the practice of carrying the pipes and services above the ground, has contributed towards general cleanliness and neat appearance of the shops.

It has been the practice in the past to plan the distribution and carrying system of water, compressed air and electricity independently above the floor level resulting in a multiplicity of supporting schemes criss-crossing the shops. The present-day development is however to lay all the services underground below the shop floor as a co-ordinated scheme. In the new factories that are under construction in Western Countries, this method is being adopted.

The Shop area is well served by concrete roads and Railway sidings to help the easy handling of material.

Individual machine foundations have been prepared for all heavy machines and for the hammers, pile foundations have been adopted. However, the common purposes machines and other lighter machines are placed directly over the concrete floor of the shops.

Ancillary Buildings

The most important of the ancillary buildings connected with the workshops is the Administrative office building. This is a four-storeyed steel-framed structure founded on piles, and is completely air-conditioned. The estimated cost of the structure including air-conditioning is Rs. 14·93 lakhs. The building has a floor area of 59,252 sq. ft.

A large double-storeyed structure outside the compound of the Factory serves as a Workers' Canteen. It is proposed to run the canteen as a Cafeteria. Under the roof of each shop, one or more Foremen's offices have been constructed on R.C.C. platforms supported on heavy R.C.C. cantilevers. The offices will be fully glazed on the sides so that from a height, the Foremen can have a good view of the Shops.

Construction Equipment

For carrying out the Civil Engineering works of the magnitude described, it is economical and also time saving if the heavy equipment and plant is procured by the Administration and given to the contractors either free for use or hired out at agreed rates. It will then be possible to put into the field several contractors of comparatively limited means, and in accordance with this policy, steam cranes, mobile cater-pillar cranes, road rollers, compressors and compressed air tools, derricks, winches, concrete mixers, etc., were procured as general charges and make available to contractors.

A small workshop under the Civil Engineering looked after the maintenance and repairs to the plant. This workshop came in handy for the manufacture of odd items of steelwork and other equipment so necessary for the successful and early completion of the works.

Staff Colony

While the Factory was thus taking shape, work on the Staff Colony proceeded rapidly, and it was possible to house most of the construction staff in these buildings, thereby avoiding unnecessary expenditure on temporary structures for housing the essential staff on the construction.

The Colony is planned on a 33 acre estate close to the Factory and has been completed at a cost of Rs. 26·8 lakhs. This Colony is well served by the Transport System of the City of Madras. The smallest type of flat has a plinth area of 325 sq. ft. and is electrified and fitted with a tap. Lavatory and bathing facilities are provided at the scale of one closet and one bathing place for two families. All the other types have individual sanitary and bathing facilities.

Dust-proof roads and water-borne sewage have been laid for the Colony. Ample playgrounds for adults and a children's park add to its amenities. Keeping of cattle has been prohibited in the Colony and to serve the needs of those who wish to own cattle, community cow sheds have been built at a convenient distance from the residential flats.

Protected water-supply for the factory and the staff quarters has been arranged by bringing water from Ennore, a distance of 11 miles from Perambur. The scheme is a joint venture of the Southern Railway and the Integral Coach Factory Administration and costs Rs. 11·5 lakhs.

Cost Data

The Project, it is confidently hoped, will be completed in all respects well within the estimated cost. The figures for the main works and for the Project as a whole, are :

		In lakhs of Rupees
1.	Land ...	5·79
2.	Shop structures including boundary walls, etc. ...	132·30
3.	Services inside shops, such as, roads, track, water-supply, drainage, sewage, etc. ...	17·15
4.	Staff Colony including services ...	34·09
5.	Administrative Office Building ...	8·12
6.	Water-supply ...	6·26
7.	Sewage Scheme ...	1·68
8.	Staff Amenity Buildings ...	3·60
9.	School and Hostel ...	10·18
10.	Machinery and Plant with foundations and general charges ...	265·48
11.	Electrical Plant and installations ...	56·22
12.	General charges for the whole Project ...	82·4
13.	Carriage and freight for the whole Project ...	46·95
14.	Preliminary expenses, permanent way, etc. ...	64·03
	Total ...	735·15

Conclusion

Any Engineer should consider himself extremely fortunate if it falls to his lot during the course of his service to be entrusted with the construction of an industrial unit of the magnitude of the Integral Coach Factory. He would be doubly fortunate, if in addition, he had something to do with the designs of such an engineering venture. It has been the rare privilege of the writer to have been associated with the designs and construction of the two major workshops established by the Ministry of Railways after Independence, viz. the Chittaranjan Locomotive Works and the Integral Coach Factory. He could not have hoped for better good fortune. The fulfilment of the task to targets set by the Government would have been impossible but for the magnificent work and co-operation from the large number of contractors engaged on this Project in Madras and in other parts of the country. It would also have been impossible without the devotion to duty and the wholehearted endeavour of the staff of the Project working in the offices and in the field, from humble unskilled worker to the topmost executive. A mighty industrial unit has been constructed and brought into production exactly three years from the date the first pile was driven at site. Judged even by standards set by countries more industrially advanced and possessing unlimited resources of building material and mechanical equipment, the team may well be proud of a fine job.

PROCUREMENT TO STORES ON A PROJECT

C. D. ELLICOTT,
B.SC. (HONS.) Edin. M.I.E.
(Deputy Controller of Stores, I.C.F.)

Introduction

IT is not the object of this article to lay down here any hard and fast technical procedure that must needs be followed by the Stores Officer attached to a Project to enable him to procure the required materials for his indentors by the dates stipulated in the indents. The sole object is to give the layman a brief insight into the work done by the Stores Organisation on Projects, some of the handicaps under which it has to work, and what is expected of it by the consuming departments.

Need for a separate Stores Organisation

To the layman, there appears at first sight to be little need for a separate Stores Organisation on a Project, inasmuch as the indenting departments know their actual requirements, and can cut out the time spent in transferring their indents to the Stores, by making the necessary enquiries themselves, and obtaining the materials direct, possibly from the very same sources as would be tapped by the Stores Department ; the bulking of the demands for the same item from different indenting departments—as on an open line Railway—does not exist on a Project, and therefore there appears little to be gained by adding to the cost of the construction, the cost of a separate Stores Organisation. On mature thought however, it will be apparent that if the officers of the consuming departments are left to procure their own materials, they will be able to do so only at the sacrifice of valuable time which they can well devote to the actual construction work, unless of course adequate extra assistance is given. The officers of the consuming departments are also usually unfamiliar with the markets where the required materials might readily be available and therefore are more liable to be exploited by small local dealers who might offer to supply the required materials at very much highest cost. Due to the natural enthusiasm to complete a work by the target date, the construction engineers may at times succumb to the temptation of purchasing their requirements locally at a much higher cost. Again the officers of the Construction Department are usually unfamiliar with the standard Purchase Procedure and the wording of the conditions of contract and tender. In spite of every possible attention they may give to the purchase

work, disputes with the suppliers will occasionally arise. The executive officer on construction has very little free time to attend to complaints from suppliers with the detailed attention this deserves, and the ensuing litigation, when it has to be faced, may well prove a costly affair. The only other organisation that might prevent things going wrong is the Accounts Department, but any rigid check by them is often hotly resented by the Engineers on the construction, who are apt to look on this merely as obstruction towards the progress of the construction work. The time, that has necessarily to be devoted towards coming to a settlement with the Accounts Department for obtaining their necessary concurrence to the purchase, or in answering audit objections, can generally be spared only at the sacrifice of supervision over the construction work, unless, as already stated above, adequate assistance is made available to the Engineering Department in the shape of officers and staff. If this were to be provided however, one might as well consider the desirability of utilising the extra expenditure involved in providing a separate Stores Organisation where the officers and staff, well experienced in procurement work, can be left to themselves to obtain expeditiously materials of the required quality from the cheapest source.

A separate Stores Organisation moreover ensures that every indent on receipt is carefully checked to see that it has been correctly prepared and signed by the competent authority, that the description of the material required is adequate to enable firms understanding what is actually required, that the materials are being purchased against a "sanctioned work", that the cost is debitable to a legitimate Head of Account, and that the necessary funds exist for the purchase. It also ensures that the routine procedure of enquiring and ordering is invariably followed in the making of purchases, and in the relatively few cases where material has of necessity to be procured on a single tender, a signed certificate from the indentor is invariably obtained, testifying that only that particular material is required, and that to the best of his knowledge no other suitable material exists which can be used for the purpose for which the particular material is being asked for. Again the chances of serious irregularities occurring are very remote, as the books of the Stores Department are available at all times for Accounts and Audit scrutiny—which incidentally is a continuous process—and all Purchase Orders for any appreciable value have first to be concurred in by the Accounts Department before being certified and issued to firms for compliance. When one remembers that crores of rupees worth of materials are required to be purchased and fed to the different departments, either for use on the construction, or in building up stocks required for use in the factory when it ultimately goes into production, the wisdom of adopting the course of having, attached to the Project, a separate organisation, specialised in procurement work, becomes at once apparent.

Commencing work

The officer in charge of the Stores Organisation on a Project is usually seriously handicapped at the commencement of operations inasmuch as he does not have a well-stocked stores depot to fall back upon for making issues against urgent demands. He has no statistics to justify the appointment of extra staff, and the bare nucleus of staff, which was considered sufficient at the start to cope with the anticipated volume of work, is soon overwhelmed with the amount of work it actually has to handle, with the result that serious arrears of work threaten to pile up. When eventually he is able to justify the need for appointing additional staff, there comes the long wait before the staff are actually appointed and by the time this happens, more construction works have been taken in

hand, and demands have so increased, that the need for further staff is again apparent. The only solution to this problem is for the officer-in-charge to ask for staff, not on the basis of statistics relating to the actual work being carried out, but on his anticipated requirements of staff that will be required to deal with the maximum amount of work that might have to be handled over a specific period of a year or two, on the understanding that the staff would be appointed up to this limit only when actually necessary. It is possible for the stores organisation to work efficiently only if adequate staff are available for handling the volume of work involved, and until staff are provided in full, one must expect things at times to go wrong.

The officer-in-charge of the Stores Organisation has to arrange for the procurement of the immediate requirements of the Engineering Department while simultaneously organising both his stores depot and the office, starting operations with a few experienced staff which he might have been fortunate to get from the Stores Departments of any of the Railways. For the balance of staff he will be getting only raw youngmen, recruited by the Regional Service Commission, and who have, in the majority of cases, just passed out of school. It is entirely the responsibility of the Stores Officer to see that these youngmen are speedily schooled in the principles of store-keeping and stores procurement work, so that they become useful to his organisation in the shortest possible time. The importance of systematic and immediate training of these youngmen can never be over-emphasised, and in fact the success of the whole stores organisation may well be said to depend on the help that will be forthcoming in the future from these new recruits, who will ultimately make up the bulk of the stores staff in the department.

While it is not possible here to describe at any length the actual organisation that has to be carried out both in the office and the depot, it will suffice if it is briefly mentioned here that three or four procurement sections must necessarily be formed in the office, each to deal with certain classes of stores. One section may for example deal with the procurement of building materials, pipes and fittings, etc., while another will be given the task of procuring steel and other metals, machinery and tools, etc. A third section may be allotted the procurement of materials such as electrical goods, stationery and miscellaneous stores. Later, when the Mechanical Department attached to the Project comes into operation, it may be necessary to sub-divide one or more of these procurement sections into two, e.g., the second section mentioned above may be formed into two separate sections, one dealing with the procurement of steel and other metals, while the other deals with the procurement of machinery and tools.

In the depot the wards should also be organised similarly so that each ward stocks only certain definite classes of materials. If this were to be done, it should always be easy to decide which section in the office is to take procurement action on an indent for some particular item, and in which ward the item on receipt is to be stocked.

Delegation of Powers

The powers of Purchase of the officer-in-charge of a Stores Organisation attached to a Project have necessarily to be far greater than those normally delegated to an officer of the same grade on a settled organisation. This is necessary since the officer-in-charge has to act more or less in the capacity of a Head of a Department, and is moreover continually faced with new problems in regard to the procurement of stores which require an immediate decision and prompt action on his part. His responsibilities when attached to the Project are therefore far more than if he were on the open line and for him to be any

measure of success at his job, it is necessary that he be delegated adequate powers to enable him to speedily implement his decisions without having to put up the matter to someone else for decision.

Urgency of Requirements

While it is possible that in the years to come efficiency will have so improved and planning so perfected that ample notice will always be given to the Stores Organisations on projects to procure all the required materials by the dates on which they are actually required for erection—thereby making it possible for the procurement work to be carried out in the normal routine manner with the observance to the rules formulated for procurement—at present a considerable quantity of material has very often to be purchased at very short notice from time to time. to supplement the bulk purchases which admittedly are arranged at the start of the construction phase. The limited time for procurement, as stated in the indent, naturally limits the scope of the enquiry and results in "ex stock" quotations having to be accepted at somewhat higher prices than at which the identical material could be obtained against longer delivery periods. Such demands are, therefore, normally frowned on by the Stores and Accounts Officers, who invariably feel that they could easily have been foreseen sufficiently early to permit purchase at the cheaper rates. Such urgent requisitions must however be considered for the present to be but a normal feature on the Project and considerably large quantities of material, often of the fabricated type, must from time to time be purchased within a matter of weeks so that the construction work on the Project progresses as per programme without any hold-up. It thus follows that not only must the procedure for the enquiry and ordering be speeded up, but each order must be continuously "chased" from the time it becomes overdue to the time the material is received and handed over to the indenting department. The layman here might well remark that, after all, this is the work which a stores organisation must be expected to carry out in the usual course, and that there appears nothing very special about it. It must be pointed out, however, that on the Project where numerous different works are simultaneously in progress, a large number of men have to be employed for various construction works from day-to-day. When any required material is not immediately available, progress is liable to come to a stop resulting in an appreciable number of men sitting idle, waiting for the material, thereby resulting in infructuous expenditure. At any one time there are always about four to five thousand purchase orders outstanding, some in India and some abroad, and each and every one of these orders has to be watched, progressed, and chased, so that there might not be even one single instance where the required material is not immediately available when required, lest this retards progress of the work on the project. Only when these implications are fully realised, the enormity of the work of the stores organisation attached to a Project can be appreciated in its correct perspective.

Whether due to lack of foresight, or. which is more often the case, due to being able to decide on the required material only as the actual construction work progresses, about 60 to 80 per cent of the indents received each month during the construction phase are "very urgent" and the Stores Department has necessarily to act promptly on these indents and to produce the goods by the date stipulated on the indent, if it is to do its bit towards the common cause of completing the construction work by the target date.

Procurement of Stores for the Integral Coach Factory

The Stores Department of the I.C.F. started functioning as a separate unit from 1-4-1952 and since then it has procured materials to the value of

Rs. 2·5 crores. While the Engineering Department issued "Works Tenders" for 7,000 tons of Steel work required for Shop Construction and obtained this quantity direct, thousands of tons of steel rods and cement, required for reinforced concrete work by the Engineering Department, have had to be procured and supplied by the Stores Department. 1,020 tons of Armco sheets were obtained by importation from America and a like amount of the same item is again shortly expected to be received from this source. 2,400 tons of steel to the German "DIN" specification had also to be imported. Including both the requirements of the Engineering and Mechanical Departments, more than 8,000 tons of steel have already been obtained by the Stores Department both from indigenous sources and by importation. The quantities of cement supplied by the Cement Factories at Dalmiapuram and Madukkarai also total approx. 25,000 tons.

For the procurement of machines required to be installed in the Factory, Global Tenders were arranged to be issued with the approval of the Railway Board and considerable publicity was given to them through the Indian Embassies in the various countries, so that quotations from firms all over the world were obtained for their supply. This tender was finalised at Schlieren, in Switzerland, and 544 machines were ordered abroad to the total value of about Rs. 1,07,23,000. In addition 65 other machines were ordered in the country to the value of Rs. 21,00,000. 512 machines have already been received and a good proportion of these have already been erected. More than 500 Erection tools had specially to be procured for the installation of these machines, and more than 2,200 different Production Tools have been ordered for use on the machines. 2,168 production tools have already been received. Tool cribs and Tool cabinets for housing these tools have since been procured from Messrs. Godrej & Boyce Manufacturing Co. who came forward in response to the enquiry issued by the Stores Department and successfully manufactured them for the first time in their workshops at Bombay.

The Integral Coach being a completely welded unit, has necessitated the purchase of 8,00,000 ft. of Oerlikon Electrodes of different gauges. The raw materials, semi-finished, and finished items required for the manufactured of 270 coaches have already been arranged for supply, and indents for similar materials will shortly be submitted for a further 175 coaches. Hundreds of gallons of special corrosion-resisting paints have also been arranged for the painting of the Integral Coaches before they are turned out of the factory.

While the aim is to ultimately have the Integral Coach manufactured entirely out of indigenous materials. at present due to Swiss Collaboration and the fact that the Swiss Technical Advisers are accustomed to Continental Specifications and practices which are new to Indian Manufacturers, a certain proportion of the coach components has temporarily to be imported from abroad. Where materials are not available in the country and there are no Agents of foreign manufacturing firms in India, and where time does not permit of the material being obtained through the Director-General. India Store Department, London. costly cables have to be sent abroad calling for quotations in sterling and orders placed thereafter, duly obtaining a user's Import Licence from the Chief Controller of Import, New Delhi. By the issue of Educational Orders in the country, however, the number of imported items is gradually being reduced and it is likely that within the next few years, the objective of building an All-Indian Coach will have been realised.

Up to this point the writer might have given the impression that all the procurement work for the Project is being done by the Stores Department attached to it, but this is neither the

intention nor the case. Procurement has been invariably arranged through the normal channels of procurement, and by the submission of indents on the Supply Department Organisation in India or in London, wherever the value required this being done and the time of delivery, as specified on the indent, permitted the adoption of such a course. In fact, special powers of purchase for direct procurement action were arranged to be obtained for the Regional Director of Supplies, Madras, by this Administration, so that this might facilitate purchases being made by him for the Integral Coach Factory. The writer must here acknowledge the ready help and co-operation he has continually been receiving from the Supply Department in the purchase of stores required for the factory.

Peculiar Purchases

A Stores Officer attached to a Project has of necessity to be resourceful and continually keep on solving problems that might well baffle the average man. It is the duty and responsibility of the Stores Officer to obtain the correct goods in time and how he does this is solely his responsibility and concern. For example, it is not uncommon for giant packing cases to be received at Madras Harbour from abroad. These have to be brought to the Integral Coach Factory as soon as they are received and some of them frequently measure anything upto 74′—0″ × 10′—0″ × 10′—0″. These cases however present very little difficulty in transport inasmuch as they are consigned to the factory from Zurich in Switzerland by Messrs. Swiss Car & Elevator Manufacturing Co., which is collaborating with the Indian Government in the manufacture of Integral Coaches at Perambur. The Swiss Technicians with their usual foresight and detailed planning have made the transport of these large cases an easy matter, but occasionally giant packing cases, received from other sources, create some consternation on receipt at the Harbour. A large case measuring 22′—0″ × 8′—0″ × 11′—6″ and weighing 38 tons 10 cwts. was recently received with material relating to a 1,000 ton hydraulic oil press which was required to be urgently installed in the factory, and while normally it should have been conveyed in a BWL "Well" truck by rail, the Southern Railway could not supply such a truck immediately, and considerable delay was anticipated in it becoming available. The Cart Contractors all shook their heads and proclaimed that the case was too heavy to be borne on their carts; all the Public Transport Companies in Madras stated that they had no suitable vehicle on which to convey it; the Military authorities, who were contacted both at Madras and Avadi for a Tank carrier, regretted that they had no immediate facilities to help in the conveyance. Finally after a good deal of more investigation the Public Works Department came to the rescue and obtained from Bhavanisagar a Foder Tractor and a 40 ton "Karymor" trailer, on which the case was successfully loaded and brought to the factory where it had to be unloaded with the help of four Locomotive Jacks obtained on loan from the Southern Railway.

As to the procurement of items of peculiar identity, the writer can quote quite a few examples but perhaps only one will serve as an illustration of what one has to cope with when procuring stores for a project. Recently the Stores Department were asked to procure urgently and stock 3,250 lbs. of Kapa Fazer Kitt. One might well wonder as to the type of material which was actually required to be purchased; which procurement section of the office was to deal with the purchase; to what line of firms were enquiries calling for quotations to be sent; and which ward was to stock the material. But why worry? Leave it to the Stores Department to procure the goods—And "immediately" please!

A COACH EVERY 6 HOURS-PRODUCTION PLANNING AND CONTROL

C. G. DEVAYA, B.SC., G.I. Mech. E.
Production Engineer
Integral Coach Factory

CONSTRUCTED and designed for a production programme of 350 broad gauge steel coaches a year, when in full swing production, the factory will turn out coaches at the rate of one in every 6 hours. To achieve this colossal Production task, the orderly planning of work through the factory is obviously necessary and the function of the Production Planning and Control Departments is to make possible such orderly arrangements. Planning is the technique of foreseeing or picturing ahead every step in a long series of separate operations, each such operation to be of maximum efficiency and of so indicating each step that routine arrangements suffice to cause it happen in the right place and at the right time. The mental labour of production is reduced to a minimum by planning before the work is started by defining what work shall be done, how the work shall be done, where the work shall be done and when the work shall be done.

In order to appreciate the complexity of the production task in this big factory requiring systematic 'thinking through' of the process in advance, a brief description of the machinery, tools, raw materials, jigs and fixtures that are required in the factory is furnished.

Machinery

At peak production in the factory, there will be nearly 900 various types of machines including welding sets in operation. Several of these are single purpose or special purpose machines capable of producing coach components at the very fast rate demanded by the heavy output programme chalked out for the factory.

The Sheet Metal shop machinery will consist of Guillotine Shearing and Straightening machines for the preliminary operations. Presses ranging from 30 to 1,000 ton capacity will produce the various pressings and other parts which go to make the body shell and the bogie frame. Welding machines include Automatic foil and butt welding machines and for flame cutting, Multi Spindle Oxy-acetelyne cutting machines will be in operation.

The Forge Shop is equipped with Eeche double acting Swaging Hammers ranging from 16,500 to 72,500 ft./lbs.

and trimming presses of 300-400 ton capacity besides other single acting forging hammers. Several forgings are required to be produced particularly for the draw and buffing gear and brake equipment. Wheel Blasting unit, Cold cutting saws, furnaces for heating the blooms and heat treatment furnaces go to make up the machinery in the forge shop.

Several light parts are required to be machined besides heavy items like Centre Pivots, axle boxes, brake beams and bogie bolsters. For this purpose. the machine shop is equipped with turret lathes from Germany as well as England, some specially tooled for particular components. Milling, Slotting, Shaping and Drilling machines besides a number of Centre lathes produced in India will tackle the lighter jobs. Machines for bar peeling and straightening prepare the various bars to be fed into the semi automatics. Horizontal boring machine, vertical turret lathes and special purpose machines for bogie bolsters, brake beams and brake shoes are also included in the machine shop. The wheel shop is equipped with modern machines for high speed production of wheel sets and axles.

A Precision Jig Borer produced in Switzerland and a Hydro-copying die milling machines are among the interesting machines with which the tool room is equipped besides the grinding machines for the high speed and cemented carbide tools. A Universal Testing Plant provides facilities for testing the raw materials and coach components for physical properties such as the yield point, ultimate tensile strength and elongation. For the purposes of surface treatment of components, anodizing and electro-plating plants are provided.

It will be thus seen that for the production of the coaches, machinery of various descriptions are provided and it is most vital that these machines are utilised to their maximum capacities.

Tools

The effective utilisation of the modern high speed machines described above, calls for the provision of upto-date tools which are being produced in the machine tool world. Tool Engineering is now a large field of specialisation in which there is constant trend towards improved methods which have far-reaching effects on production. The technical elements of the subject are the concern of the Tool Engineer but the Production Engineer however should be alive to the possibility that affect his work. The Production Department therefore has ensured that the factory is equipped with the latest tools that are being manufactured to assist the industries to cope up with the demands for high speed production in this era of mechanisation.

To quote one example of the vast strides that have been made in Tool Engineering, manufacturing operations involving cutting of steel and other metals have been speeded up by about 400 per cent by the use of cemented carbide tools which are manufactured by the process of sintering of tungsten and carbon with cobalt featuring where special properties are desired. Krupps of Essen, Germany were the pioneers in the manufacture of this extremely hard carbide alloy but now such tools are being manufactured by various enterprises all over the world. This carbide hard metal which is not steel is harder than the hardest steel. Even at 700°C, its hardness is still greater than that of the high speed steel (18 per cent Tungsten) at room temperature which explains the reason for its unbelievable cutting capacity and long tool life.

For the factory, in the first instance, the tool requirements for the production of 250 coaches have been procured and this consists of 2,168 different items of tools totalling to about 2,50,000 numbers purchased at a cost of about Rs. 16 lakhs. The enormous numbers of tools that will be required in the factory against the various categories

will be appreciated from the figures furnished below :

		Nos.
Twist drill	...	19,788
Centre drill	...	1,020
Taps	...	5,893
Threading	...	515
Chasers	...	28
Counter borer	...	544
Reamers	...	721
Lathe tools	...	10,805
Shaper	...	124
Milling	...	6,071
Grinding wheels	...	1,529
Gauges	...	650
Measuring tools	...	1,870
Files	...	9,978
Chisels	...	600
Pincers	...	1,453
Hammers	...	4,495
Wrenches	...	1,210
Miscellaneous	...	76,610
Hand tools	...	1,04,029

Besides these, several special tools have been procured for use on special purpose machines.

An efficient organisation for tool control will ensure the availability of the correct tools and their maintenance. Proper maintenance of inventories and tool records including their history in service will enable evolving tooling of jobs to an efficient degree.

The issue of tools in the various shops will be from suitably located tool cribs which enables the various tools to be stocked and issued in a systematic manner. The tool room will ensure that the tools are kept ready in advance so that when required by the operator, the right tools are immediately available at the tool cribs. Inefficient tooling and tool control are frequent causes of workshops not obtaining the maximum output from the installed capacity. The tool crib operation will provide for careful, accurate and rapid service. The double token system which will ensure quick issue without any paper work will also locate the tools already issued as well as the parties to whom issued.

Jigs and Fixtures

As this factory has been built to produce one particular type of coach known as the 'Integral Coach' in the first instance, there is a concentration on manufacture of specific type of products as compared to the various types to be manufactured against customers' requirements in other commercial factories. In other words, long production runs are made possible which gives the maximum scope for the use of jigs and fixtures. Taking full advantage of this fact, in the pre-production planning, 670 jigs have been provided for at an approximate cost of Rs. 20 lakhs which will greatly assist to simplify the manufacturing operations by eliminating individual attention that would otherwise be necessary to the Marking and clamping of the work and guiding of tools with respect to each job. Of these jigs, four are large assembly jigs, for welding the various members together to be utilised in the assembly shop for the under frame, roof construction, end construction and final body assembly where the shell is completed.

Raw Materials

The coach to be manufactured has been designed by the continental firm The Swiss Car & Elevator Manufacturing Corporation Ltd., Schlieren-Zurich, Switzerland and the specifications for the various raw materials have been drawn out taking into consideration the stresses that the members to be manufactured from these raw materials have to bear and also manufacturing operations that are involved. For each part, it is therefore to be ensured that the correct raw material is supplied.

Steel items of various sections, thin steel sheets and plates, light alloy sheets, tubes and pipes, rubber profiles and parts, light alloy extrusions castings and forgings, pipes and pipe connections, stainless steel screws and nuts, springs, paint and insulation material, etc., are the various types of raw materials that are required for the coach.

When the coach is turned out of the factory in an unfurnished state together with the bogie, each coach will weigh 32 tons and for the 350 coaches it will be seen that about 11,200 tons of materials will have to be stocked in stores and handled through the manufacturing shops. In addition to these 350 coaches which will be currently turned out during the year, the components for the future batch orders will have to be manufactured continuously and the amount of materials that will be stocked and handled is expected to be at least 20 to 30 times the above tonnage including the several items of other consumable items and indirect materials required for the manufacturing processes and the maintenance of plant. By scheduling carefully well in advance it will be ensured that the raw materials are made available for the commencement of production on each batch order.

Handling

Efficient handling and conveying arrangements are most essential for economical production. The transport of materials, so that they will be made available at the proper time and at the proper place with correct quantities, requires considerable organisation.

Each part has to be handled to and from each machine or through each manufacturing operation and must be transported from department to department during the course of manufacturing. The greatest part of the indirect labour that is employed is engaged in handling material and it is a well-known fact that the hand labour is the most expensive kind of transport to employ particularly in a factory like this where the volume of work to be handled offer opportunities for mechanical handling. Very often cost of production is almost directly proportional to cost of handling materials. Handling has therefore been eliminated wherever possible and for the handling that is necessary mechanical means have been provided for. Fork Lift trucks, Lister trucks with trailers, pallets, containers etc. cater for the movement of smaller parts between shops and good concrete roads provide for efficient intercommunication. The installations include 20 cranes of 5 ton capacity, 4 cranes of 20 ton capacity, 2 traversers of 70 ton capacity, 3 lifts and several portable hoisting arrangements for feeding the various machines. Wheels and axles in storage are handled by a 5 ton steam crane and a Neals 5 ton tractor crane is available for other miscellaneous purposes. For the handling of sheet metal between the various machines, ball transfer arrangement has been adopted.

In order to ensure easy transort and availability of the purchased and manufactured parts required on the assembly lines, each part or subassembly is nominated to be stocked in a conveniently located Finished Part Stores.

Man Power

It is anticipated that at peak production, the factory will be employing about 4,000 workers in the different trade categories. Apprentices carefully recruited are being trained in a well-organised Technical School.

Production Planning

Careful pre-planning involving the study of the methods of manufacture to be adopted for the production of these coaches has resulted in the decision to equip the factory with the machinery, plant and equipment described above and the project involves a capital outlay of about 8 crores of rupees. To ensure the mobilisation of the man power to an ever-increasing degree and to direct the attention to the maximum employment of all the above production resources is the function of the Production Planning and Control Department. Considerable thought and great attention to details is given to the organisation of the department to ensure that the labour and machines are utilised to the utmost thereby deriving the greatest output from the

investment made. Cost consciousness is an essential part of production planning and great emphasis is therefore rightly given to the need for economical output.

Parts to be manufactured

In preparing for production, a master list of parts has been drawn out after dividing the coach into various groups indicating the individual components required for the roof, side walls, end construction, under frame, draw bar and buffing gear, vacuum brake and bogies separately. The decision whether the part is to be manufactured or purchased and the number of coaches to be produced on each production order is decided taking into consideration the manufacturing capacity developed at each stage. The maximum efficiency in production is no doubt obtained by manufacturing the required quantity of the product, of the required quality, at the required time by the best and cheapest method. In several cases parts are stored as sub-assemblies for greater ease and efficiency in assembling.

Machinery Capacity

A complete analysis of the machinery capacity is first made out by the Production Department to have readily accurate information as to the capacity of the plant to manufacture the various parts under different conditions. The machines are divided into various groups, each group consisting of machines of similar manufacturing capacity. The potentialities of each machine is then recorded to enable the planner readily to know the various operations that the machine is capable of and as to how long the machine will take to perform each operation on a unit quantity of material. The necessary information is obtained by both actual experiment and time study and by reference to the capacity of the machine as claimed by the manufacturers. Such analysis is complicated due to the fact that the speed at which the material can be fed and cut varies according to the nature of material, the type of tools used, the degree of finish or accuracy required. In machine work operation, the speed varies according as hard steel, cast iron, brass, copper, aluminium, etc. are being worked on. The condition of the work particularly the castings may cause wide variations in possible operating time. If coarse work is being done quicker work may be expected than when fine tolerances are being aimed at. The ability of machines to take heavy cuts depends on the rigidity of construction, method of mounting cutting tools and the amount of power that can be delivered to it. In working near the limit of capacity of a machine, insufficient power may be available or the awkward character of the job may prevent power being applied to the right extent. Machine analysis to a maximum extent that is practically possible is a necessary pre-requisite to deciding the sequence of manufacturing operation for unless the capacity of each machine concerned in production is accurately known, there can be no intelligent planning. Thus for each given machine, the best cutting speeds and feeds and depth of cut to be used for the various materials are determined and recorded in the form of charts so that at the time of planning, the most suitable speeds and feeds may be easily determined and the time required for each operation fixed.

Operation Plan

Having analysed the machinery capacity and decided the number of parts to be manufactured a detailed operation study is made for each coach component to determine the raw material required, the most suitable method of manufacture duly selecting the most suitable machine and to give the time allowances for each operation and the sequence of operations. The special tools, jigs and fixtures that are to be utilised for the purpose is also decided. Such operation study is a highly technical process and can be entrusted to only those who have experience and the technical training which has made them perfectly

familiar with the production problems of the class work being done in the plant. A master operation plan is made out after the operation study indicating description of the part to be manufactured, the raw material required, the machine group to be utilised for each operation, special tools, jigs or fixtures to be used and setting and operating time for each operation.

Time Study

For most of the jobs actual time study is carried out while the operation is in progress to ensure the accuracy of timings laid down. Special instruction sheets furnishing the particulars of tooling, speeds feeds and depth of cuts are issued to shops so that the operator is in possession of the complete 'know-how' to produce the job. The gauging of the efficiency of the plant and the success of any incentive system of payment that may be introduced in the factory will greatly depend on the efficient planning and rate fixing for the various operations.

For the time study therefore, experienced men who can command the respect of the operators are selected. Mass timings of large groups of elementary operation is almost useless. The operations are split up and listed and the time required for all the motions of the operator and the operation itself is recorded by means of stop watches so that the time for the complete work cycle can be analysed in detail. Thus in a time and motion study the time required for such operations as setting the jig, clamping the work, moving the tool, withdrawing the tool, changing the tool, etc. is recorded and the decision taken as to which of the operations can be quickened by adopting alternative methods. It must be realised that time study is not made to force the last ounce of effort out of the workers but its usefulness lies in the fact that by a scientific study reasonable timings are fixed and as a result very often it is possible to improve methods and also standardise equipment. Certain operations are eliminated or simplified or a better sequence of operations adopted. Time observations are made over a long stretch of period and several such observations are made as there is a difference between what a man can do for short times and what he can maintain. This enables fixation of reasonable timings for the preparation of the master plan where taking all the above factors into consideration, the time for setting up and operation is recorded.

Production Documentation

The operation plan is typed out on a specially designed hectograph master form which is used for reproducing the other production documents which are required to be issued to the shops. Such reproduction is done by means of the Reproducing Machine manufactured by 'Ormig' of Germany and enables the whole or a portion of the contents of the master operation plan to be transferred on to the various production documents which are necessary thus eliminating a lot of repetition of typing work and also avoiding errors which might otherwise crop up if the production documents are to be prepared individually. For every production order issued on the manufacturing shops a material requisition, a job card, a route sheet and a progress sheet are reproduced from the master operation sheet. The forms are so designed as to include all relevant data keeping in view the necessity to reduce the number of documents required to record information and simplify paper work where shops are concerned at the same time ensuring that the work flows smoothly right from the supply of raw materials to the completion of the coach.

The material requisition is an authority for the shops to draw the required quantity of the correct materials from the stores and enables the accountal for materials used on the basis of the information on the card which is reproduced from the top portion of the master card. The job card constitutes the authority for the execution of each operation required for the production of the component in the shop concerned and indicates the time allowed for each operation. The time of commencement and completion by the individual worker for the particular operation is punched directly on this card by means of Job Costing Recorders which have been provided in each shop for the purpose. From the job card, the time actually taken for the particular operation is computed by the Accounts Department for the purposes of job costing. The route sheet serves as a means of indicating to the shops, the sequences of operations besides providing for the particulars of inspection to be entered. The route sheet accompanies the materials right through the various sequences of operations until the finished product is received in by the Stores Department from where it is transmitted to the Accounts Department through the Production Department for accounting purposes. The progress sheet which contains information similar to the route sheet is retained by the Production Control Office to keep a watch on the date of commencement and completion for each operation to ensure that the shops keep up to the scheduled dates and thus ensure the availability of the components when required for assembly on the production lines.

Scheduling

A scheduling section working in the Production Department is responsible for fitting of the specific jobs into a general time table so that in mass production each component may arrive at and enter into an assembly in due order and on time. A preliminary schedule is first made out approximately fixing the quantities of each variety of product to be made in a future period and to collate the call on manufacturing capacity set up with the normal manufacturing capacity available. The order or sequence in which different items are to follow each other, i.e., approximate periods in which specific quantities are to be manufactured, is an essential feature. Such Master Schedules are compiled for each separate line of product and show at least approximately the time required to process each item and hence to carry along a unit quantity of product through all stages of manufacture. Such preliminary scheduling is general in character and does not pin down the specific dates.

After the manufacturing processes have been finalised by the Planning Department, the Scheduling Section gets down to the detailed schedule wherein specific target dates are assigned for each job duly taking into consideration the raw material availability, the time required for the manufacture of the components, machinery capacity available and the latest date by which the coach componet is required on the assembly lines. These assigned dates for each component is entered in the job cards and the progress sheets so that the manufacturing and the Production Control Departments can watch and ensure that the programme is actually put into effect and the dates set for each operation are observed.

Progressing

The function of the Progress or Expediting Section is to ensure that for each operation the raw materials are available in time and that the operations are commenced and completed as per the scheduled dates. All delays are pin pointed and necessary expediting action taken. While the progress sheets enable the watching of the progress on individual operation, a Master Progress Board is maintained which at a glance indicates up-to-the-minute information as to the inventories and the progress of manufacture in relation to the planned programme. If bottlenecks or obstructions arise to impede the flow of production, it is for the Progress Department to take effective action and clear the way so that the production programme can be adhered to.

Machine Loading

This is an important aspect in production control as with the issue of the

various production orders, it has to be ensured that the machinery capacity is properly utilised and the loading on the various groups of machines is evenly balanced. Due to several varying factors, such as machinery breakdowns, non-availiability of the correct tools, jigs or fixures, inability to keep up to the planned timings, sickness of operators, etc. it would be necessary to do certain operations on machines not visualised for a particular operation in the initial planning. For this purpose Gantt Charts in various forms are maintained by the Production Control Department to compare the machinery capacity availability with the load brought on to the machine group by the issue of the various production orders by the Production Department. If at a particular stage for any reason, the load on a group of machine exceeds the capacity available, the machine loading section brings this fact to the attention of the Production Planning Department who in turn will plan the operations to be carried out on other types of machines where spare capacity may still be available. For the purposes of machine loading in the factory, the Ruegg Naegeli Production Control machine will be utilised.

Against each group of machines, a colour plastic strip with a length representing the number of machine hours involved for the operations on the particular order is fixed in a specially designed bracket so that the total linear length of all the strips will represent directly the load in machine hours at any time.

At a glance from the board, the Production Department will be in a position to keep a track on machine loading and have up-to-the-minute information regarding the capacity available in each machine group for the absorption of the future production orders.

Plant Efficiency

From the detailed planning of manufacturing operations, the actual time that should be taken on the various jobs in the plant is known and this is compared with the actual time taken. In every manufacturing unit, due to several reasons, the actual time taken differs from the actual time allotted as per the operation plans and the difference between the two figures represent the loss or gain in the machine hours from which the efficiency of the plant with respect to each machine group is recorded. Such losses are analysed under the various headings such as machine breakdowns, inefficiency of operator, inefficiency of tooling, defective materials, etc. and the Planning Department investigates the reasons for such losses in machine hours and take necessary action to prevent the future leakage of machinery capacity due to such reasons.

Cost Control

Planned production serves as a means of waste elimination and cost control. It is most essential that the coaches should be produced in the most economical manner and the aim is to bring the cost of production to as low a level as possible as compared to the cost of coaches that were being imported. To ensure this, strict vigilance will be maintained in the factory on the various items of expenditure.

The production documents, the job cards and the material requisitions when completed afford the necessary data for ascertaining the cost of direct material and labour. The overhead expenditure of the factory is separately ascertained as indirect charges for each shop by booking of the expenditure against the various items and for this purpose special standing expense numbers are issued for each shops. The factory is divided into various shops for this purpose, a shop being a unit where the various manufacturing operations carried out are similar in nature. The overhead expenditure cannot be directly allocated to individual jobs and therefore is treated as indirect expenditure. Supply of fuel, power, light, water, indirect materials and labour such as transport, depreciation of building and equipment are some of the examples of such indirect expenditure which are collected as factory overhead expenditure

Punched Card System

It is intended to introduce an elaborate cost accounting system so that a maximum analysis of expenditure is possible whereby a check can be maintained on wasteful production and expenditure. The system of punched cards is likely to be adopted in the factory and with this end in view, the production documentation is so designed that the relevant data can be transferred on to the punched cards. The part numbering for the coach components, drawing numbers, Work Order numbering, shop and expense numbers etc. had to be carefully thought out to ensure the adoption of the punched card system. In order to ensure efficient cost, stores and production control in a large undertaking such as this factory, a quick analysis of a colossal number of figures is required. The quantum of clerical work involved would be considerable and mechanisation is therefore the only answer. The punched card system fulfils this function by a series of processes which necessitate the transcription of the information on the original production documents (job cards and material requisition) into a form in which they can be mechanically analysed and totalled. This is done by punching the various data represented by digits on to the punched cards by means of punching machines whereafter the punched card itself operates the various machines through which it is passed. After a verification process, the punched cards are sorted out on sorting machines and grouped under the various headings under which it is desired to take totals, the totalling being done by tabulating machines through which the sorted cards are passed. Such a system of mechanical tabulation is most in valuable for planning and production control as it caters for the tabulation of data required for machine loading, scheduling, recording efficiency and ascertainting reasons for rejections of materials. By a proper system of coding, the information required by the Production Engineer can be extracted accurately and quickly.

These are the various means whereby when the factory sets about its task of producing 350 coaches each year, the inevitable operating friction will be reduced to a minimum and clear instructions are issued to every man in the factory regarding the production methods so that high man and machine hour productivity is ensured.

WATER SUPPLY FOR THE INTEGRAL COACH FACTORY FROM ENNORE

A. K. RAMAYYA,
Executive Engineer

General

THE Integral Coach Factory when in full production is estimated to provide employment for about 4,000 workers. But the Staff Colony attached to the factory has been built to accommodate 400 workers of the essential category.

The water supply scheme for the Integral Coach Factory has, therefore, been planned not only to meet the requirements of water for production processes but also for the needs of the workers within the workshop area for drinking and washing and for domestic consumption in the Staff Colony. In addition, the water requirements of a Swiss Hostel, Club Building for Staff, Rest Houses for Officers and Subordinate officials, Hostel for 250 apprentice trainees, a Technical School with attached satellite workshops and last but not the least the horticultural activities in the Staff Colony and workshop area, have to be catered for.

For the Staff Colony, which is completely sanitized with modern fittings and water borne underground sewerage system, it is proposed to allow 40 to 50 gallons of water per head per day. Assuming five persons in an average family, the following statement gives the total quantity of water required daily :

	Gallons
(a) Staff Colony including Officers' Flats and Swiss Hostel ..	85,000
(b) For workers inside the factory (4,000 x 5 gallons) ..	20,000
(c) Manufacturing Operations ..	50,000
	1,55,000

This quantity, viz., 1,55,000 gallons, which represents the total requirements of raw and filtered water for the factory per day, will meet the needs of the factory during normal times. An allowance of 45,000 gallons per day is, however, made for future expansion of the Colony and increased production in the workshops, thus placing the total anticipated requirements at 2 lakhs of gallons per day.

The Southern Railway Workshops and their staff colony in Perambur have also been experiencing much difficulty for water in the past. And, as most of the efforts to obtain entire requirements of water in and around Perambur had failed, a joint scheme costing Rs. 11·55 lakhs was drawn up by the Integral Coach Factory in consultation with the Southern Railway Administration for pumping adequate quantities of water from a site near Ennore Village to Perambur.

Preliminary Investigation

At the time of taking up the preliminary investigation for the location of the Integral Coach Factory at Perambur in the year 1951, a scheme to sink two or three 20 ft. dia. shallow wells in Cooum River-bed and to pump the water thus obtained to the factory at Perambur was thought of. A trial well 6 ft. in diameter was, accordingly, sunk in the river-bed opposite to mile 4/6 on the Poonamallee High Road upto a depth of about 25 ft. but the yield from this well was so poor that the scheme had to be given up.

The feasibility of obtaining part of our requirements of water locally in Perambur by digging wells, was next considered. Three wells of 16 ft. dia. were also sunk to depths varying from 25 ft. to 35 ft.; but the yields from these wells was so poor that it was decided not to continue these investigations any further.

A 11 inches dia. deep bore was next tried and sunk to a depth of 150 ft. at a place about a furlong away from the factory premises, which, too, gave no promise of yielding water sufficient to our requirements. The possibility of obtaining water from Madras Corporation was also considered but given up in view of the prohibitive cost of purchasing the water from them.

Joint Venture with the Southern Railway

At present the Southern Railway Administration have a pumping installation on the North-East line at mile 7 (from Madras) between Ennore and Tiruvottiyur Stations, from where water is being pumped through a 9 inches C. I. Pumping main to Tondiarpet Marshalling Yard and Basin Bridge. This supply meets the demands of the Southern Railway at Basin Bridge Loco Shed, Madras Central Station and the Railway Marshalling Yard at Tondiarpet. The feasibility of expanding this source and pumping the additional yield thus obtained to Perambur, to meet the increasing demands by the Southern Railway and fresh requirements of the Integral Coach Factory, was taken up for examination.

The requirements of water for the Southern Railway at Perambur to meet the needs of the Staff Colony and the Loco and Carriage Repair Shops was computed to be approximately 4,50,000 gallons per day. Adding to this 2 lakhs gallons of water required for the Integral Coach Factory, the total requirements at Perambur would amount to 6,50,000 gallons per day. Out of this, 2½ lakh gallons will be filtered water for domestic consumption and for drinking inside the Shops and this will be supplied by a pumping station already working at Perambur which filters water from a nearby Ground Level reservoir and supplies the same through a set of five high level tanks after chlorination.

The total combined demand for Basin Bridge, Central Station and Tondiarpet Marshalling Yard is assessed at 6 lakh gallons of water per day. Adding to this another 4 lakhs gallons required at Perambur, the total proposed out-take of water from the pumping station at mile 7 would be approximately 10 lakhs of gallons of water daily.

Pumping Station at Ennore

To meet this demand, a scheme costing about Rs. 11·55 lakhs was drawn up (i) to improve the source of supply at mile 7, (ii) to electrify the existing diesel driven pumps, (iii) to lay a duplicate 12 inches dia. C. I. Pumping main from Mile 7 North-East Line to Korukkupet and a new 9 inches C. I. Main from Korukkupet to Perambur, (iv) to build ground level reservoirs and pumphouses at Mile 7 North-East Line and Korukkupet, (v) to take electric supply from the Madras Electricity System, (vi) to acquire additional land around the water supply source, etc.

The area where the pumping installation of the Southern Railway at

Mile 7 North-East Line is located consists of a sandy stretch about 1/2 mile in width between the sea coast and the railway line and about 5 to 6 miles in length. Open excavations in this sandy bed upto a depth of 10 ft. to 15 ft. yield fresh water, which is free from salinity and is drinkable. The Southern Railway are, at present, having 3 shallow excavations, about 10 ft. to 15 ft. deep and approximately 10,000 sq. ft. in area from where the water is pumped towards Madras. In order to augment the supply of water in these open reservoirs, long and narrow gullets, varying from 1,500 ft. to 2,000 ft. in length, were also dug attached to each reservoir. From the reservoirs referred to above, the Southern Railway obtain 4½ to 5 lakhs gallons of water per day commencing from the year 1939.

During the investigations by the Southern Railway in the early stages of this source, a series of shallow bores mostly upto 45 ft. below ground level and occasionally upto 75 ft. were put in at intervals of about 200 ft. to examine the underground strata. From these experiments, conclusions were drawn that the whole of this area contains one trough of sub-soil water, overlaying a clayey stratum which varies in thickness from 20 to 50 ft. This sub-soil water level naturally has seasonal fluctuations and varies in any normal year between × 5·00 MSL and—2·00 MSL. Occasionally, fluctuations as much as + 11·00 MSL and — 5·00 MSL were also observed.

The existing diesel pumps at each of the three open reservoirs at miles 7/5, 7/14 and 7/19, are of 100 ft. head, capable of pumping about 20,000 gallons of water per hour. As the head is insufficient to pump direct to Basin Bridge, an intermediate pumping station at Tiruvottiyur was built. Pumping is now done from each of the reservoirs for 8 hours at a stretch, so that, through the 9 inches pumping main water is pumped at the rate of 20,000 gallons per hour—round the clock. The depression in the water level at any one of the reservoirs during this period of 8 hours was found to be not more than 4 inches at—2·00 MSL.

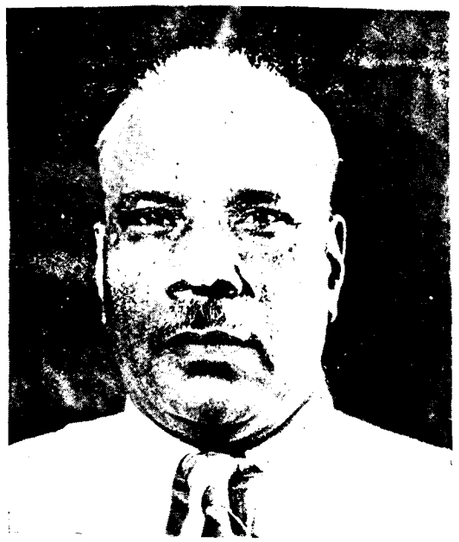
In order to pump 1 million gallons of water per day as now proposed, it was decided to lay an additional 12 inches dia. C. I. Pumping main from Mile 7/12 to Korukkupet Station in addition to the existing 9 inches dia. pipe. There will also be a new 9 inches line from Korukkupet to Perambur. The duplicating of the pipeline from mile 7/12 to Korukkupet will have the advantage that, in the event of one of the pipes bursting or being put out of commission for repairs, the other pipe can still be used for pumping the essential requirements of water without stoppage.

With a view to improve the source of supply, experiments were also conducted by the Integral Coach Factory with deep tube wells to see if there was a possibility of tapping underground water-bearing layer, if any, which can supplement the surface water. If these experiments were to succeed, the subterranean source would be capable of considerable improvement. It was, however, feared that by going below the clayey layer within a distance of 1/2 mile from the sea coast, there existed a possibility of contamination of the entire area by sea water in the long run, if not in the immediate future. As an experiment, a deep tube well of 8 inches dia. capable of giving 15,000 to 20,000 gallons of water per hour provided suitable water bearing strata were to be met with, was tried in this area. The water that was met with below 67 ft. from ground level, when tested by the Analyst, was reported to be pure sea water. Thus, the scheme to tap sub-soil water at lower depths had to be abandoned, Great precautions were also taken to plug the bore that was put in the clayey strata with cement concrete, so that the sub-soil sea water may not seep through the hole and contaminate the fresh surface water above. It was then decided to sink five 20 ft. dia. shallow wells upto a maximum depth of 25 ft. as the first step to improve the source of supply. The point in favour of the shallow wells as against the open reservoirs was that a great deal of water will not be wasted through evaporation.

Individual pump houses would be provided at each of these five sources with low lift automatic electric pumps pumping into a central open ground level reservoir of 1 lakh gallon capacity at mile 7. Two automatic pumps with a head of 50 ft. and capable of pumping 20,000 gallons each per hour will be installed at each of these wells, one for working and the other as spare. At the central reservoir at mile 7/12, there will be a pump house with electrically driven high lift pumps, pumping water to the intermediate pumping station at Korukkupet through the old 9 inches and the new 12 inches C. I. Pumping mains. From calculations it was found that 3 numbers of electric pumps will be required at this house with a capacity of 30,000 gallons each per hour, and capable of pumping against 150 ft. head ; two will be working at a time and one will be spare. The main advantage of the central collecting reservoir is that it dispenses with the necessity for installing high lift pumps at each individual source if they were to pump directly into the pumping main. With the proposed 5 additional wells and 3 existing ground-level reservoirs, 16 such high lift pumps would naturally be required, and this is obviously a costly proposition. At the central pump house remote control switches for operating the automatic low lift pumps at each of the sources will be installed.

It may be asked as to why the individual pump houses cannot be eliminated by having long suction pipes from the central reservoir to each source of water or why syphon arrangements could not be made to syphon the water from the individual wells into the central reservoir. Both these ideas have, after careful thought, been dropped as such long suction or syphon pipes at great depths are likely to be sources of permanent trouble. The prevention of the air-leaks in those pipes would be difficult. In view of these considerations, individual low head pumps at each source were considered the best. The only objection that may be raised against this scheme is that the number of pump drivers will have to be increased, resulting in increased running costs. Pump drivers at each pump house can be eliminated by making the pump sets fully automatic at an additional cost of about Rs. 4,000 to Rs. 5,000 per set. Only the central pump house will be maintained by a pump driver who will control the other low lift pumps at individual sources through remote control switches installed in the central pump house. This would, therefore, mean that just one driver per shift is all that is required to look after the entire pumping installation in this area.

A two-lakh gallon capacity masonry ground level reservoir will also be built at Korukkupet Station to receive all the water from mile 7 and pump the same to Basin Bridge and Perambur high level tanks. Four high lift pumps, each capable of pumping 500 gallons per minute, will be installed here, of which two will have 150 ft. head and the other two 300 ft. head. Of the four pumps, two will be working at any one time and two will be spare. The 150 ft. head pump is for pumping water direct to the high level tank at Basin Bridge and the 300 ft. head pump is to pump water to the high level tank at Perambur. By direct pumping to the high level tanks, the necessity for installation of booster pumps at the foot of the high level tanks is eliminated. At the same time there will be sufficient pressure in the pipe lines to fill any other intermediate high level tanks were they to be erected at any future date.



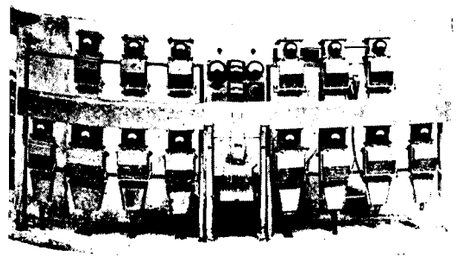
POWER DISTRIBUTION & LIGHTING FOR THE INTEGRAL COACH FACTORY PERAMBUR

G. N. UPADHYAY,
B.SC. (Engg.) A.M.I.E.
Dist. Elec. Engineer, ICF/PER.

THANKS to the rapid strides made in the development and application of electricity in recent years, electric motive power has come to be regarded as the vital backbone of industry. Availability of adequate, reliable and cheap power supply is, therefore, of primary consideration in deciding the location of any large scale industry, and this criterion, no doubt, influenced the choice of Perambur for the location of this important manufacturing project of the Indian Railways under the first Five Year Plan. With the Basin Bridge Thermal Power Station of the Government of Madras nearby and the proximity of their Korattur 110—66/33/11 K.V. Tie station which links up the former with the Mettur, Moyar and Pykara Hydro Electric Stations into a 'Grid' permitting interchange of block power between the Hydel and Thermal Systems and assuring, therefore reliability of continuous adequate power supply right round the year, Perambur has, indeed, been a most suitable choice.

With the large 110/33/11 K.V. Korattur Substation being only about 3 miles away, it was finally decided jointly by M.E.S. and I.C.F. Administration, to construct a double circuit 11 K.V. feeder from the Korattur Substation to the factory site. One of the circuits would be strung initially to meet the growing power demand of the factory and the second circuit added later on with a year to meet the increased power load gradually rising till factory comes to full production, the supply being subject to a minimum annual revenue guarantee of 10 per cent on the total cost of extension.

The work of permanent H.T. supply was, however, delayed since the question of advancement of the entire cost of extension as loan to the Madras Electricity Department was raised in view of the then stringent "ways and means" position of the State Government. After further negotiations and with improvement in the State Government's financial position, the work of 11 K.V. double circuit with both the circuits strung initially itself, was taken in hand early in 1955. The double circuit 11 K.V. Aerial main terminates outside the Workshop on three pole structures and through Isolators, two separate three core ·1 sq. inch H.T. cables are taken underground in Shop area to I.C.F. Receiving Substation, wherein they terminate on Metal clad switch cubicles of the



Typical L.T. Switch Board in the Integral Coach Factory Substation

M.E.S., with their metering equipment consisting of maximum K.W. and K.V.A. meters to record peak load on 1/2 hourly basis and K.W.H. meters to record total units consumed as per their bulk supply tariff for H.T. Supply.

The 11 K.V. permanent supply was made available to the I.C.F. on and from 23-3-1955. The 11 K.V. supply to the factory was officially switched on at an impressive ceremony on 29-3-55 by Shri G. Pande, Chairman, Railway Board.

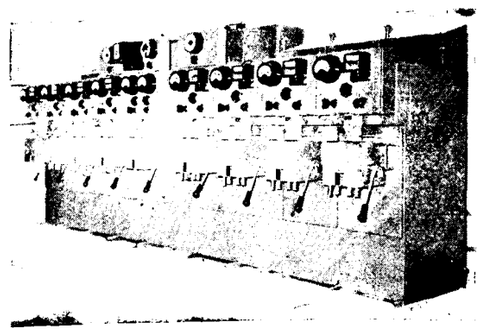
I.C.F. Receiving Station and Substations

The 11 K.V., H.T. bulk supply from the Madras Electricity System is received on a 9-panel drop-down draw-out truck type 11 K.V. Switchboard installed at the I.C.F. Receiving Station sited in the heart of the factory area. The Receiving Station H.T. Switchboard comprises two sections, linked up by a bus-section O.C.B. and each section has four panels, one for receiving the M.E.S. feeder, one for the out-going workshop feeder, one for the out-going township feeder and the last being spare unit. The two outgoing workshop feeders, each 3 core, 0·15 sq. inch PILC DSTA H.T. cable, form a closed H.T. ring main and connect 7 tee-off ring main Substations sited at load centres in the different manufacturing shops. The township feeder (3 core, 0·0225 sq. inch PILC DSTA H.T. Cable) feeds an overhead 11 K.V. single circuit line stretching upto the staff colony and connects three outdoor Substations—one for the Administrative Office, the second for the Basic Technical Training School and the last for the Colony. 16 Power transformers—2 of 750 KVA capacity, 11 of 500 KVA capacity and 3 of 150 KVA capacity—are spread over these 10 Substations based on the magnitude of loads to be catered for.

The Substation in Machine Shop was completed and brought into commission on 29-3-55 along with the inauguration of the Receiving Station and the remaining Substations were energised subsequently as machines in the Shops were erected and put into service or load position warranted the same.

All the Substations are of the enclosed busbar type, with 400 V. 3 phase 4 wire standard voltage on the L.V. side and with transformers delta connected on the High Voltage side and Wye-connected on the low tension side. The in-coming and out-going H.T. supply at each Shop Substation is controlled by oil immersed load-breaking type isolators. Drop-down draw-out truck type 11 K.V. O.C.B.'s on H.T. side and metal-clad O.C.Bs. on L.V. side provide control for transformers in Shop Substations, while in the out-door Substations, the H.T. control is by air-break pole mounted isolating switches combined with drop-out fuses. The Substation L.T. switchboards comprise transformer L.V.,

9-panel 11 K.V. Switch Board in the Integral Coach Factory Receiving Station



O.C.B.'s with adequate number and size switch-fuse feeder units lined up on either side thereof.

In view of the tariff conditions which discourage low power factor of demand, static power capacitors of sizes ranging from 50 KVAR to 200 KVAR and aggregating to 2200 KVAR capacity, with individual control gears on each units, are being installed mostly in the Shop Substations and the remainder at suitable locations across low power factor machinery in the Shops themselves.

Emergency or low load period feeding from one or two Substations to others has been provided for by suitably looping up the different Shop Substations by inter-connecting L.T. cables.

In line with Government policy, efforts have been made in I.C.F. to use indigenous make equipment and it is gratifying to mention that all I.C.F. power transformers are of Indian make manufactured at Bombay.

Load Summary and Capital Cost

The factory has the initial target of manufacturing 250 Broad Gauge passenger coaches in the first stage and 350 B.G. coaches when the second and final stage is reached. For the first stage production target, 572 electrical machines,including 260 portable D.C. arc welding sets and aggregating to about 10,000 H.P. connected load have been installed. When the final target of 350 coaches per year is attained, it is anticipated to have in all 932 electrical machines, including 480 welding sets, with a total connected load of about 15,000 H.P.

The maximum power demand for the ultimate target of 350 coaches per year is expected to be 2,000 K.Ws. with an annual energy consumption of six million units.

The electrical portion of this factory project has been estimated to cost Rs. 62·84 lakhs.

Power Distribution in the Shops

Capacity and location of the various Substations have been determined by the loads of individual Shops. Each Shop has its own peculiarity in load and load conditions. Presses, Spot and Butt welding sets in "A" Shop (Sheet Metal) compare differently with Furnaces, heavy hammers and chemical plant in "D" Shop. In "B" Shop (Assembly) the load consists almost exclusively of hundreds of small portable welding sets, fed through interlocking plugs fixed up on various jigs and fixtures suitably located to facilitate working.

The factory is equipped with machines of the most modern continental design incorporating latest electrical techniques. They range from small lathes, grinders, drills and portable welding sets to large Hydraulic Presses, Compressors, Guillotine shears, 248 KVA Spot and Butt welding machines, 200 KW furnaces, nickel plating, chromium plating and anodizing electrolytic plants and 350 H.P. synchronous motor driven rotary air compressors, each of 1,350 c.ft. per minute capacity.

The various factory electrical machines have special features like electronic devices for precision working, D.C. rectifier operation for sure and accurate control, Ward-Leonard control for variable speeds, thermostatic devices for correct and timely control of heat treatment processes, etc.

The power distribution in the Shops for the various electrical machines and plug points is done on what may be termed as the "cascade" system. The outgoing cable feeders from the various Substation L.T. switchboards vary in size from single 3 or 3½ × 0·04 sq. inch PILC DSTA cable to twin 3 × 0·3 sq. inch PILC DSTA cables for different loads and are run in conventional main and subsidiary cable trenches laid along and across the length of the Shops alongside columns.

The feeders terminate on primary feeder pillars sited at load centres close to the Shop columns with the minimum encroachment on working space in the Shop floor area. Each out-going feeder from the pillar connects a main distribution board similarly sited, which in turn feeds sub-distribution boards and thence the individual machines. Different types of feeder pillars and distribution board with incoming and outgoing switch-fuse units ranging from 15 amp. capacity to 300 amps. capacity have been used in this planned distribution.

Large individual loads are fed by separate feeders directly from the Substations. Most of the machines have been provided with their own individual lights of modern design for precision working.

For the operation of portable welding sets in the various Shops, adequate number of 3 phase interlocked power plugs are provided on the Shop columns or on the jigs themselves to suit the individual convenience. Similarly, a number of single phase interlocked plugs have been installed on the shop columns and on the jigs themselves for the operation of electrical hand tools and small tools to suit the convenience of work. For safety reasons, provisions have also been made for single phase 24 V. plugs for inspection lamps.

For operating the heavy pneumatic hammers in the Smithy Shop and other air-operated tools spread over the different Shops, 6 Nos. 350 H.P. auto-synchronous motor driven rotary air compressors, each capable of delivering 1,350 c.f. of air per minute at 120 p.s.i. pressure are being installed with cooling tower 13 ft. square and 25 ft. high with spray nozzles and requisite number of pumps.

To provide good storage facilities for coated electrodes, a 5-ton self-contained type Dehumidifying plant, with a similar unit as standby and the necessary cooling water circulating pumpsets is being installed in the Electrodes Storage Room in the Stores Shed ("H" Shop). The plant maintains the inside conditions at 40—42 per cent relative humidity and temperature not exceeding 5°F above the ambient temperature so that the electrodes do not get wetted when removed from the storage.

Shop Lighting—Interior

The illumination of large modern industrial workshops presents problems both psychological and technical. With the increasing realisation of the importance of visual comfort in stepping up the outturn of modern workshops, the psychological aspect has been assuming more and more importance than the technical which is more or less a simple and straightforward affair. This factor along with economy of operation and maintenance have been taken into account in designing the shop illumination.

The intensity of general illumination provided varies from 4 to 7-foot candles according to the actual requirements of the Shops and Shop sections, keeping in view the provision of individual machine lights for precision work. Likewise, the type of lamps installed in the different shops varies according to the heights of the shop bays and the specific requirements of the Shop sections. Thus, twin 80-Watt industrial fluorescent light fittings have been installed in bays where overhead cranes run, while twin 40-Watt industrial fluorescent fittings have been used in other sections. Owing to the roof being as high as 44 ft., 250-W, high pressure mercury vapour lamps in RLM reflectors have been installed in the Assembly bays. The Stores and other ancillary sections have been provided with 200-W filament lamps in 14 inches dispersive reflectors.

Shop Lighting—Exterior

The uncovered area between Shops is lit up with 250-W flood lights enclosed in tiltable reflectors designed for flood lighting downwards and forwards. The main roads inside the factory area and approach road are provided with

mercury vapour street light lantern fittings, mounted on individual 14 ft. high R.C.C. lamp posts sited in a zig-zag on either side of the roads. 10 Nos. 1000-W gas-filled flood light projectors on high tubular masts located at suitable points provide general external illumination of the Shops. Besides, compound lights along the factory boundary wall and police lights for security reasons have been provided.

Cranes and Traversers

Quick operating haulage devices in heavy production shops are indispensable to economise time, money and labour, and in the Integral Coach Factory, this requirement has been adequately fulfilled. Besides, self-powered diesel trucks conveying small materials inside and between Shops there are 22 Nos. 5-ton E.O.T. cranes, 4 Nos. 20/5-ton E.O.T. cranes, 4 Nos. 5-ton gantry cranes and 2 Nos. 75-ton electric pit type traversers to assist in the movement of materials inside the Shops and along the production line.

Bare copper electrolytic conductors supported on porcelain reel insulators suitably fixed by brackets on to Shop columns provide power supply for the operation of the cranes while independent steel lattice masts carrying trolley wires have been provided for the operation of the traversers.

In addition to the above, four Goods Lifts—two in Smithy Shop which has a mezzanine floor at the top and two in the Store Shed (Shop H)—each with a capacity of 3 tons and covering two floors and incorporated with attended-cum automatic type control are being installed for transportation of materials from ground floor to the top and vice versa.

Electric Repair Shop

To enable maintenance, repair and overhaul of the Electrical Equipment of Shop machinery and the various H.T. and L.T. electrical equipment, a full-fledged electrical Repair Shop with a floor area of 11,000 sq. ft. has been set up in "J" Shop. The Repair Shop equipment include an up-to-date and comprehensive meter testing board with substandard grade testing instruments, one 3 ft. dia. × 4 ft. deep thermostatically controlled, vacuum/pressure impregnating plant capable of handling the largest piece of electrical apparatus, namely, the rotor of the 350 H.P. motor of air compressors, automatic coil winding machines, electrical drying oven for drying out windings, H.T. oil testing set, arc welding sets, lathes, shapers and other workshop machines. In addition, portable apparatus like precision instruments to test insultation, resistance and other electrical quantities rotating sub-standard meters to check and calibrate energy meters, oil drier-cum-filter, etc., are equipped in the Electrical Repair Shop to facilitate site tests as well.

Offices and Colony : Electrical Installation

The general electrification outside the factory mainly consists of—

(1) Administrative Building. Air-conditioning and Lighting
(2) Technical Training School.
(3) I.C.F. Colony and Officers' Flats.
(4) Amenity Buildings and other ancillaries.

Air-conditioning

Owing to local weather conditions and availability of limited floor space, it has been found both desirable and necessary to air-condition the entire three-storeyed Administrative Office building except the corridors, staircases, entrance foyers, and Canteen rooms, so as to provide comfort and incentive for the most efficient working of the organisation. The 195-ton air-conditioning system serves a total floor area of 45,100 sq. ft. covering a total air-conditioned space of 473,900 c.ft. and has been designed for the following inside conditions :

76°F—80°F temperature, dry bulb and 60—65 per cent relative humidity with two fresh air changes per hour, and a limiting air velocity of 30 ft. per minute at head level in the rooms.

The air-conditioning plant room with its cooling system and out-door Electric Substation having 2 Nos. 150 KVA 11 KV/400 V. power transformers is located in a separate building behind the Administrative Office, leaving a passage of 15 ft. The air-conditioning plant comprises mainly :

3 Nos. 65-ton single stage reciprocating compressors coupled by V belt to 75 H.P. slip ring electric motor, complete with fly wheels, shut-off valves, unloader, hi-low pressure stat, etc.
2 Nos. 100-ton shell and tube condensers with liquid line valve, relief valve, etc.
6 Nos. direct expansion finned type evaporators.
2 Nos. 15 H.P. motor driven 725 R.P.M. air blower fans each of capacity 29, 1000 c.fm.
2 Nos. 12·5 H.P. centrifugal water pumpsets each of capacity 300 G.P.M. and 70 ft. head and air filters, valves, indicators, temperature and pressure controls, duct-work, etc.

The plant room has space provision for one spare unit of the essential items among the above to provide for future expansion and breakdown and ensure efficient functioning of the plant.

The air-conditioning plant works on the compression refrigeration cycle with direct expansion type refrigerant evaporation. The Freon 22 refrigerant liquid is allowed to vaporize freely at low pressure in the evaporator by the absorption of heat from the warm air in the process of its cooling work. The vapour is drawn in by the compressor at 70 lbs. per square inch gauge pressure and 40°F temperature compressed to 213 lbs. per square inch gauge pressure and 105°F temperature and delivered to the condenser. The vapour under pressure is liquefied in the condenser, its latent heat of vaporization being absorbed by the condenser cooling water. The liquefied refrigerant is fed back to the cooling coils of the evaporator, and after low pressure expansion and evaporation, the refrigerant is drawn into the compressor at 70 lbs. pressure and the cycle is repeated.

In the other cycle of operation which goes on simultaneously, the hot return air is passed through the cooling coils of the evaporator and, after being cooled in the process to 50°—55° F temperature, is delivered by the two blowers at a velocity of 1,800 ft. per minute into two sets of G.I. sheet metal supply air ducts, each 5 ft. wide × 3 ft. deep, which are enclosed in 8 ft. wide × 5 ft. deep underground R.C. ducts and project into the building upto the corridor, one on either side of the Entrance Hall. The cold air ducts then rise vertically upto the top of the building with branch-off ducts in the east and west corridors in the different floors, stretching out side-wards to the ends of the building and subsidiary ducts connecting the inlet grills fixed on the walls of the different rooms above door level. The rectangular shaped grills are of adjustable type, made of oxidised copper and of standard size 22″ × 5″, their number varying according to the size of rooms air-conditioned. The return air from the rooms escape through another set of non-adjustable grills into the annular space outside the supply ducts over the false ceiling and the masonry of the building which forms the void between the main air supply ducts and its enclosing R.C. duct back into the blower room via the large air filters fixed in the blower room.

The three-storeyed Administrative Office building is provided with modern concealed conduit wiring type electrical installation to cater for an illumination of 8 ft. to 10 ft. candles by means of decorative multi-tube fluorescent fittings, ranging from 2 ft. to 4 ft. lengths, with special directional

type fittings in locations like Drawing Office, Laboratory, Museum Hall, etc. The large neon-sign bearing the name of the factory to be provided on top of this building make the factory easily a significant landmark over a large area around. Amenities provided in the Administrative Office include, besides the air conditioning of the entire building, a passenger lift, capacity 6 persons plus the lift attendant, located to the west of the Entrance Hall and serving all the four floors. The lift works on the semi-dual control system incorporating both car switch control and automatic push button control so that the lift can be operated by an attendant during busy periods and by the individuals at other times. Also an Office lift, 110 lbs. carrying capacity and serving all the four floors, with automatic push button control has been installed to the west of the East end staircase for carrying drawings and files from one floor to the other. The lift machinery for both lifts are located in lift rooms built directly on top of the lift wells. Call bells, luminous indicator system and other requisites for efficient functioning of the organisation have also been provided in the Administrative Office. The approach road and frontage of the building are lit with decorative mercury vapour dome lights supported on R.C.C. posts.

Technical Training School

The Technical Training School attached to the factory for training of Mechanical Apprentices commenced functioning in March 1954 with a modest workshop and its electrical load requirements was met initially from the Southern Railway temporary L.T. supply. Owing, however, to the rapid development of the Institution, a temporary 150 KVA 11 KV/400V outdoor Substation was specially installed behind the school building in April, 1955 and supply was switched over to the permanent 500 KVA Technical Training School Substation later this year. The School Workshop loads comprise portable arc welding sets, lathes, grinders and other Workshop machines, one 60 H.P. air compressor, etc., aggregating to over 500 H.P.

I.C.F. Colony and Officers' Flats

A housing colony with accommodation for 412 families of different categories of essential staff has been built up within two furlongs from the factory proper. All these quarters including those meant for Class IV staff have been electrified. Besides, lights, ceiling fans and convenience plugs have been provided in certain types of quarters as per the prescribed Railway standard in this regard, I.C.F. Officers' Flats at Perambur have been electrified.

The Colony roads are adequately lit with street lights and the children's park with mercury vapour lamps mounted on R.C.C. lamp posts.

Utility combined with a decent degree of comfort has been the keynote in regard to the lighting of the residential colony.

Institute, Rest House for Subordinates, Primary School, Boarding House for Swiss Technicians and other ancillary buildings have been provided with lighting and fans with frontage and approach well lit-up.

The approach to the Main Works Entrance of the factory is lit-up with mercury vapour post lights. The Rest Shed-cum-Canteen building meant for refreshments and recreation for factory staff is provided with a Food Lift, carrying capacity 110 lbs. and suitable for automatic push button control.

Staff Amenities

Adequate number of water coolers located at convenient points in the offices, workshops and service buildings provide cool drinking water to staff. Bracket and pedestal type air circulators are being installed in the Shops to afford comfort to the working staff and improve the efficiency of their turnover. Announcing equipment to transmit messages, instructions and lunch time music as well has been provided in the Shops.

Telephones

150 Railway telephones connected to the 400-line automatic telephone exchange recently erected by the Southern Railway at their new Perambur Exchange and 50 Oriental telephones connected to the P & T Main Exchange provide adequate telephone facilities, internal and external, in the Offices, Workshops and Colony. In addition, quick inter-communication facilities by means of inter-communication sets between Principal Officers and Key Executive Staff in the Shops have also been provided for.

Pumping Installations

Two lakh gallons of water per day are required for the I.C.F. To cater for this as well as the additional requirements of the Southern Railway at Basin Bridge, Central, Tondiarpet and Perambur, a joint scheme with the Southern Railway "Improvements to Ennore Watering Arrangements" was approved by the Railway Board in 1951 at a cost of Rs. 11·55 lakhs for a total supply of 12·5 lakh gallons of water per day, the total cost being borne equally by the I.C.F. and the Southern Railway. The scheme, which is under execution by the I.C.F. envisages :

(i) Establishment at Ennore of a one lac gallon capacity open reservoir and a Central Pump House with 4 Nos. 30,000 G.P.H. 150 ft. head centrifugal water pumpsets to pump all available water in this area to the open reservoir at Korukkupet with a storage capacity of 2 lac gallons.

(ii) Replacement of existing oil engine driven pumpsets in the existing 3 Pump Houses, each fed by an open gullet in the sand bed at Ennore, by electric driven pumps of capacity 20,000 G.P.H. and 50 ft. head with automatic remote control from the Central Pump House and local float switch control on suction side, to pump the available gullet water to the Central Pump House reservoir.

(iii) Sinking two 20 ft. dia. wells at Ennore and installation of two 20,000 G.P.H. and 50 ft. head vertical spindle turbine pumps in each well with remote control from the Central Pumphouse and local float switch control, to pump water from the wells to the Central Pumphouse reservoir.

To cater for the above pumping loads, a separate 11 K.V. H.T. point of supply is being taken from the Madras Electricity Department near the Central Pumphouse and an outdoor 11 KV/400 V Substation, with 2 Nos. 150 KVA transformers and necessary H.T. and L.T. switchgear are being installed.

(iv) Installation of 2 Nos. 30,000 G.P.H., 300 ft. head and an equal number of 30,000 G.P.H. 150 ft. head electrical pumpsets at Korukkupet intermediate pumping station. The former two pumps pump water through 12" water main direct to High Level Tank near the Perambur Filter House for serving the Perambur area and the latter two units to deliver water through 9" main to Basin Bridge High Level Tank for serving Loco Shed, Central Station, etc. To cater for this pumping load, a separate H.T. point of supply is being taken at Korukkupet from the Madras Electricity Department and an Outdoor 11 KV/400 V Substation with 2 Nos. 150 KVA transformers and necessary H.T. and L.T. switchgear is being installed near the Korukkupet Intermediate Pumphouse.

For water supply to the service buildings, children's garden in the Colony and emergency water storage in the factory area, small pumphouses with electric water pumpsets have been built at convenient locations.

A sewage Pumphouse with 2 Nos. 70 G.P.M. and 45 ft. head sewage pumpsets have been installed in the factory area for disposal of the factory sewage. The existing sewage pumpsets in the Sewage Pumphouse of the Southern Railway at Aynavaram

serves the I.C.F. Colony as well but, owing to inadequacy of capacity these have been replaced recently by 2. Nos. 15 H.P. 350 G.P.M. and 56 ft. head electric pumpsets.

Earthing

Proper earthing is one of the vital points in Electrical and Tele-communication system. It ensures safety to human life and safety-cum-stability to the Electrical equipments by providing a safe and sure discharge path to ground for abnormal voltages and currents and maintaining the non-current carrying parts at zero potential.

All the Substation gears and electrical equipments in the Shops and Township are efficiently earthed by two independent earths in conformity with the latest I.E.E. regulations. Two copper earth plates 2′ × 2′ × 1/4″ are laid vertically 8 ft. below ground level at either ends of the shops and connected together by two 1″ × 1/8″ hard drawn copper strips run along side walls of the Shop cable trenches, thus providing two earths for electrical equipment installed in the Shops and also earthing for Shop columns throughout.

Each Substation has two independent earth plates of the same size, similarly laid, providing two separate earths to H.T. and L.T. equipment in Substation and also solid earthing for the neutral on L.T. side of transformer.

All electrical equipment in Shops and Township are solidly earthed by copper strip 1″ × 1/8″ or 1/2″ × 1/16″ and 7/18″ standard copper wire with terminal to suit the current carrying capacity of the equipment. For testing purposes and for ensuring efficient earthing, 2″ G.I. or C.I. pipes with staggered perforated holes have been brought up to ground level for testing and pouring in brine water to ensure good earth.

All aerial mains,—H.T. and L.T.—have been provided with two running earth wires of suitable galvanised iron wire, located below the main conductor and forming guard-cradle upto suitable distances on either side of the poles to ensure proper earthing and also for effectively grounding the conductors for safety reasons, in case copper wire snaps. The running earth wires are connected to earth plates at 4 to 6 points per mile of transmission line and as far as possible, at junction points of the aerial main, separate individual earth plates have been provided. Suitable lighting arresters, efficiently earthed, have been provided on both H.T. and L.T. aerial mains at vulnerable points for conducting lightning surges to ground without endangering life and equipment.

Conclusion

The electrical organisation of the factory comprises Indian personnel, and all basic preparatory work like survey, design and planning of the electrical works have been done locally.

Except air-conditioning and house-wiring jobs, all the electrical works have been executed departmentally with the aid of unskilled, skilled and supervisory staff of the electrical organisation of the project. Owing to the dearth of well experienced technical hands all-round, efforts have been made, right from the commencement of the electrical works, to recruit trained and experienced technical men and given them the benefit of further experience by engaging them on the different construction works so as to have a nucleus of thoroughly trained and competent technical staff. The men who thus acquire intimate knowledge and experience of the intricate details of the equipment and installations, become fit to shoulder the responsibilities of trouble-free operation, repairs and maintenance, when the construction phase is over and the factory strides into production activity

TRAINING WORKER CITIZENS FOR THE INTEGRAL COACH FACTORY

U. A. KAMATH

Principal, Technical School, I.C.F.

[This paper deals with the setting up of the Technical Training School of the Integral Coach Factory, the Training methods adopted and the aims and ideals which have been kept in view in formulating the training policy.]

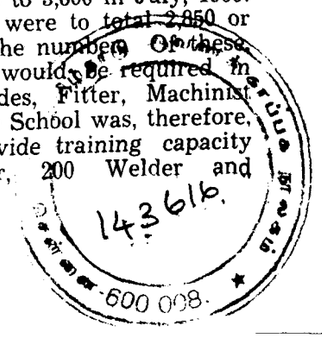
THE Technical Training School of the Integral Coach Factory was inaugurated on 20th March, 1954 by the Deputy Minister for Railways, Sri O. V. Alagesan, acting on behalf of Sri C. Rajagopalachari, the then Chief Minister of Madras, who could not be present in person. In his message wishing the School success, Sri C. Rajagopalachari made the following observation :

> "May this School flourish. The most important part of a factory is its training side. It keeps the thread of efficient work unbroken. A factory without a School attached to it is useful but barren. With a School attached, the factory becomes a living and procreative organism like nature's every fruit that carries a seed within it for multiplication."

Since that date last year, 18 months have passed by and the School has grown from strength to strength carrying out its important function.

The Railway Board, with a view to make the country self-sufficient in passenger coach manufacture, decided to set up the Integral Coach Factory at Perambur in Madras. During 1953, whilst the initial planning for the factory was in progress, it was soon realised that the large requirement of skilled labour required from start to attainment of full production over a period of 4 years from 1955, could only be met by setting up in advance, independent training facilities for the purpose. It was decided to instal sufficient training capacity to meet the peak and urgent demands of the factory after which the School will have to switch over to normal apprenticeship training to meet only the wastage in the factory.

To meet the production targets laid down, the labour force in the factory was scheduled to be increased from 110 in July, 1955 to 3,800 in July, 1959. Skilled workers were to total 2,850 or 75 per cent of the number. Of these, a total of 2,545 would be required in three main trades, Fitter, Machinist and Welder. The School was, therefore, designed to provide training capacity for 200 Fitter, 200 Welder and



120 Machinist apprentices, every year, recruitment being half yearly. By 1959, it was planned that the School would turn out 1,300 Fitters, 520 Welders and 725 Machinists, thereby meeting a major portion of the demand for skilled workers in the factory.

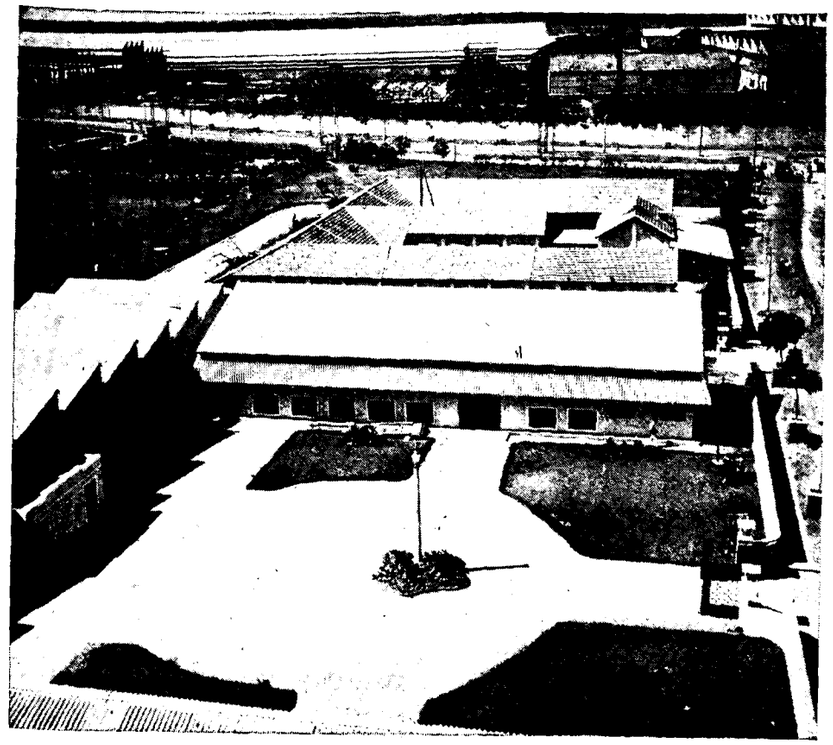
In modern times, efficient industrialisation is necessary not only for economic stability but also for security in times of war. The last war clearly brought out the fact that the military strength of a nation depended mainly upon the productivity of its industries, which in turn depended upon the availability of skilled and trained industrial man power. In India of to-day, the accent is rightly placed on rapid and efficient industrialisation. With the stepping up of the tempo of industrialisation, it has become increasingly evident that the tempo cannot be maintained, let alone be increased, without at the same time increasing the reservoir of skilled labour available in the country.

The need for increased productivity and for improved utilisation of scarce and valuable machinery stresses the necessity for higher and higher skills of industrial labour. Doing a job is just not enough. A high rate of performance has to be obtained to reduce the unit cost. In spite of the mechanisation, specialisation and rationalisation that are taking place in industry, the key to increased productivity rests on the mental and manual skills of individual operators.

In modern industry, relatively few people are required to work in isolation. Most work in groups of varying size. The efficiency of the industrial organisation is a sum of the efficiency of these smaller groups. Although the basis of the groups is occupational, each is a social group as well. If the social organisation inside each group is substantially unhealthy, the industry is beset with the phenomena of strikes, excessive absenteeism, discord, high accident rates and high labour turnover. The problem, therefore, basically revolves around the physical and mental health of the individual worker and whether he is prepard to be a part of the team and to play the game with the rest of the group. Education for industry should, therefore, aim not only at increasing the vocational skill but also to promote adaptability, develop a sense of responsibility and loyalty to the firm and stimulate inventiveness. Vocational training by itself will not achieve maximum output or induce maximum happiness among the labour force, unless the workers are trained to fit in with the team inside the factory.

At the same time, a most important trend in industrial education to-day has been the realisation amongst employers of the need to consider something more than mere technical training and improvement of vocational skills. The pattern of society visualised for the country presupposes that all those engaged in producing the nation's wealth would be educated enough to be a citizen and actively contribute to the life and well-being of the community around him. Citizenship, in the modern sense, involves active social interest, responsibility and participation in the happiness around him, eagerness to be informed and a sense of oneness with one another and mankind. Effective training for citizenship, therefore, depends on the building up through social experience of correct social attitudes at every stage of life, starting from childhood through adolescence and adult life. One of the most decisive factors in citizenship promoting experience however is in the quality of the relations existing in the Schools. If apprentices are brought up during their apprenticeship through friendly and sound interpersonal relationships, wherein all are encouraged to participate co-operatively, qualities of good citizenship are developed.

In brief, the task of training worker citizens for the Integral Coach Factory involves training for proficiency in work, instruction for encouraging a



A general view of the Technical Training School and Training Workshops

sense of belonging within the firm and non-vocational education for life. These then are the goals which the Training School has set before itself.

The system of training skilled craftsmen adopted at the Technical School is without any precedent in India where apprenticeship of 3½ to 5 years is accepted as standard. With a view to meet urgently the factory production targets, the Railway Board agreed, as a special case, to reduction of the period of apprenticeship to 1½ years This reduction is achieved by the twin method of recruiting apprentices who before enrolment have undergone a minimum of 1½ years training in their particular trade and by adopting more improved, intensive and efficient methods of training. The apprentice, on recruitment, is required to be between the age group of 18 to 25, to have passed Fourth Form and to have successfully completed 18 months technical training in a Government recognised Industrial Training Centre. All applications for recruitment are scrutinised and only those with the stipulated qualifications are required to undergo a series of tests designed to weed out those that are unsuitable. These include written tests in Arithmetic, General Knowledge and Sketching, a practical trade test, a games test to test the candidate's endurance and stamina and finally an interview. So far as the apprentices are considered, excellent material has been forthcoming who have been very eager to learn and have co-operated with the Instructional staff in raising the standards of the Institution.

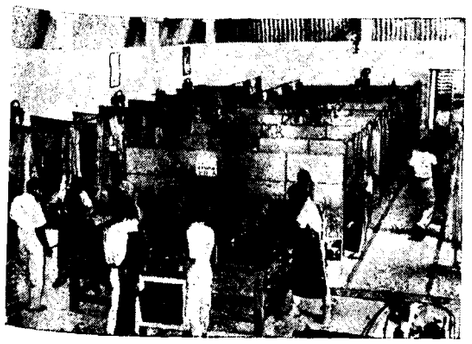
In view of the lack of precedent for this type of training in India, the syllabi of training have had to be developed from scratch. The apprenticeship is made up of 6 months basic training in the Training Workshops attached to the School followed by 12 months specialised training in the factory. This initial Basic Training is an important part of the training scheme. The main emphasis is on practical work on which the apprentice spends 27 hours a week, the theoretical and citizenship training consuming 21 hours, making a total of 48 hours a week. The training centre is like an enclosed swimming pool in which apprentices learn to swim, the factory being the open sea with some quite large waves. There are many advantages in doing the basic training in a separate training workshop situated close to but not inside the factory. The apprentice has less distractions and the nervousness of working in a large factory and developing an inferiority complex are avoided. The apprentice can be trained to use most suitable methods of operation by a systematic training programme. The right attitude to work and interest in his firm can be inculcated and team spirit and sense of confidence can be developed more easily in him. Such advantages are so valuable that it is worth while making the training Workshop a model with conditions for a factory.

The Training Workshops cover an area of 12,900 sq. ft. The main bay 192′ × 36′ houses fitters benches, Assembly Department, Compressor house, Smithy and Tool Crib. Two wings each 96′ × 32′ house the Welder and Machinist departments. Machine tools and equipment worth Rs. 6 lakhs have been provided. Each department has provision for imparting all-round basic training. Necessary tools and equipment are not lacking and each apprentice has the benefit of using all the best and most up-to-date tools required for his training. It is a light airy structure with clean and bright decorations and adequate natural lighting, conditions which are conducive to good standards of work. A high standard set by surroundings, human and material, naturally result in a better chance of higher standards of workmanship being attained by the apprentices under training.

The greater the skill involved in industrial processes, the more important does the question of training become. Inefficiency in working carries a number of undesirable results and hence from the very start new entrants are taught correct techniques of working and wrong and faulty techniques are eradicated and prevented from becoming habitual. From the very start accuracy is insisted upon and as soon as correct habits are formed the basis of training is quickened so that speed follows accuracy and not vice versa.

Practical training in the Training Workshop is under the expert guidance of Swiss Instructors, one for each of the three departments, Fitter, Machinist and Welder, assisted by Indian Instructors, working under a Senior Swiss Instructor. Control is intensive to ensure that all apprentices attain a minimum basic level of skill by concentrated attention and provision of adequate raw materials, tools and other facilities, so that when they go to the factory floor for further training, they are in a position to handle independently under close supervision, jobs which naturally fall to the lot of skilled workers. This satisfactory result is obtained by systematic graded exercises which have been specially developed. The exercise work-pieces as well as the 6-weekly Practical test work-pieces are evaluated by qualified Inspectors who judge not only the quality of the work but the time taken, the apprentice being made acquainted with the factor of time right from the beginning of apprenticeship. The trainee is carefully watched to spot any inherent talents and capabilities so as to lead him to specialise in a suitable branch of the trade. Side by side with this development of skill, the apprentice is made to develop a pride in workmanship, and obtain the satisfaction that comes of seeing a job done well.

One of the highlights of the Training Workshop is its Welding department.



A view of the Welder Department of the Training Workshops showing the electric welding booths

The Integral Coach is an all-welded design and this throws a heavy responsibility on the School for training the high-grade welders whose work will always be dependable and who can be relied upon to turn out modern all-welded passenger coaches under conditions of mass production. The lack of partially trained welders offering for recruitment places an additional burden on the School which has to be made up by relaxing standards of admission, by stricter control during training and by increased supervision.

While the main emphasis is on the practical training, theoretical training is a valuable adjunct, keeps in step with it and assists the apprentices to grasp their practical work more clearly. Great emphasis is placed on the development of ability to sketch mechanical details and to read blue-prints so that, on the shop floor, he will be able to read and work to blue-prints without constant guidance from his supervisor. A drawing syllabus suited to the requirements and starting from basic principles has therefore been drawn up. Subjects are also included which aid in enlarging the trainee's outlook and general knowledge and make him conscious of his responsibilities both at work and as a citizen. The subjects covered and the time spent on each per week are given below :

Machine Drawing and Sketching	...	6 hours
Trade Theory	...	4 ,,
Workshop Mathematics	...	2 ,,
Workshop Science	...	1 ,,
Geography	...	1 ,,
Individual Expression	...	1 ,,
Film and Visual Instruction	...	1 ,,
Citizenship Lectures	...	1 ,,

A total of 17 hours per week is spent on class room instruction. Tests are held every two months. The class room Instructor, while he may not be highly qualified on the theoretical side which he teaches, is however well acquainted in the practical aspects.

It is made compulsory for all apprentices to join the Auxiliary Cadet Corps which was inaugurated in August, 1954. Training in this Corps has many facets such as Parades, Physical Training, Citizenship Training, Community Work and Sports covering a total of 5 hours per week. In addition an hour has been set apart for an "Individual Expression" class to develop qualities of clear and coherent expression. Opportunities

Instruction on Oxy-Acetylene cutting in the Welder Department under the eyes of the Swiss Instructor

have thus been made available for displaying inherent qualities of leadership and develop traits of good citizenship.

Even more important than the training place itself are the Instructors. The selection and training of Instructors constitute an important line of activity to ensure success of the training scheme. Reduction of training time and increasing productivity of the trained labour is secured by use of specialised methods of training, employment of proper devices and exercises and skilful applications by Instructors of modern techniques and methods of training. With this end in view, the number of Instructors has been increased to provide one for every 10 apprentices and a full-time Principal is employed. Starting from 4 Indian and 2 Swiss Instructors in March, 1954, the School has now on its roll 22 Indian and 4 Swiss Instructors. The apprentices are made to feel at one with the Instructors and the basic underlying philosophy actuating the Instructor has been that those "with whom we earn our bread in the factory are deserving of as much respect as those with whom we eat the bread." The Instructors have a sound respect for the skills, and training is regarded as "something for what it can evoke from the people and not for driving them, to liberate the physical energy of the apprentices and to guide it efficiently into useful and productive channels." Eight of the Instructors have been or are being trained abroad. The School, therefore, has at its disposal a nucleus of excellent Instructional staff which can be depended upon to constantly strive and improve the standard of instruction in the School.

A separate organisation termed the factory Training Organization deals with the transfers of the Apprentices to the factory, after the basic training and follows up their progress on the factory floor. They maintain contact with the trainees while still under basic training, study the requirements of the factory by maintaining close co-operation with the Foreman and by ensuring correct placement, see that the trainees fit into the new surroundings of the factory. Correct placement of each apprentice not only assists in obtaining maximum output from each worker but gives each worker an occupation suited to his aptitude thereby making him a contented and satisfied worker.

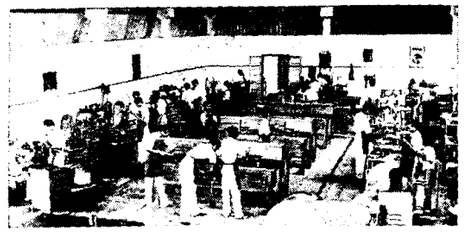
In-plant training for 12 months is an integral part of the apprenticeship scheme. During this period, the apprentice, who is already accustomed to independent work in the Training Workshop and possesses a versatile training, is given tasks which otherwise fall to a qualified worker. During this period, they are put in small batches to work under Swiss Technicians and Indian Technicians who had training in Schlieren. His abilities and attention to duties are recorded and a final trade test is given before his entry into the skilled grade.

Ever since the School was inaugurated in March, 1954 with 2 wings of the Workshop, a third wing has been built and brought into commission in October, 1954. The temporary offices in which the School is sited at present are however not the final home for the theoretical classes and the administrative staff of the School. A new school building to cost Rs. 3 lakhs is planned to be built and brought into use early next year. The building will have an Assembly Hall 70′ × 40′ which will be used for stage plays, debates educational film shows and for other group functions. This building will house the Principal's office, rest rooms for Instructional staff, a Library and a Model Room and have adequate number of class rooms.

To assist the apprentices in gaining valuable social experience in community living, a Hostel to house 250 Apprentices has been planned and is now being built. The foundation-stone for the Hostel was laid by the Governor of Madras, Shri Sri Prakasa in December, 1954 and it is expected that this Hostel will be ready for occupation late this year or in the early part of 1956. This Hostel will, when completed, cost Rs. 8,43,000 and will become the centre of the social life of the apprentices after working hours.

These new and impressive buildings for the School and Hostel are expected to be ready before March next year and therefore it can be claimed that when the School completes its second year of existence in March, 1956, it would be well set to fulfil its functions laid before it in a satisfactory and efficient manner. The total capital costs would then total about Rs. 20 lakhs in all. Plans are also on the anvil for increasing the floor space and equipment provided for the Training Workshop with a view to further improve the standard of practical training.

While the initial recruitment of apprentices will be restricted to Trade Apprentices, the Administration, as a matter of policy, have decided to give the maximum opportunities for advancement to such of those Trade Apprentices, who by hard work and merit are fit for further promotions. After their 18 months training, specially selected apprentices will be fitted into supervisory positions in the factory after further training. It should be possible for any Trade



A general view of the Machine Department of the Training Workshops. Most of the Machine Tools in this department are of Indian manufacture

Apprentice who enters the School, to reach the top rungs of the ladder by dint of sheer hard work and merit.

The aim of the Integral Coach Factory Technical Training School is, in short, to harness the ability and intelligence of the trainees, to impart suitable training through methodical practical work, to inculcate a sense of discipline and enthusiasm by widening the outlook through class room lectures, visual aids, opportunities for Individual expression, etc. and thus to mould him into a craftsman in the correct sense of the word. The School is designed to ensure efficiency and complete happiness in one's daily work and to emphasise that "Craftsmanship signifies not only possession of a particular skill but also effort, responsibility, dependability and pride in a good job of work done."

THE ART OF STORE KEEPING

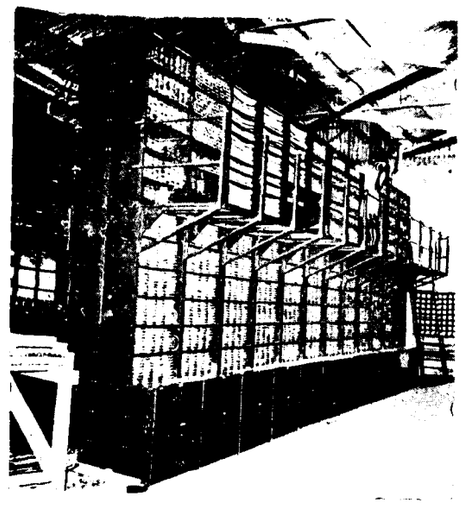
A. V. SUGAVANESWARAN, B.E.
District Controller of Stores, I.C.F.

Introduction

THE efficient housewife seldom comes up with the excuse that she has forgotten to buy the next tube of toothpaste in time ; nor does she find herself at a loss to know where she has kept the pen knife or the spare shoe lace ; in other words she knows when to buy and how much to buy ; where to keep and how to keep. As the household grows bigger her responsibilities also increase.

The Stores depot in a railway administration plays the part of an efficient housewife in a household. It assesses the requirements of the various items of stores for the other departments of the railway such as workshops, Civil Engineering Department, Electrical Engineering Department, Signals Department, etc., arranges to obtain them in adequate quantities, carries the stock when received, issues in small quantities as and when required and recoups the stocks in time so that before the existing stocks run out fresh stocks are received. The stores depot also arranges for the disposal of all scrap and other items not required by the other departments. When it is remembered that the requirements of a railway organisation vary from a pin to a pyrometer or a bolt to a boiler and run to several thousands of items, the extent of organisation required to recoup them in time, keep them safely and handle them quickly will be appreciated. There are railway stores depots in this country which carry stocks of materials ranging from two crores of rupees to three crores of rupees. In view of such heavy holdings of stock and the various responsibilities connected with the safe custody, timely recoupment and prompt issues of materials, the railway administrations have found it necessary to have a few separate full fledged stores depots in each railway, apart from the main purchase office.

In view of the fact that in a construction project the number of items to be stocked in the stores depot is comparatively limited whereas the vast majority of the items will pass through the stores depot to the construction engineers, the organisation of a permanent stores depot is not generally feasible. A temporary construction depot was however hastily organised when the Coach Factory started functioning early in 1952, which had been meeting the needs of the construction all along. Once production commences however the pattern of stores requirements will naturally take



A view of the Main Stores Depot showing 15 ft. high Steel Racks

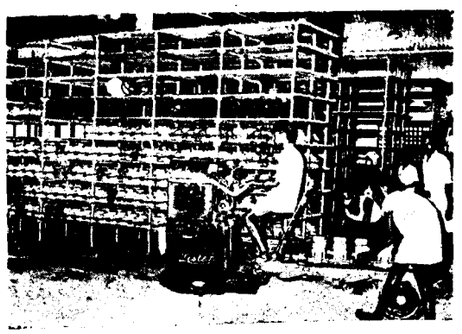
a definite shape and the requirements of materials will be fairly constant and their issues in small quantities at a time will be regular feature. At present it is proposed to manufacture only the Integral type of Coach and the target production has been fixed at 350 coaches per annum. This will involve turning out of about 30 coaches per month approximately. As it is not possible to litter the shop floor with materials, the issues from the stores depot will have to be in small quantities. Further the materials required at the various points of the various shops should be kept as far as possible adjacent to the places of consumption to reduce transportation ; this applies more particularly to heavy materials which cost more for transportation. The organisation of the permanent stores depot was taken in hand keeping in view all these requirements.

It has been assessed that about 2,200 items of tools are required for the various operations in the workshop. All these will have to be stocked in the stores depot to enable replacement when the tools in the shops are broken or damaged. The raw materials required for the manufacture of the various coach components run to 250 items. Obviously such items as rubber fittings, glass sheets, etc. will have to be purchased from outside, as no coach manufacturing shop anywhere can set up a separate organisation for the manufacture of these items. Such purchased items of coach components run to 250 items. Apart from these requirements there are consumable stores such as oils, greases and chemicals, spare parts of plant and machinery, stationery and forms and the requirements of the Technical School and Electrical Department, all of which will have to be stocked in the Stores Depot. The total number of stock items is expected to exceed 10,000.

Layout and Design

The above materials requiring to be stocked in the depot may be broadly classified into two groups, those that should be kept in a shed and those that can be kept in the open. Items such as stationery, tools, rubber fittings, machinery spares, etc., should obviously be kept in a shed, whereas steel

A busy morning in the Stores Depot—Issue of Materials



sections may be kept outside. Even among steel sections there are special kinds of steel which may be badly corroded if kept in the open and which therefore should be kept in a covered accommodation.

The cardinal factors guiding the design and layout of a Stores Depot include an assessment of the total covered accommodation required as well as the distribution and location of this accommodation in such a manner that materials are kept as near as possible to the point in the workshop where they are ultimately used. In the Integral Coach Factory, for example, we have provided enclosed areas inside some of the major shops to keep materials required in those particular shops. This practice eliminates wasteful transportation and contributes to economy.

The knowledgeable store keeper will disperse his materials in such a way that all statutory obligations are complied with and fire risk is reduced to the minimum. He should not, for example, keep fuel oil and cotton waste in the same godown. Designs of oil godown, carbide shed and oxygen shed should conform to the rules governing the construction of these sheds.

An important feature of any major stores organisation is the provision of suitable and adequate crane power for handling heavy materials. In the Integral Coach Factory, we stock heavy steel sections which are handled by three gantry cranes. There are different types of cranes such as gantry cranes, goliath cranes, mobile cranes and steam cranes each suited to a particular job. As gantry cranes are most useful in small yards with a large daily turn-over of materials such as in the Integral Coach Factory, these cranes have been preferred for handling the heavy materials.

The floor level of the stores godowns should preferably be at the same height from the ground as the floor level of the wagons to enable easy and quick unloading. Where barrels and other similar materials require loading or unloading, suitable ramps should be provided. The need for suitable approach roads and railway tracks for the stores godowns is too obvious to need emphasis. Adequate security of the godowns should be ensured to prevent possibility of thefts.

The design of racks to suit the various categories of materials is an important feature in any stores depot. Various factors govern the design of racks. In the first place the justification for a rack is to utilise the height ; the rack should, therefore, be as high as possible. Secondly, facility in issue is an important criterion ; it is no use stacking things in racks in such a way that you cannot get at them quickly when you want them. Thirdly, the racks should be such that the particular material for which it is designed can be kept there safely, properly and without damage. In the Integral Coach Factory 15′ high steel racks have been erected for keeping various items of tools, screws and other light items. This rack is in 3 parts ; the bottom portion can be locked up, the middle and top ones being open. The top portion is reached by a gantry provided with ladders. The main advantage of this type of rack is the height. For keeping heavier items of coach components sturdy racks have been designed. For the mezzanine floor in the H shop light racks have been provided for. There are certain rubber rings required for vacuum cylinders. The best method of keeping them is to have wooden drums of the same diameter as the inner diameter of the rubber rings so that the rings may be slipped into the drums. The drums can be piled one over the other. This method ensures that the rings are kept in proper shape and also facilitates issue. In this manner special racks and stacking devices are provided in a stores depot.

Receipt and Issue

Every day the stores depot receives materials from various sources. Firms in Madras may deliver the materials by their transport. Alternatively staff of the stores depot in some cases may have to go to collect the materials from firms' premises. These staff have also to collect parcel materials from railway stations. Materials coming from outstations in full wagon loads will also be received in the depot. There is a centralised receipt branch where all such materials are received, checked and accounted for. Materials on receipt will have to be checked both for quality and quantity. The checking of complicated items is carried out with the help of technical staff from the indenting department. Whenever supply is stipulated to be made to approved samples, the approved samples are sent to this branch for comparison with the bulk supply. Materials not upto the specification or sample are rejected. The accepted materials are then sent to the respective wards for stocking. All correspondence in connection with rejection or variation in quantity and other allied matters are dealt with in this section. This section also issues periodical reminders to firms when they fail to effect supply within the due dates.

The issues from the stores depot are normally made to the various indentors on the presentation of a requisition signed by an authorised official. In the Integral Coach Factory we have broadly divided the materials kept in the stores depot into two categories for the purpose of issue. The first category comprising of raw materials for manufacture of coach components, purchased items of coach components and shop manufactured items of coach component are proposed to be issued on presentation of what are called Production Forms. The quantities of these materials for production of a fixed number of coaches will be constant, whereas in a stores depot in an open line railway there will be no such constancy in the demands. The Production Control Office in the Integral Coach Factory is therefore in a good position to control the quantities to be issued to the various shops for their requirements. A lot of clerical work is eliminated by the use of these forms. This is a special feature of production units such as Chittaranjan Locomotive Works and the Integral Coach Factory. For the issue of tools, consumable stores, etc., a combined requisition and issue note is used. Materials for coach manufacture will be drawn for a definite number of coaches and this is termed as a "Batch". The batch quantity for the manufacture of the components will be larger whereas the batch quantity for assembly of coaches will be smaller ; the idea is to enable the manufacturing shops to manufacture a larger quantity at a time so that the production will be economical whereas the batch quantity for assembly is kept low to avoid congesting the assembly shop floor. Consumable stores and stationery which will be regularly required are proposed to be issued on a fixed monthly quota basis for each shop.

During manufacture quite a lot of cut pieces of steel as well as turnings and borings will be accumulated on the shop floors. These are returned to the stores depot and are handled by the Returned Stores Section. Broken tools, rejected items of coach components, empty tins and barrels and other items of stores that are not required in the shops will be returned to this section. All these scrap are classified properly in this section and kept separately. Sometimes a few of the returned items could be used after slight reclamation or items returned by one shop can be used by other shops. Whatever cannot be used by any department in the Administration is ultimately auctioned off.

Recoupment of Stores

One of the major responsibilities of a stores depot is to ensure that all the items stocked by it are always available in adequate quantities for the consumer to draw. In other words the depot has got to ensure that before the stock of an item runs out fresh stocks are received. The consumption of most

of the items of stores, on an average, will be more or less regular. On the basis of the consumption of an item over a period, say one year, the average monthly consumption is fixed. It is also known from past experience as also from the general condition of the market that the procurement of a certain item will take a definite period of time say 3 months or 6 months which may be termed " Procurement Period ". This period is required for the depot to submit its requirements to the purchase office, for the purchase office to invite tenders or otherwise process it, for the purchase order being placed, for the firm to manufacture the goods and for the transit time. It is obvious that the recoupment of an item should be timed when the stock of that item reaches a quantity representing the consumption of the item during the procurement period. When this limit is reached the stores depot sends an advice to the purchase office for the purchase of this item. Theoretically speaking, the fresh supply should be received just when the existing stock has come down to nil. The quantity that should be actually purchased is determined on the basis of various factors such as availability of rack or yard space, lock-up of capital, economic quantity to be purchased at a time, etc.

The receipts and issues of all items of stores are posted on ledger cards in a central section. A card is maintained for each item of stores stocked in the depot. The wards pass on the receipt and issue vouchers to this section where they are posted in the respective cards. At any time, therefore, this section will be in a position to give not only the balance in stock of an item but also all the history of the item such as past consumption, receipts and other details. The responsibility for the recoupment of stores as explained in the previous paragraph will also vest in this section. The procurement period will fluctuate depending on market conditions and transport bottlenecks. It is the responsibility of this section to make alterations as and when necessary on the procurement periods for the various categories of stores and note down the changes for future recoupments.

The Integral Coach Factory stores depot will make a prior reservation of raw materials and coach components so that when the work is taken in hand in the shops the materials are correctly available for that particular job. This reservation is also proposed to be done in the ledger section. The importance of this section can best be realised when it is appreciated that if timely recoupment is not done even in a single case, then the stock of the item will fall down to nil and a lot of work in the shops will suffer.

Care of Materials

One of the main responsibilities of the stores depot is to safeguard all materials in its custody from the ravages of weather, insects, etc. A considerable measure of knowledge of the various types of materials and protective measures necessary is required to effectively safeguard the materials against deterioration while in stock. For example all rubber materials should be kept in a cool dark place and should be dusted with french chalk to prevent them from being damaged. In the Integral Coach Factory it is proposed to have a small enclosure which is kept dark to house the rubber materials. The Integral Coach requires a considerable extent of welding and so a large quantity of various types of electrodes have to be carried in stock. The electrodes are a very delicate item of stores and the coating of flux on the electrodes is likely to be damaged by the humidity present in the atmosphere. Madras being a particularly humid place, the Integral Coach Factory has decided to have a separate de-humidified room for the storage of electrodes. It is proposed to install a de-humidifying plant in this room so that the humidity here may be controlled and kept at a level not injurious to the flux of the electrodes. In the same way various other materials have to be kept carefully to avoid damage. Ball-bearings for example should be kept coated with grease. The bristles of certain types of brushes are liable to be attacked by insects and therefore insecticides have to be kept in the bins where such brushes are stored. Steel sections are coated with anti-corrosive oils or paints to prevent rusting. Ready mixed paints should not be allowed to lie unhandled for a long time as the paint may set and prove useless ; they have got to be taken out and rolled periodically to avoid such setting. These are only illustrative, but not exhaustive of the various precautions necessary in a stores depot.

General Remarks

The men behind this big organisation naturally require adequate training and experience to equip themselves with the knowledge required to discharge their responsibilities efficiently. The Stores Depot of the Integral Coach Factory has already initiated an effective system of coaching designed to educate the junior staff in a proper appreciation of the duties of the various sections of the depot.

Quite a few of the items of stores kept in the depot may be inflammable. It is essential that an adequate system of Fire Fighting suited to the needs of the various materials kept in stock should be organised. It is also necessary to ensure the security of materials both during the day and night. For this purpose an effective system of Watch and Ward supervision is essential. All materials leaving the workshop area should be accompanied by a gate pass signed by an authorised official. In the evenings when the wards are closed, the locks of the various wards should be properly sealed and handed over to the Watch and Ward staff. A special procedure is necessary for handing over the keys in the evenings to the Watch and Ward and taking over the keys in the mornings from them. All godowns must be secure and as far as possible pilfer-proof.

For collection of stores from outside firms as well as parcels from railway stations, the Stores depot is allotted a lorry and a van. For issues to the various shops trucks, wheel barrows, etc., are provided.

Quite often while handling certain materials, particularly heavier items of stores, some of the staff are likely to be injured accidentally. It is, therefore, necessary that a few of the Stores staff should be trained adequately in First Aid to render immediate medical assistance to such men. First Aid Boxes should also be kept at vantage points within easy reach.

The Stores staff should also take special steps to prevent items becoming surplus. Stores are rendered surplus due to various reasons such as change in design, incorrect estimate of consumption, improved techniques, etc. An efficient store-keeper keeps watch and tries to force the issue of such items on the indentors to the maximum extent and disposes of the balance otherwise.

The Accounts department maintains price ledger cards for all the items for which numerical ledger cards are held in the Stores depot. All transactions are evaluated in this section at the end of each month and the value of closing balances for various categories of stores are sent to the Depot Officer for information. The Depot Officer will then know at a glance the total value of the stores he holds, the total value of receipts and issues and the distribution by categories. Major questions of stores policy with regard to stores holdings as well as budget control are exercised through this evaluation.

Such a great variety of stores running to thousands of items has been grouped into various categories for their easy identification. A common code in this respect is followed in all State Railways. For example 'G' stands for General Stores and in this major group there are subdivisions such as GA for tools, GB5 for Painter's stores and so on. A nomenclature list is prepared for each

category or class of stores listing alphabetically all the materials under that class and giving other particulars such as serial number by which each item is identified, specification, drawing reference and rate. A correct standard description of the article is also available in this list. Adequate number of such copies of nomenclature lists are printed and distributed to the various indentors for facility of easy indenting and prompt compliance.

Such in brief is how the Stores depot of the Integral Coach Factory is taking shape. It is a sturdy youngster now and no doubt in the fullness of time it will fulfil its task as the housewife of the Integral Coach Factory. It is the Civil Engineer who steals the thunder during the construction phase of an organisation. When once the construction is completed and the factory starts production, it is the Mechanical Engineer who comes to limelight. In an open line the Traffic Department is the master of the situation and the public generally identify the Traffic Department with the railway. The Stores Department is generally forgotten in all the phases. When the department is remembered, it is perhaps because an important item of stores is out of stock and work suffers. Then the department, no doubt, comes into the limelight, not as the hero but as the villain of the piece. The picture of an anxious stores officer awaiting receipt of important and urgently required materials which have been delayed in transit is a most unenviable one. The measure of effort and anxious chasing that the stores officer has to put in to ensure that vital items of stores are always available in adequate quantities is generally not known. Only when a single item out of thousands of items goes out of stock, he comes in for criticism. But why bother about criticism ? In the words of the Poet, let us do our duty, and "still achieving, still pursuing, learn to labour and to wait".

A FAMILY OF FOUR THOUSAND

K SUBRAMONIAN
Personnel Officer, Integral Coach Factory

"OUR approach to labour problems rests on considerations which are related on the one hand to the requirements of the well-being of the working class and on the other to its vital contribution to the economic stability and progress of the country. The worker is the principal instrument in the fulfilment of the targets of the Plan and in the achievement of economic progress generally. His co-operation will be an essential factor in creating an economic organisation in the country which will best subserve the needs of social justice. Certain rights and obligations are associated with this distinctive role."

— First Five-Year Plan — Ch. XXXIV

Inspired by these eloquent sentiments recorded by the Planning Commission, the Integral Coach Factory authorities have been devoting considerable attention towards developing and building up an Organisation for the Personnel Management which will on the one hand ensure that the workers who, when the factory reaches full production will be about four thousand strong, enjoy the rights due to them and at the same time realise and act up to the obligations devolving on them. The function of providing the worker with the facilities to enjoy his rights will vest in a Welfare Officer who will be assisted by a number of Welfare Inspectors. Before dealing in detail with the functions of the Welfare Officer and his staff in this factory, it would not be out of place to examine the objectives usually associated with a welfare organisation in a factory and to see how the conception of such an organisation developed.

The first step towards the formation of a separate and distinct welfare organisation in factories was taken in Great Britain during the First World War. Under the impact of the unprecedented demand for munitions and other items required for the prosecution of war, working hours in factories were raised to as many as seventy-two hours a week and instead of production increasing as anticipated

by the authorities, there was actually a decline in total output. Added to this, absence due to sickness and other causes registered a rapid increase. The British Government appointed the Health of Munition Workers' Committee in 1915 to " consider and advise on questions of industrial fatigue, hours of labour and other matters affecting the personal health and efficiency of workers in munition factories and workshops ". The findings of this Committee shattered the generally held notions about Labour being one of the factors of production just like machinery and raw materials, with output regulated by pure arithmetic. The Committee realised the importance of what is now known as the " Human Factor " in Industry consisting of the physical conditions and the social relations of workers and laid the foundations for the development of the science of Industrial Psychology or Personnel Management. It should not be assumed here that the British Health of Munition Workers' Committee was the first to realise that a worker is not a mere machine and that he also deserved attention from management as a human being. It is over a hundred years since a leading British employer exhorted his fellow-employers—not with much success—in these words : " If the care which you bestow upon machinery can give you such excellent results, may you not expect equally good results from care spent on human beings with their infinitely superior structure ? " But such a realisation came only to few until the great challenge of the First War, leading to the appointment of the Committee referred to a short while ago. One of the recommendations of this Committee was that a Welfare Supervisor should be appointed wherever women were employed. And thus started the chain of developments leading to the almost universal acceptance of the need for a Welfare Organisation in all Industries. In India the fillip to the appointment of Welfare Officers in Factories was given as in Great Britain by conditions created by War—with this difference, that it was the Second World War in India as against the First in Great Britain. The Factories Act, 1948, has made it compulsory for all factories employing over 500 workers to appoint Welfare Officers.

The aim of a Welfare Organisation is not merely to look after the welfare of the workmen by categorising the items of their physical needs and social relationships and catering to them. These are no doubt important but only as means to an end—the end being the complete identification of the worker with the organisation in which he works.

The Integral Coach Factory is an undertaking in the Public Sector and " a worker in a public undertaking stands on a different footing from a worker in private undertakings. He has a dual role of master and servant ; master as a citizen of the country and servant as a worker of the undertaking. It is therefore necessary that he should be made conscious that in serving the undertaking he is serving himself and that the better he works and the greater his efficiency the better he will serve and help himself. He must be made to feel that the responsibility for the success or failure is as much his as that of the management and that the undertaking belongs to the country as a whole including himself. He should take pride in his contribution to the success of the undertaking." (First Five-Year Plan). It is the realisation of these objectives that constitutes the goal of the Welfare Organisation.

A short account will now be given of the provisions made or being made to meet the physical needs of the workmen and to provide congenial conditions of work.

The first place in this account will be taken by the factory where the worker will have to work. Needless to say, the planning of the factory meets all the requirements of the Factories Act in regard to safety, cleanliness, ventilation, lighting and

allied matters. The entire factory construction has been so planned that the interior of any shop presents a pleasing appearance and the machinery layout so drawn up that machines are arranged in regular order. There are no belts to jar the scene, all the machines being fitted with individual motors, in keeping with the latest practice. Plenty of moving space has been provided between and around the machines and the entire floor space is unobstructed. All the electric leads for the machines, compressed air, water, etc. are brought along trenches, which are covered with checkered plates, flush with the floor. The rails in the factory too have been laid flush with the floor so that the risk of anyone tripping and falling down is eliminated. A pleasing colour scheme is proposed to be painted on the shop walls. The roads inside the factory are all dust-proof cement roads. Ice-cold water will be available at hand for all workmen from water-coolers which will be provided at the rate of about 1 for every 200 workmen, each water-cooler costing over Rs. 3,000 and with a capacity of 80 gallons. So much for the worker while at work.

A spacious double-storeyed building has been constructed at a cost of over Rs. 1½ lakhs to house a Canteen and Rest Shed. The canteen will be housed in the ground floor with an area of about 9,600 sq. ft. and provided with two washing rooms of 750 sq. ft. and 112 sq. ft. Spacious kitchen, store-room and pantry have been provided and the kitchen is being fitted up with the latest electrical cooking ovens. Equipment, all in stainless steel, and steel furniture at a cost of over Rs. 40,000 are being supplied by the administration. The canteen will be run by a

Canteen Building of the Integral Coach Factory

committee consisting of equal numbers of representatives of workmen and the administration. Arrangements are also being made for the supply of snacks and coffee/tea for the workmen at the workspot both during the forenoon and afternoon sessions and for this purpose orders have been placed for streamlined stainless steel canteen trolleys.

The first floor of the Canteen building will have a spacious lunch room for the benefit of workmen who bring their own meals and also a lounge to serve as a rest-room where it is hoped to provide newspapers and other light reading matter. The rest-room and lounge will also be furnished with steel furniture. The entire building is well-ventilated and amply provided with electric fans.

Encouragement is given to workmen to practice thrift and develop self-reliance through co-operation. A consumer co-operative society is being formed with the active assistance of the Administration. Facilities to the co-operative society will include provision of accommodation at nominal rent and a subsidy in the shape of payment of half the Establishment charges for the first three years. It is also the policy of the Railway Ministry to encourage such co-operative societies to take over the management of staff canteens and in accordance with this policy the Staff Canteen in the Administrative Offices has been handed over to the co-operative society with furniture and equipment at a cost of about Rs. 9,000.

Next comes recreation and amusement. The Administration has provided a furnished building to be used as an Institute (or a Club House) by workmen. In addition there is also an I.C.F. Sports Club which is actively encouraged. As active steps towards encouragement of sports, employees taking part in inter-shop, inter-railway or recognised outside tournaments are given free passes and special casual leave.

On the question of wages, the Integral Coach Factory is a Central Government-managed concern and its employees are paid the Government of India scales of pay and allowances which are generally higher than those prevailing in private undertakings in the vicinity.

We have traced in brief the concrete steps taken towards the welfare of the workers. These as emphasized before, are only means and not ends in themselves, the end being the complete identification of the workers in the Integral Coach Factory. Now how do we propose to attain this end ?

A reference may be made here to the well-known "attitude survey" undertaken by the Hawthorne Works of the Western Electric Company of America. This study established that wages, physical amenities, improved working conditions and allied factors did not really count as much as the attitude of the workmen towards management. If this attitude were hostile or even suspicious no amount of welfare measures can be of real use. According to Sargant Florence, "the position of the average worker in much of modern industry may be summed up as dominated by four R's: repetition, routine, red-tape and risk" and the aim should be to reduce, by the largest extent possible, the dominance of these R's.

The repetitive nature of the work in a manufacturing shop like the I.C.F based on the Production-line idea, creates feelings of monotony resulting in boredom and a certain amount of feeling of apathy to the work and to the undertaking. Routine, in the matter of working to regular hours, under regular conditions and according to regular practices, with the same people about and above, might similarly blunt one's keenness and enthusiasm for work. Red-tape is such a well-known expression that it needs no explanation. But here it is used in a special sense, to indicate the feeling of being just one cog in a huge plant, resulting in frustration. The risk element refers to the risk of accidents, of losing one's job, resulting in a feeling of insecurity.

These R's must be eliminated and a positive feeling of security and confidence created in the workmen. The effect of the repetition element will be minimised by the introduction in due course of a Bonus system of payment for production over specified norms. To do away with the ravages of routine it is necessary that every workman must have a quick and effective outlet to ventilate his grievances without let or hindrance. It is proposed to ensure this by the steps detailed below. There will be a team of Welfare Inspectors who will go round the shops every day and will hear any complaints or grievances a workman may have. The grievances may be real or imagined ; in either case a patient hearing will be given, in the strictest confidence and it will be the duty of the Wefare Inspector to get in touch with the authorities concerned and wherever possible, have the cause for grievance removed. Most of the grievances relate to petty issues like leave, passes, etc. and can be easily redressed by the Welfare Inspectors by contacting the appropriate office. The Welfare Officer will also be available for interviews with workmen, during fixed times every day. The Welfare Officer and his staff will maintain the closest personal contact with the workmen and endeavour to inspire confidence and a feeling of security in them, at the same time impressing on them the need to realise and act up to their responsibilities. Each individual worker will have to be made to feel that he counts and that his contribution is as important as the contribution of any one in authority over him. The risk of losing one's job is very small in Government undertakings as compared to private undertakings and all workmen in the I.C.F., being Government servants, have the protection afforded by the Constitution.

All these are not mere wishes for the future. Right from the inception of the I.C.F. Project a conscious effort has been made by all those employed in it to develop mutual co-operation and trust. The emphasis has all along been placed on the harmonious building up of the edifice as a monument of mutual trust, co-operation and team work in all ranks. We are trying, in our limited field, to develop a new attitude in the day-to-day relationships between employees from the highest to the lowest which would truly reflect the democratic set up in our country and the trend towards the establishment of a Socialistic Welfare State. If there is any hitch anywhere, be it major or minor, and it is no secret that hitches do arise in a new project of this magnitude—what is done is for those concerned to get together and see how best it could be overcome. The team spirit displayed by officers and men in the project has attracted the admiration of many a visitor and drawn eloquent tributes from Shri Lal Bahadur Shastri who was pleased to say: "I was glad to learn that there is a nice team spirit amongst officers as well as the workers, and I would like you to continue working in the same co-operation and friendliness amongst yourselves as you have done so far." Apart from contacts in the course of day-to-day working, no opportunity for the free mixing of officers and workmen of all ranks outside working hours is missed. During Independence and Republic Day celebrations, elaborate programmes of sports are gone through with special emphasis on the free mingling of all classes of employees.

"The Railway system can only be run with the fullest co-operation of all those engaged in it, keeping in view always the good of the public as well as the good of those engaged in serving the public through this vast organisation," said Shri Jawaharlal Nehru. This inspiring message will be constantly before all those employed in the I.C.F. and it will be their earnest endeavour to make it, in the truest sense of the word, **a family of four thousand.**

THE NEED FOR APPRENTICE TRAINING IN INDIA

J. MATTHAN

Mechanical Engineer, I. C. F.

THE training of workmen through apprenticeship schemes possesses advantages which outweigh purely financial considerations. The writer proposes in the course of this brief article to outline some of the advantages of well-organised and efficiently run apprentice training schemes in order to emphasise the place that such schemes should have in every engineering undertaking.

Apprentice training—the effective method of meeting skilled manpower requirements

Among the principal reasons for our country's hitherto slow progress in the field of industrial development are the shortage of steel, the lack of an adequate machine-tool industry and the shortage of skilled technicians. The first two drawbacks are being remedied—at least to some extent—by the establishment of the three new steel plants and of the Machine Tool Prototype Factory at Ambernath, the Hindustan Machine Tools at Bangalore and other Machine Tool Factories such as Kirloskar, Harihar in the private sector. Unless however the third shortage—that of skilled technicians—is effectively tackled, no real progress will be possible.

With the large-scale industrialisation that is envisaged in the Second Five-Year Plan and thereafter, the already meagre supply of skilled artisans now available for employment will dwindle to vanishing point, and industry will be faced with a serious problem in finding its requirements of skilled manpower. There are two possible alternatives :

(1) the policy of employing unskilled labour on the actual work processes and waiting for them to pick up the trade and

(2) the introduction of apprentice training schemes.

While the first alternative can no doubt be adopted with advantage in a factory where production can be broken down to a series of repetitive operations requiring little skill, it cannot be applied economically and often not at all, in certain trades where higher degrees of skill are essential. In such trades the employment of unskilled labour and their inevitably slow assimilation of the required manual skills on the actual work processes can only mean a low order of output, both in respect of quality and quantity. A workman trained in this manner would take as much as 10 years before he could attain an acceptable standard of skill. On the other hand, with the introduction of a well-organised apprentice training scheme of a duration of, say, 3 to 3½ years, a vastly improved product would be available. With one year of this period spent in a training school where the basic skills would be imparted, and the remaining period spent in the factory in gradually absorbing the know-how of each work-process under expert instructors, the apprentice trained workman would have acquired the necessary background to enable him in the course of another two years or so, to become really proficient in his trade. The expenditure incurred during the training period would be offset by higher productivity after apprenticeship.

Apprentice training as a means of reducing overheads

Efficient production in a factory is dependent on the economic use of labour and material and the reduction of oncosts to the minimum possible. Supervision charges form a part of oncost and it is therefore important to keep supervision down to a minimum. If we compare the supervision ratio in a factory in the West with a similar factory in India, we find that it is appreciably higher in India. While there are no doubt other factors contributing to this, I feel that one of the reasons is the fact that most Indian workmen have not had the benefit of apprentice-training. They are unable to work independently and without the constant guidance of a supervisor. For example, the blueprint of a component to be manufactured is unintelligible to the workman and the supervisor has at every stage to come to his assistance. The result is that a larger number of supervisors has to be employed. With workmen trained under an apprenticeship scheme, the position is different. The closely-supervised practical training they have had under experts on the various processes, tools, material and equipment, and the related technical instruction they have received during their apprenticeship make them self-reliant and competent to work more or less independently of their supervisors.

Apprentice-training as a means towards improved labour relations

A factory where relation between management and labour are strained cannot work efficiently even if it possesses the most up-to-date machinery and employs the most efficient production methods. Where workers are obtained direct from the open market, there cannot be that mutual interest and respect beween employee and employer so essential for good labour relations. Where however the bulk of the workers are those who have first been trained as apprentices and then employed as workers there is an undefinable bond between the employee and employer. Just as a student develops loyalty towards his school or university, the employee who has had the benefit of an apprenticeship bears a loyalty to his firm which even adverse circumstances cannot destroy. Similarly the employee feels a greater responsibility for the well being of the apprentice he has trained. What better atmosphere could be developed for cordial relations between management and labour !

The writer has so far endeavoured to describe the advantages which would accrue to industry by the adoption of apprenticeship schemes. To the apprentice himself, it affords advantages which cannot be ignored.

Apprenticeship affords the young man the opportunity to plan his future according to his aptitude. He has a definite goal to strive for, and his training breeds in him a sense of security that he will in due course of time become a skilled workman, able to earn

a satisfactory wage, and useful to the community. During his training he absorbs all the varied skill of his particular trade and therefore becomes versatile enough to find employment easily wherever his domestic circumstances may take him.

The writer had the opportunity recently of studying apprentice training schemes as they function in West European countries, particularly in Switzerland. The impression that he gathered was that the greatest importance is attached to the training of apprentices. Almost every factory has a scheme for such training. Practical instruction is imparted in the factory by selected craftsmen and theoretical instruction is given usually in the local Technical School on one or two half days per week. It was found, rather surprisingly that management do not insist that apprentices trained by them should serve them for a stipulated period after apprenticeship. Apprentices are free to seek employment after apprenticeship wherever they pleased. In fact some factories encourage their apprentices to take up employment elsewhere so that they may acquire greater versatility and more varied experience in their particular trade. All this goes to show the measure of importance that is attached in Western Countries to the training of craftsmen.

The prosperity of the industrially-advanced countries and in fact their entire economy is based on the productivity of their skilled workmen. If India is to move forward to greater prosperity, we must recognise the fundamental need for building up reserves of skilled manpower by the establishment of apprentice-training schemes throughout the length and breadth of our country.

THE INTEGRAL DESIGN OF THE MODERN RAILWAY COACHES

W. BRAEM

Chief Technical Manager, I. C. F.

IN the last two decades the construction of railway passenger coaches has undergone a revolutionary change. It was not only a question of seeking means for greater economy in Railway rolling stock operation but, in particular, also to provide for greater riding comfort of the passengers so that Railway travel may be more agreeable and be actually an attraction for the travelling public.

New developments in manufacturing processes, availability of the correct raw materials produced to specifications drawn out to meet the various requirements and, above all, the introduction of the electric arc and spot welding technique which in Europe dates back from 1930, opened new vistas in the coach building industry. As a result of these advancements, the old customary principles of construction were completely abandoned and new methods adopted.

Under this influence in Europe a specific new development of an all-steel coach design became popular which distinguished itself particularly by virtue of its considerably lighter weight when compared to the coaches of earlier manufactures, at the same time improving the running qualities of the coach and also ensuring greater safety of the passenger by the so-called "integrated design". This new method of construction had its birth in Switzerland, the first execution of which dates back to 1933, when Messrs. Swiss Car & Elevator Manufacturing Corporation Ltd., Schlieren-Zurich, in co-operation with the Swiss Federal Railways, built an experimental coach of the "integrated design". The final tests and the concluding trial runs were so promising that with this new coach the foundation-stone for a new epoch in Railway coach building industry was laid. With the good practical experience gained in the meantime, this new type was declared as the standard type by the Swiss Federal Railways as far back as 1937. Today this mode of construction has already been adopted by most of the European countries. The design of the coach has been accepted as the ideal by the modern coach building industry.

The apparent characteristic feature of this new construction lies in the unique constructional features of the coach shell. According to the old principle the walls with the roof were built as a superstructure on the underframe which by itself had to serve as a carrying unit or a supporting bridge resting on the running gears or bogies at both ends. This superstructure served only as a protecting hood to offer passengers the seating and other comforts and protection from the elements and did not subscribe to the strength of the structure. In the new construction, this "protecting hood" is so designed as to form part of the supporting construction itself. The under carriage, the side and end walls and roof—all together constitute an integrated structural body which can in a certain sense be well compared to a quadrilateral girder construction : consequently the entire coach shell which for simplicity can also be imagined as a large hollow tube constitutes a carrying unit thus serving a dual purpose. By employing **intelligent** methods of construction, especially by the exclusive employment of the most modern electrical welding technique, it was also possible to include the relatively thin side wall and roof covering plates of steel sheets of 1/16" to 3/32" thickness as the so called "skin stressed members" in the computations for the carrying capacity. By this a further reduction in weight has been made possible without in any way decreasing the carrying capacity or the stability of the coach body. This type of coach has therefore, been rightly termed as an "all welded light weight steel coach".

With this type of construction, savings in weight upto 30 per cent can be achieved. In the case of the new passenger stock designed for the Indian Railways, 7 tons of steel will be saved for every individual coach. For the entire coach body "low carbon mild steel sheets" with commercially specified standard values for tensile strength and other physical properties will be exclusively employed.

Since the entire construction is based on electrical spot and seam welding, it is absolutely necessary that the steel employed should be weldable. When the new governmental steel plants start functioning, India will be able to supply the raw materials of the required quality for these coaches from the country's own resources.

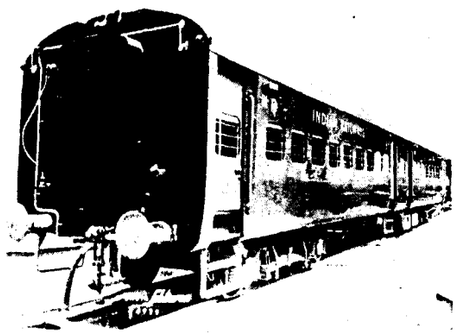
The under-carriage incorporates a steel plate corrugated welded floor, running throughout the entire length and so designed as to absorb in particular the various tractional forces and the buffing shocks. The end constructions are heavily reinforced so as to resist every kind of telescopic action in the event of a collision. The Louver and glass windows have light metal frames manufactured from extrusions and for ensuring better sealing against dust, light metal guides with felt linings are provided. The entrance doors have special hinges with ball bearing arrangement and are further provided with protective guides so that any possibility of injury to the passengers by jamming of fingers or having parts of their dress caught, etc., are positively eliminated.

As a protection against the danger of rusting of the sheet steel body shell, the complete interior wall and roof plates receive a 3-fold coating of special bituminous paint. Further the walls and the roof are also inlaid with an asbestos insulation layer as protection against the conduction of heat into the coach interior and also as an anti-reverberating medium.

The design of the coach enables the entire construction to be processed continuously commencing from the manufacturing of details, sub-assemblies right up to the finished stages ensuring for smooth flow of work on the various assembly lines.

In developing this new integral all welded light weight steel coach design, attempts have been made to improve

on the previous design of running gears also. It would be superfluous to emphasise that the bogies are the most vital parts of a railway coach. The riding quality depends almost exclusively on a good bogie construction. The bogie is the part which is most liable to wear and tear. Its behaviour in actual service contributes towards the efficiency factor of a coach. Therefore it has to be so constructed that it can withstand the heavy wear and tear and thus ensure long, uninterrupted maintenance-free service.

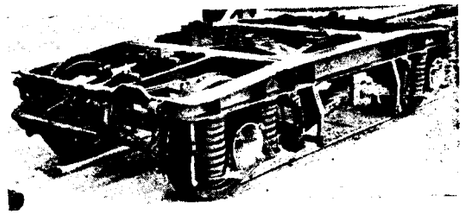


"Schlieren" design for the Indian Railways

The "Schlieren" bogie that has been adopted by the Indian Railways, incorporates several new features. Taking advantage of the new processing methods, welding techniques, etc. it had been possible to reduce its weight by 20 per cent as against the other I.R. bogies in use. As explained elsewhere, this reduction in weight had been achieved by resorting to a reliable welded construction throughout the bogie frame and bogie bolster.

The axle boxes which play an important role are fitted with spherical roller bearings. The old jerky axle-box guides have been eliminated and are replaced by an entirely new arrangement of guides working in an oil bath sealed against dust and water which in turn ensures a smooth working with practically no wear and tear of moving parts. The axle box helical springs are controlled by shock absorbers. The laminated bolster springs arranged longitudinally have a special spring leaf design which ensures better lubrication between the leaves, on a long run. This is an additional improvement of the spring which provides for better shock absorbing capacity which consequently produces a softer cushioning effect in the riding of a coach. These springs are suspended by swivelling hangers to the bogie frame thus taking up the lateral shocks as well as the side swinging of the running gear thus isolating such movements from the coach body. An absolutely play-free connection between the body bolster and the bogie frame by means of two anchor links, longitudinally arranged diminishes additional jerking while the coach is running. The brake rigging in the bogie has an improved arrangement so that the centre pivot is entirely relieved of the heavy pulls of several tons applied through the brake rod. The brake blocks are designed as two parts, consisting of the brake shoe and the brake shoe holder, with the result that the relatively cheap brake shoe as wearing part has only to be replaced when worn and brakes have to be reset.

The Schlieren Bogie



HOUSING AND WELFARE OF THE FACTORY WORKERS

R. M. SAMBAMOORTHI
Executive Engineer, Workshops, I.C.F.

IT is becoming increasingly recognised all the world over that unless congenial and healthy surroundings are created for the factory worker to work in, he cannot be expected to give of his best to any industry. In a Welfare State like ours, it becomes all the more essential that the welfare of the worker within the works, as well as of his family outside, receives the special attention it deserves. The Indian Railways, biggest of the nationalized undertakings of our country, has been well-known to be the Pioneer in Labour Welfare. Apart from the vast sums being spent on providing or improving labour amenities such as housing, recreational, educational and medical assistance and such like on existing railways, on new undertakings such as the Integral Coach Factory, the housing of the staff and other amenities for the workers form an essential part of the project. Side by side with the construction of the project works, the labour amenity works are also taken in hand, so that both are completed together to give the worker all the amenities required from the start.

On the Integral Coach Facory, the workers' colony is sited close to the works and is intended to house all the essential categories of workers required to live near the workshops, such as the Security Force, Fire Brigade, Key Operating Staff for each Shop for any emergency, Electrical Staff, Chargemen, Foremen, etc. The colony, built on a 35-acre plot is at present intended to house 400 families and has ben built on the flat system to conserve space. The colony has well laid out, dust-proofed, asphalted roads, planted with shade giving and flower trees and is fully electrified and provided with underground water borne sanitation. The flats are laid out compactly within this 35-acre plot and the colony is self-contained with its own Children's School, Park and Playground, a Recreational Institute, a Bachelors' Chummery and a Subordinates' Rest House. A sanitary cow-shed has been provided on nominal rent to occupants of the colony to house their cattle away from the colony, but within easy reach. In course of time, it is intended to have a Post Office and a small marketing centre for the colony to make it completely self-contained. In addition, the colony is well connected by the Madras city bus routes and the important business and marketing centres of the city are, therefore, within easy reach of the colony.

A street scene in the Workers' Colony, Integral Coach Factory

The strength of the factory at full production is expected to be about 4,000 workers. Perambur, where the factory is situated, is well connected by Suburban trains and buses and it is expected that a good proportion of the 4,000 workers will come to the factory by the suburban services. Accommodation has, therefore, been provided in the colony in the first instance for 400 families. Of the 400 flats provided in the colony, 200 are of Type I for lowest grade semi-skilled and unskilled workers. The next 100 of Type II are for skilled workers and artisans. Of the balance, 76 of Type III are for Chargemen and 24 of Type IV for Foremen.

This colony of 400 flats has been constructed at a cost of Rs. 26·8 lakhs. This is exclusive of the development cost on roads, drains, sewers, water supply and electricity. The cost of these services for the whole colony works out to Rs. 3·39 lakhs. The cost of the other ancillary buildings, such as the Institute, Rest House, Apprentices' Hostel, etc., is Rs. 8·98 lakhs. This would put the figure for the colony, including these ancillary buildings, at Rs. 39·17 lakhs.

The floor area and living accommodation provided for each of the above categories of workers is roughly based on the living habits of each class and caters for the progressive improvement in status and emoluments. From the statement attached can be seen at a glance, the floor area, accommodation and amenities provided, the capital cost, economic rent, etc., for each type. Type I, intended for the lowest grade of workers provides a living room 10′ × 12′, a kitchen 7′ × 5′ and a rear verandah 7′ × 7′. Bath-rooms and lavatories have been provided attached to the block at the rate of one set for two families. The kitchen has a raised cooking platform and chimney and is provided with individual water tap and wall shelves for storing utensils. The rear verandah has a loft above for storing fuel, junk, etc. The main living room itself has wall shelves for books and other odds and ends and is well ventilated. The flat is electrified with individual meter and the sanitized bath rooms and lavatories are connected to the underground sewerage. This type is intended for occupation by workers drawing a salary from Rs. 30 p.m. to Rs. 55 p.m. Under the extant rules in the Indian Railways, recovery of rent for accommodation provided by the Railways is limited to a maximum of 10 per cent of the salary of the occupant in cases where the economic rent of the building is higher than this 10 per cent. Accordingly, the maximum average rent that can be realized by the Administration for Type I is Rs. 5 p.m. and it will be agreed readily that for this rent, the accommodation and amenities provided cannot be realized in private buildings even in less costly areas than Madras.

The quarters of this type have been so designed that at any time later, they can be easily converted to two-roomed types. It may be noted here that even for this lowest type of quarters, individual water tap, water-borne lavatories and electrification with individual meters have been provided —facilities not ordinarily realized even

by middle class families in big cities like Madras.

Type II is intended for skilled workers and artisans, drawing pay between Rs. 55 p.m. and Rs. 150 p.m. and for this salary, the rent realized by this Administration works out to an average figure of Rs. 13 p.m. For this rent, this type provides two living rooms of 10′ × 13′ each, one kitchen 7′ × 9′, one rear verandah 7′ × 17′ with individual attached bath room 5′ × 4′, and lavatory 3′ × 5′. This type also is fully electrified and sanitized and provided with built-in wall shelves, fire place, cradle hooks, etc.

Type III, the next higher type, has an additional living room 12′ × 13′ and a store-room 6′ × 5′. This type has 2 electrical ceiling fans as part of the electrical fittings and F.O.L.

Type IV, the highest type in the colony has a combined drawing-cum-dining room, 12′ × 20′ with a front verandah 7′ × 20′, two bed-rooms each 12′ × 14′, a small rear verandah and kitchen, a store room and a suite of bath room and lavatory, and an attached servants' room of 9′ × 12′. This type has 3 ceiling fans and one wash hand basin with F.O.L. For both types III and IV, overhead day tanks have been provided to provide continuous supply of water for flushing purposes.

While providing the amenities described above in each of the above types, the need for keeping the overall cost of construction as low as possible has been constantly kept in mind and economies wherever possible have been achieved without however reducing quality or standards of amenity prescribed. The layout for each type was decided in consultation with the Railway Architect to achieve maximum free living space with minimum floor and wall spaces. All the buildings in the colony have been treated architecturally to give a pleasing exterior and improve the aesthetic appearance of the colony as a whole.

Economy in construction has been achieved by the following methods :

1. Construction of double-storeyed flats to save ground space and save on foundations.
2. Grouping a convenient number of flats in one block, with a view to making one stair case serve the entire block.
3. Compact planning of the various blocks in the colony to reduce the cost on the leading of services, such as electricity, water mains, sewers, roads, etc.
4. Use of 9″ thick masonry walls with lean cement mortar 1 : 5 for both ground and first floor for Types I to III.
5. Use of countrywood for trellises in verandahs and such unimportant places and use of ½″ thick planks in lieu of ¾″ planks for panelling of doors, windows, etc.
6. Use of steel shuttering for RCC floors and roofs to reduce cost on shuttering and to eliminate plastering of ceiling.

From the statement below of the cost of construction and rates for each type, it will be seen that the costs compare very favourably with buildings of similar construction elsewhere. Though built of I class brick masonry in cement with RCC floors and roofs and teakwood doors and windows, it has been possible to lower the cost of construction without sacrificing quality because of the above-mentioned substantial economies achieved in construction.

Next to housing, the colony contains the following important items of amenities, essential to the community life of the residents :

1. Children's School ;
2. Children's Park and Playgrounds ; and
3. A Recreational Institute for the Staff.

The school is housed in a separate building built for it within the colony

and provides instructions for children upto the Vth Standard. The full strength of the school is 230 and with the colony only partly occupied, the attendance at the school is already 163. This is a very good indication of the need for this school in this locality and the appreciation of the facility provided by the Administration. This school is aided by the local Government, the railway meeting the balance of the running expenses.

The children's park and playground is situated centrally in the colony and is provided with see-saws, swings, slides and other facilities for children to play. The park has well-laid out lawns and flower beds.

The Institute (Club House) which is the centre of social activity of this colony is in a building with a plinth area of 4,250 sq.ft. This has a stage and an auditorium, a library and indoor games room with an attached snacks room or canteen. Around the building, ample space has been included in the compound for developing outdoor games such as Tennis, Badminton, etc. This Institute building is built and furnished by the Railway at a cost of nearly Rs. 46,000 and handed over to the staff for running. This is managed by an executive committee elected by the subscribing members of the Institute. In addition to daily use of the Institute for indoor and outdoor games and library, periodical music and dramatic performances are conducted by the staff as part of their cultural activities.

To cater to the staff attached to, or visiting the factory on duty, a rest house and a chummery have been provided in the colony. The rest house is intended for the use of staff of other Railways or Government Departments visiting the factory on duty. The chummery is intended for temporary accommodation of staff of this factory who may be bachelors or may be living without their families and so do not need a whole house to be allotted to them, but who are prepared to chum up with similar staff using a common kitchen and dining room as a sort of miniature hostel. Here also, the buildings are provided by the Administration free to be run by the occupants.

In the factory proper, the amenities provided in the precincts of the workshops are :

1. Works Canteen.
2. Lavatories and Bathing Cubicles.
3. First Aid Post and Dispensary.

The works canteen is an imposing double-storeyed structure with a 200 ft. long frontage. It consists of a Canteen Hall in the ground floor with an attached service block of kitchen, servery, store rooms, etc. The entire first floor is one long hall, intended as accommodation for workers to take rest during the daily mid-day recess. The halls are very well ventilated and lighted. In the ground floor canteen, there is a service counter at one end for serving food stuff. The kitchen will be provided with electrical cooking apparatus for preparation of these food stuffs with a small food lift being provided for sending drinks and other eatables to the first floor also for serving there. This canteen is intended to accommodate at a time 1,400 workers and fully complies with the requirements of the Factories Act in this connection. It is also the intention to organise later, instructional film shows for workers, after working hours, in the first floor hall and with this in view, these halls have been constructed without any obstructing pillars or cross walls as one long hall. This canteen has been constructed at a total cost of Rs. 2 lakhs, including furniture, and it may well claim to be one of the modern industrial canteens in the country.

Attached to each of the workshops, lavatories have been provided inside the factory, complying with the Factories Act. These are designed as neat looking structures with up-to-date sanitary fittings with flush-out and sanitary mosaic floors and dados. To avoid the worker having to walk a long

INTEGRAL COACH FACTORY, PERAMBUR
Data regarding Construction of Staff Quarters in I.C.F.

Type of Quarters	Plinth area per unit in sq. ft.	Floor area per unit in sq. ft.	Floor area, size and No. of main rooms in 1 Unit			Floor area of verandah and secondary rooms in sq. ft.	Cost of portion
			No.	Size	Total area sq. ft.		Cost per unit
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Type I	325	251	1	1 - 12' × 10'	120	131	Rs. 3,166
Type II	725	565	2	2 - 13' × 10'	260	305	6,658
Type III	1,022	810	3	2 - 12' × 10' 1 - 13' × 12'	396	414	9,783
Type IV	1,633	1,215	3	1 - 20' × 12' 2 - 14' × 12'	576	639	16,329

Building only	Sanitation	Electrification		Total Cost		Rent per unit	
Cost per sq. ft. of plinth	Cost per unit	Cost per sq. ft. of plinth	Cost per unit in Block	Cost per sq. ft. of plinth	Cost per unit	Cost per sq.ft. of plinth.	Per mensem 4% cost	Per mensem 10% of average salary
(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Rs. A. P.	Rs.	Rs. A. P.	Rs.	Rs. A. P.	Rs.	Rs. A. P.	Rs.	Rs.
9 12 0	326	1 0 0	107	0 5 0	2,599	11 1 0	12	5
9 3 0	541	0 12 0	101	0 9 0	7,603	10 8 0	25	13
9 9 0	872	0 14 0	1,112	1 1 0	11,767	11 8 0	39	26
10 0 0	1,499	0 15 0	1,505	0 15 0	19,333	11 14 0	64	49

way in hot sun or in rain as is usual in ther workshops, these lavatories have been attached to the workshop structures. In addition, cloak rooms are being provided in each Shop for the workers' convenience.

Cutside the individual Shops, at elected places, bathing cubicles have lso been planned to enable workers, articularly from the Paint and Smithy Shops, to have shower baths to cleanse themselves at the end of the day. This, apart from the cleansing aspect, in a hot country like ours, is a very great facility indeed.

At the entrance to the factory premises, a combined First Aid Post and Dispensary has been provided. A doctor will be in attendance here during working hours of the factory.

In addition to attending First Aid cases, the Dispensary will attend to normal sickness amongst the workers and dispense medicines. It is considered that this combination of First Aid Post and Dispensary inside the factory premises will lead to better health of workers and reduce sickness absence.

Lastly, mention must be made of the extensive gardening being undertaken to beautify the surroundings of the workshops of this factory. It is unfortunately too true that the surroundings of most of the existing factories and workshops in India and even elsewhere abroad are proverbially humdrum places of work, where even in modern times the main attention and emphasis is mostly on the factory building and its equipment. In the few cases where some attention is bestowed on improving the outside of the workshops, such improvement stops with providing concrete or similar dustless roads and with possibly a small garden for the main Administrative Office. It has to be admitted that little or no such attention is bestowed on the actual place of work where the worker spends all his time.

Even the best of the factory buildings with the finest equipment installed in it is incomplete if the surroundings are bare and neglected, with only the heat and glare of the concrete roads to relieve the atmosphere. A place where thousands of human beings work has to have a restful and congenial atmosphere. It has to be recognised that apart from the need for providing amenities for the physical well-being of the worker, the satisfying of the aesthetic sense of the human being in the worker is also very essential.

On this Integral Coach Factory, no efforts have been spared to create this atmosphere, restful to the eye and congenial to work in. Extensive lawns with flower beds and gardens have been laid out around the various workshops of the factory. In front of the works Canteen also where the workers take their food and spend their midday recess, a beautiful garden with lawns, pergolas, etc., has been laid out. These extensive lawns and gardens have been laid to suit the lay-out of the various workshops and to fit in with the busy industrial atmosphere of the factory.

These, along with the housing and other amenities provided to the worker, described above, emphasize the attention bestowed on the aspect of welfare of the worker on the physical, as well as the cultural side of this factory. Having built a modern factory with up-to-date workshop structures and the latest equipment, if the Administration did not rest on its oars, but went a further step emphasizing the welfare of the worker, from the commencement, it is because of the full recognition of the fact that "A CONTENTED WORKER IS THE BEST ASSET OF AN INDUSTRIAL UNDERTAKING."

SPECIAL PURPOSE MACHINERY ORDERED FOR THE INTEGRAL COACH FACTORY

MAHENDRA LAL
Works Manager, I.C.F.

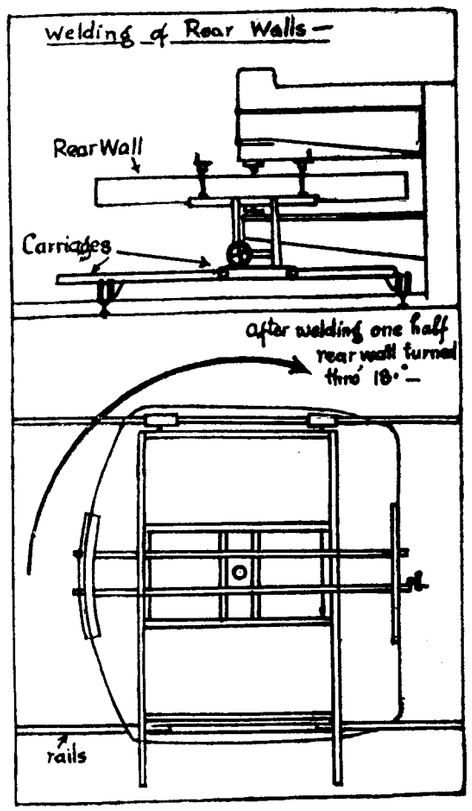
IN a production workshop, it is necessary to reserve certain machines for certain specific jobs in order to save setting up and operational time. Often, when diverse types of operations have to be performed on the same work piece, it becomes economical to design a machine that would perform all the operations without the necessity of having to shift the job from one machine to another. For the first phase of production in the Integral Coach Factory, a total of 596 machines were ordered. Of these, 60 were tooled up for special jobs and of the latter 60, there are 8 important machines which were designed and provided with auxiliary equipment for certain specific operations—which entitles these machines to be called "Special Purpose Machines". In this article, it is proposed to deal with these 8 machines.

Welding Machines

Today the tendency to apply the spot weld connection in the construction of sheet metal coaching stock is becoming more and more noticeable. Due to this, it has become necessary to improve the quality of the spot weld, which has, naturally, resulted in a rather rapid evolution in the design and construction of spot welding machinery. For high quality welding a machine must be suitably designed. In particular, the machine must be coupled with a resistance welding transformer of sufficient power and it should be capable of producing a sufficiently large pressure on the electrodes. It must also be possible to control, with a reasonable degree of accuracy, the time for the flow of current through the electrodes. Messrs. Brown Boveri & Co., Baden, Switzerland have supplied 4 spot welding machines for the Sheet Metal Shop in this factory, which comprise features of design that ensure these prerequisites. These machines which are suitable for spot welding of mild steel upto 3/32" are provided with electronic control for the 'on' and 'off' switching of the primary current and for a precise control of the timing between welds. With this equipment, it is possible to choose the time between the individual welds and to regulate it by means of predetermined delays in the firing of the ignitrons. This enables the operator to have an extremely accurate control of the current and the timing, with the result, that the quality of the weld is improved. There is also an additional advantage that there are no mechanically moving parts and the operation is quite noiseless.

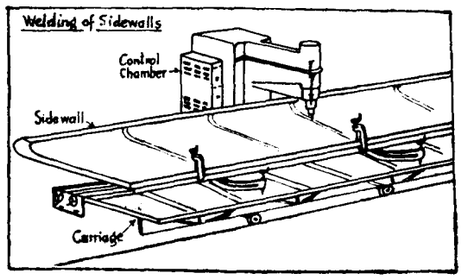
Of the 4 spot welding machines, 2 are to be used for the welding of the front and rear walls of the coach and 2 for the welding of the side walls. All the 4 machines are for single phase connection without series condenser and consist of a machine frame of the welded steel construction, transformer, fan with motor and wind channel, upper and lower arm, welding current conductor, electrode holders, cooling water system, upper and lower air operated heads and a complete air system feeding the air operated heads and the pedal switch.

The 2 machines for the welding of front and rear walls of the coach are equipped with welding devices which have been specially designed for welding the front and rear walls of the coach. These comprise of what appears at first glance to be a rather complicated carriage (See Sketch A). The carriage runs on rails and on its surface can move another carriage in a transverse direction. The latter can be turned through 180°. The front end wall is first fixed on the upper carriage and after welding the upper part, the carriage is turned through 180° to weld the lower part of the end wall. One machine is to be used for the spot welding of the front wall and the other for the rear wall. The welding devices save valuable time that would otherwise have to be wasted in setting up the steel plate, holding them together and welding them. Similarly the 2 machines for the welding of the side walls are provided with a carriage (Sketch B). For the lower part of the side walls, curved rails are mounted on the carriage, so that the side walls



SKETCH 'A'

can be slided along these rails in such a manner that the part of the side walls being welded between the electrodes is always kept horizontal. For the upper part of the side walls, the arrangement is similar, but the rails are horizontal. With this arrangement, it is possible to completely weld the pillars and the stiffners to the side skin with a total number of 6,600 welds in 8 hours. With these 2 machines for the side walls, it is possible that the requirements of the workshop will be met for the first 2—3 years of production. As however the production increases, it will be necessary to



SKETCH 'B'

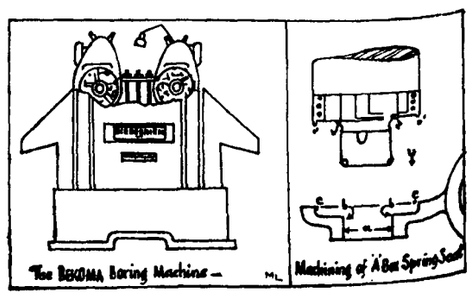
obtain one or more machines of similar type.

In the welding section has also been provided a new butt welding machine to seamweld the sheets together into one sheet, forming one half of the side wall and requiring only the minimum of straightening and cleaning up of the weld. This butt welding machine has been supplied by Messrs. PECO Elektr, Muenchen-Pasing/Germany and is specially suitable for the welding of thin sheets. It is a fully automatic machine suitable for welding plates of 1 to 3 mm thickness and can weld at a time a length of 3,000 mm. On this machine, it is possible to weld the side walls at a rate of 80" per minute during the provisional assembly and at a rate of 40" per minute during the final assembly. The welding current control in this case also is by means of the electronic synchoronous ignitron system.

Special Purpose Boring Machines

In the machining operations of turning, drilling and boring, very often considerable time has to be spent in setting up and transport from one machine to another of a work piece that requires a series of these operations to be performed on it. In view of this two of the important pieces, the axlebox housing and the brake beam, requiring prolonged machining, were selected to be tackled by special purpose machines. Accordingly for the Machine Shop have been provided 2 special purpose boring machines—one double headed boring machine for the boring and facing simultaneously of the two spring seats on the Axle Box Housing, and the other for turning boring and drilling of the Brake Beams.

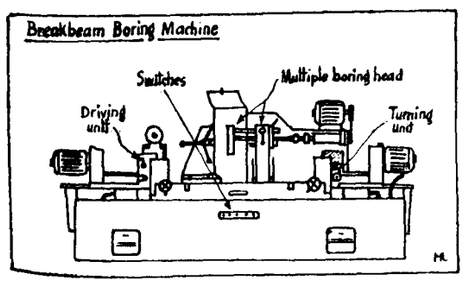
The double headed horizontal boring machine has been supplied by Messrs. Bekoma Boehringer, Coeppingen, Germany. This machine (Sketch C) is provided with 2 Drebomat boring units along with semi-automatic hydraulic operation of the table movement, rapid power traverse, rapid reverse and automatic selection of feed. The boring heads (Sketch C2) are of special interest as each of these is an intricate and ingenious combination of tools designed with one end in view—to save as much time as possible. On this machine, the axle box housing is clamped on the table, with the help of a special clamping attachment and the boring head, performs the complete machining of the portion as shown in sketch C2 in one setting. This is achieved in the following manner : The boring head first drills the small dia. 'a'. Next the tools at 'b' dig into the metal at 'b'. Simultaneously, the tools at 'c' dig into the metal at 'c'. When this



SKETCH. 'C'

is done, the tools at b' start moving out towards c', thus completely machining the portion in between the 2 sets of tools. The entire operation is completed in 20 minutes. On the conventional types of machines, the same work would take approximately 2½ hours.

The special purpose boring machine for the Brake Beams is supplied by Messrs. George Ganss of Stuttgart, Germany, and is designed for the machining of the 3 ends of the Brake Beam triangle in one setting. Sketch D illustrates the machine and the principal tool posts. On either side of the table, there are 2 turning heads in the front and 2 drilling units at the back at right angles to the turning units. Over these is situated in the centre the 4 spindle revolver head for the boring of the centre piece of the Brake Beam. A special fixture had been designed for holding these brake beams. When the machine is switched on, the turning head on either side rush up to the work piece in rapid motion. The change over to the working operation is effected by cams and limit switches which also effect the change over to the rapid return movement. After the turning is finished, the limit switch also effects a cutting out of the turning heads and simultaneously with this cutting out, the drilling units move up in rapid motion from behind. After turning and drilling of the side ends, the revolver head takes over the boring of the centre piece. This is done by the 4 spindle head in 4 steps—boring 24·5 mm, counter boring 34 mm.

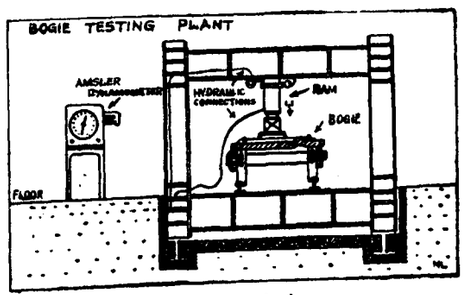


SKETCH 'D'

counter boring 40·8 mm and the final reaming to 41·2 mm or 1·5/8". The feed gear mechanism is an ingenious combination of epicyclic and reduction gearing which coupled with the change over system, comprising of the limit switches, cams and electromagnetic clutches, ensures an extremely efficient and fool-proof operation of the machine. The entire machining of the Brake Beam is done in 10 minutes as against approximately 1 hour required on the conventional type of machinery.

The Axle Copying, Bogie Testing and Grit Blasting Plants

For the rather complicated machining of the heavy axles, a special copying lathe has been obtained from Messrs. George Fischer of Schaffhausen, Switzerland, which is able to machine an axle in 62 minutes. The tool is guided by a template and the turning of the axle is done in 2 settings. The machine has a swing over carriage of 4½", maximum turning length of 100" and can turn axles upto 14" dia. The centres of the template support are so arranged that they can be used either with a template or a prototype. The machine is also suitable for internal copying for which of course different templates are necessary. Another important machine is the Bogie Testing Plant supplied by Messrs. Alfred J. Amsler of Schaffhouse, Switzerland. The testing of the 2 bogies that carry the shell is essential in order to ascertain that the bogies are sturdy enough and are provided with springs that can carry the load of the coach without undue strain. The bogie testing machine has a capacity of 30 tons. The suspension arrangement is illustrated in Sketch E. The machine consists of a hydraulic



SKETCH 'E'

ram of 30 tons capacity and has a stroke of about 400 mm. There is arrangement for balancing the ram comprising of 4 pulleys, suspension cables and limit switches for stopping the ram at the end of the stroke. The load exerted is indicated on an Amsler Pendulum Dynamometer, and all the necessary tubing for connecting the hydraulic rams to the Amsler Pendulum Dynamometer has been provided with the machine. The jack is to be loaded successively in increments of 1 ton on all the 4 load ranges of the Pendulum Dynamometer and the pump of the Dynamometer is used for this purpose. The bogie will be tested first at tare weight and then at the maximum vertical load of 18 tons on each bogie.

In order to ensure that the paints adhere well to the surface of the coach it is necessary to first clean the panelling thoroughly. For this purpose the method of grit blasting whereby a spray of small metallic grit is blasted against the sides of the coach with the help of compressed air, will be employed in this workshop. A special Grit Blasting Plant for grit blasting the coach prior to painting has been manufactured and supplied by M/s. Sommerfield Ltd., London. The plant comprises of a shot blasting room in which about 10′ of the coach can be shot blasted at one time by means of angular metallic grit. The room complete with duct extraction plant of the multiple fabric bag type, totally enclosed with a complete set of duct connections, conveyers, elevators, pressure chambers, hoses etc., and has been designed for simultaneous operation by 6 operators at a time. Control equipment has been supplied for 6 operators, as also protective equipment for 2 operators to work inside the room when required. There is provision for suspension of small components such as the bogie frame if necessary for grit blasting from inside when the external work is not being done. The plant is fed by an air compressor equipment comprising of 2 Broomwade compressors supplying a total of 1,200 c.ft. of free air per minute at a pressure of 60 lbs. per sq. inch. This compressed air is supplied to the 6 pressure chambers at the rate of approximately 200 c.ft. per minute and the grit is released simultaneously, through 6 tungsten carbide nozzles. The complete grit blasting of the coach is done in about 10 hours.

RAILWAY COACHES THROUGH A CENTURY

PROGRESS MADE ON INDIAN RAILWAYS

B. S. SINDHU

B.SC. (Engg.), A.M.I.E. (India), A.M.I. (Loco) E.

Chief Design Engineer, Central Standards Office

MANY changes have taken place in the design, construction, and furnishing of railway carriages since the commencement of rail transport. Advancing technology and changing conceptions of rail travel have combined to produce progressively greater comfort and safety. The process of evolution continues.

While the Indian Railways have already made great strides, revolutionary changes in the standards of comfort may be expected in the near future—as plans for the construction of the all-metal light-weight carriage materialise.

This article attempts to record briefly the history of the railway carriage in India, with pertinent references to parallel developments in the American and European continents.

Early Coaches in England

The earliest railway carriages in England were nothing more than road coaches converted to run on rails, and represented a union between the body of a road coach and the underframe of a tram road wagon. They served well and were entirely in keeping with the tracks over which they ran and the locomotives which hauled them. Progress in carriage designs had quite properly to await improvements in both permanent way construction and motive power, since these were the primary factors upon which the development of the railway carriage was dependent.

The railway carriage of 1832 resembled somewhat a modern high-sided open wagon with vertical swing doors. This carriage was without spring buffers, but the body itself was supported on springs. No or little attempt seems to have been made to make the passengers comfortable. An improved version appeared in 1839 with spring loaded buffers and draft gear and extended wheel base, but in other respects the design was substantially similar to the earlier model. The single plate traverse buffer spring was, strange as it may appear, fitted outside the head stock connected to a beam on which buffers were mounted.

The history of the railway carriage in India is long and varied, but little is known about the early types, particularly those introduced during the first three decades. Unfortunately, hardly any photographs, drawings or

authentic written material concerning these carriages have been preserved. It is, however, certain that they were entirely of teakwood construction closely following the features of carriages in service in England at that time.

Early Indian Coaches

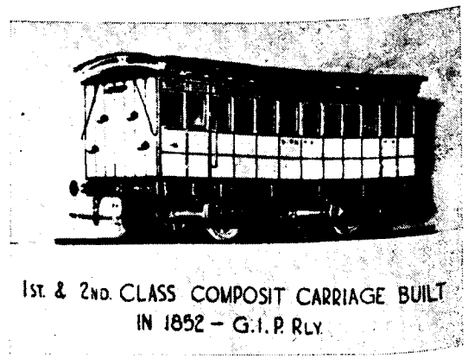
In England, railway construction commenced about 1825 and in India some 25 years later. By that time the railway carriage had undergone much evolution and had improved to a marked degree. Freak coaches had been superseded by improved types representing advanced craftsmanship. The open type carriage had been abandoned and features, such as springs, buffers, glass windows, upholstery, and oil lamps, had been introduced to provide comforts according to the standards of the time.

The first Indian carriage, therefore, embodied the progress that had been made up to that time. Notwithstanding these improvements, the design was still primitive compared with the modern carriage.

The typical third class broad gauge carriage of 1857-1885 had timber underframe and superstructure, four wheels, outward opening doors, longitudinal seats with restricted dimensions for hip, depth and knee-room, and provided seating accommodation for 40 to 60 passengers. The length varied from 20 to 30 feet and the tare from 8 to 15 tons.

There were no lavatories in the compartments of these carriages.

Through passenger traffic between some remote points of the sub-continent appears to have been introduced about 1875. Calcutta had been linked by rail with Delhi, Lahore and Multan ; from Bombay radiated lines to Allahabad, Nagpur and Madras. Carriages on such services often had to traverse over a thousand miles on a single journey through sand storms, torrential rains and a considerable range of temperature and humidity. Without the amenities, such as the carriage of today offers, rail travel in those days must have been an arduous experience.



Old passenger coach built in 1852 for the Indian Railways

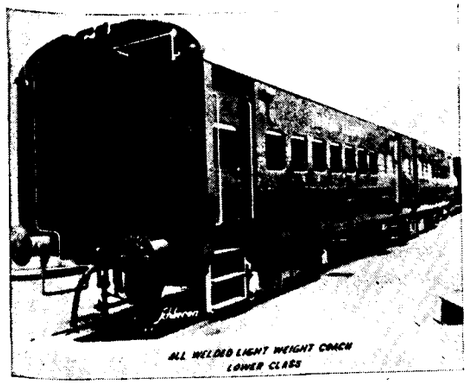
Double-Decker Third Class

About 1863 the Bombay, Baroda and Central India Railway and the East Indian Railway introduced double-decker third class carriages of unusual construction. There were no benches on the upper deck and, due to dimensional limitations, the passengers had to squat on the floor. One double-decker saloon was built for the Governor of Bombay for his gubernatorial tours. These designs which offered a very poor standard of comfort did not survive long.

At the beginning of this century, increasing weight and speed of trains necessitated the introduction of bogie carriages ; inward opening doors were introduced, but the longitudinal seating arrangement was retained. The standard of amenities was improved and a lavatory was attached to each third class compartment.

Carriages with Hand-brake

Not all the carriages in early trains had brakes. The system of providing a hand-brake on the first and the last carriage seems to have continued for



The modern all-steel, light-weight coach, which will be manufactured at I.C.F. from October 2, 1955

many years. The head-guard sat on the roof of the last carriage, looking forward, while the under-guard sat on the roof of the first carriage to indicate to the engine crew to apply the tender brakes in case the train parted as it often did. Both the guards assisted in applying the hand-brakes and trains often overshot the platforms while stopping. The stops were jerky which sometimes caused derailments and injury to passengers. The crushing of a nose or the loss of some teeth were not infrequent phenomena. The hand-brakes remained in vogue for many years, but they were far from satisfactory.

Not till about 1900 was adopted the continuous vacuum brake which utilised atmospheric pressure as source of power and made possible higher speeds and operational safety. This type of brake is extremely flexible in operation both during the application and release, and is automatic in action in the event of parting of the train.

In America and in some other countries, the automatic compressed air brake was introduced in 1875 and has remained standard up to now. Indian Railways have, however, retained the vacuum brake primarily on account of its comparative simplicity and low initial and maintenance costs.

Train Lighting by Candle

Some of the earlier attempts at train lighting seem to have been prompted more for the safety of the passenger than for his comfort. Felonious attacks on passengers in carriages without lights were common in England up to about 1850. At that time, such coaches as were lit at all suffered from the vagaries of oil lamps and candles and the attendant fire hazard. Candles were available on demand to privileged passengers and often passengers carried their own oil lamps and candles.

Gas lighting was adopted in England and America about 1870. This was a step forward even though the fire hazard remained. Gas was carried first in collapsible bags or bellows and later in metal cylinders compressed to high pressures.

By 1900 gas lighting was in wide use in India and this innovation added much to passenger comfort. Gas lighting remained in use till about 1920 although the process of its substitution by electric lighting started some years earlier. Gas lighting suffered from many disadvantages of which the most serious was the fire hazard. Among the other disadvantages may be mentioned the high cost of maintenance at charging stations, upkeep and the inconvenience of ignition.

Electric Lighting introduced

The first train with electric train-lighting employed accumulators or batteries which had to be charged at frequent intervals. Although this innovation met with immediate approval of the travelling public, it fell short of practical requirements. In 1894, an axle driven dynamo was developed which enabled charging of the batteries during running of the train. In India, however, electric lighting did not make much headway till about 1905 when railway workshops embarked

upon an ambitious programme for large-scale production of carriages. By 1920 electric train-lighting had been introduced on almost all the major railway systems in India.

In recent years, fluorescent lights have been used with great success for illumination of railway carriages. Fluorescent tubes give more light and consume less current, also their life is three times more than that of the ordinary lamp.

The electric suburban coaches recently placed in service in the Bombay area are fitted with fluorescent lights throughout which seem to have been well received by the railway patrons.

Coach manufacture in India

The construction of timber body carriages was inaugurated in a few railway workshops in the early sixties of the last century. By 1880 the manufacturing technique had attained a degree of specialization. About 1885 the steel underframe had replaced the wooden framework.

Railway workshops were expanded and adequately equipped with machinery in the early years of this century to accelerate the rate of production of carriages to meet the increasing demand for more and better stock. The first three decades of this century witnessed intense manufacturing activity in railway workshops and indigenous supply industries. Many thousands of carriages were placed on the rails which made possible extension of much needed train services all over the country. The railways owned 6,600 carriages in 1880, and 20,767 in 1951, excluding Pakistan. The trend in passenger traffic was even more phenomenal. In 1888 the railways carried 103 million passengers and in 1950 this figure had risen to 1,290 million.

For fabrication of the body structure, teakwood has been employed since very early times. There are over a hundred varieties of timber species of commercial value found in different parts of the country. Among these, teak has held, and still holds, a place of prime importance. Experience has justified its use for railway carriage construction for nearly a century.

World's most luxurious train

India is rich in experience in the construction of special carriages of various types. Princes have in the past spent large fortunes on their private saloons. The Viceregal train built with the best of materials and workmanship was perhaps the most luxurious train in existence in the world. I have seen nothing like it during my tours in America and Europe.

A bewildering variety of raw and finished materials, both indigenous and imported, are used in the construction of a railway carriage. These may vary from the ordinary ash-trays to axles, from tiny buttons to massive batteries. For a number of materials required for carriage construction India still depends on foreign countries and a sizeable portion of the total cost of a carriage constitutes imports from abroad. Indigenous industries are, however, rapidly growing and we may look forward to self-sufficiency in this regard in the near future.

The present-day cost of a timber body third class bogie carriage is about Rs. 1,25,000 of which the steel underframe and bogies account for about Rs. 25,000 and lighting equipment about Rs. 20,000.

The effective life of a timber body carriage in tropical climates is about 25 years and thereafter timber components tend to show signs of decay and maintenance costs rise sharply.

The steel underframe, however, with proper protective coat of paint can give an efficient service for 50 years or more. Some experts maintain that timber body should be completely renovated or renewed after 20 years

and the life of a coach as a whole extended from 30 to 40 years.

The next stage in the evolution of the passenger carriage was the adoption of composite carriage bodies of timber-cum-steel construction. Steel box brackets, gussets and knees were introduced to join timber members by means of bolts. This produced a somewhat stronger coach, but joints were still susceptible to dry-rot round the bolt holes and there was no appreciable advantage from the standpoint of life.

Steel Coach popular

The next evolutionary stage was the development of the all-steel carriage of integral construction in which the underframe, body sides and the roof shared the load.

In America, timber body construction was discarded about 1908 in favour of an all-steel construction. About this time the all-steel carriage started gaining favour on some railways in Europe. In the twenties of this century, the all-steel carriage had become fairly common on many railways in the world.

Two hundred and fifty all-steel carriages built in England were placed in service in 1925 on the Indian Railways, more in the nature of an experiment than as a general practice. These carriages are still in service, but corrosion has been experienced on the body sheets of thin gauges where there is poor circulation of air and interior surfaces are not accessible for examination and repainting. The modern designs aim at eliminating dead pockets and providing free air space to combat condensation and corrosion that is associated with it.

During World War II, Railway workshops were pressed to produce urgently needed war materials and coach building was virtually at a standstill. Meanwhile, thousands of carriages had completed their normal span of 30 years' life and had become uneconomical to maintain. With the cessation of hostilities Indian Railways were faced with an extreme shortage of carriages. About this time, the Hindustan Aircraft Limited, established during the war to maintain fighters and bombers of the allied air forces, were in difficulties due to lack of work. It was then decided to protect this infant industry of national importance by absorbing the surplus capacity of these works for the production of urgently needed carriages. These works are now regularly producing passenger carriages for railways at a rate of over 150 per year.

Air-conditioned Travel

A small number of air-conditioned carriages built in Indian Railway workshops, using either ice-activated or electro-mechanical systems, were placed on main line services on some important through trains about 20 years ago. Unfortunately, the war intervened and the plans for the extension of air-conditioned services received a setback, and slow economic recovery during the post-war period has delayed progress in this direction.

The Indian Railways are gradually introducing air-conditioned carriages on the main routes. Air-conditioned coaches are now being built in railway workshops on a scale hitherto not attempted.

Air-conditioning is to India what heating is to countries with cold climate. There is no passenger carriage on the continents of Europe and America that is not provided with some kind of heating system. In U.S.A. all new passenger carriages are air-conditioned despite the fact that hot weather lasts in that country only for a few months. Hot weather in India lasts for the best part of the year and in some parts of the country, there are only two seasons, namely, hot and hotter, and yet air-conditioning has not so far assumed its proper role in our life.

Indonesia has recently introduced air-conditioned coaches for third class. This is evidence of the interest this young Republic is taking in the well-being of the common man.

Lightweight Coach Adopted

The annual fuel bill of the Indian Railways is of the tune of Rs. 30 crores and the fuel resources of India are by no means unlimited. The question of weight reduction of locomotives and passenger carriages on a long term basis is, therefore, one of great economic importance and deserves serious study.

The lightweight movement gained considerable momentum in the early thirties and the development of carriages of lightweight designs started simultaneously in Europe and America.

Soon after the close of World War II, the Indian Railways decided to adopt all-metal lightweight construction for passenger carriages with improved amenity standards in third class compartments. In preparing new designs, advantage was taken of the progress that had been made in this field in the more advanced countries and our own experience within all-metal carriages.

One basic shell was designed in collaboration with Swiss carriage building firm which has long experience in the construction of lightweight all-metal carriages, for furnishing the four classes of passenger compartments with a view to achieving production economies and standardization. It took us over one year to complete about 1,000 drawings that were required for the guidance of manufacturers.

The all-metal body of our new carriage constitutes six main units, namely, a roof, two body sides, two body ends, and the underframe which are joined together rigidly to form one integral structure, in which all the members share stresses. These units are produced in jigs to ensure interchangeability.

The conventional third class carriage with timber or steel body weighs about 42 tons on rails. To save even one ton of weight in a carriage had presented many design problems. In the new carriage, however, a reduction of seven tons has been achieved and the tare weight reduced to 35 tons. In a train of 10 bogies, it means 70 tons of less dead weight, or two additional carriages can be hauled for no extra cost in fuel. This saving would have been impossible had we not adopted the skin stressed tubular construction.

Safe and Relaxed Travel

The amenity standards in the new carriage for third class passengers by far surpass those in the older carriages. The lavatories in this class are similar to those in upper classes. The appointments in the lavatory include a mirror, wash-basin in China or stainless steel with spring loaded push cock, flushing type pan of improved design in stainless steel, spring loaded lotah filler cock, and attractive interior finish.

In the compartment, we have provided seats with curved profile to minimise fatigue, 16″ ceiling fans on a liberal scale, balanced window shutters in light alloy, window runners also in light alloy, interior finish in attractive colour scheme and blue night lamps to keep the insects out which are attracted towards ordinary lights. The minimum intensity of lighting has been increased from one to about two foot candles.

In short, the third class carriage that we are now placing in service is expected to meet in full measure the hopes and expectations of our people. This carriage offers safe and relaxed travel, and not the least feature of the progress made is that the Railways are offering so much for so little.

THE I.C.F. STAFF COLONY—AN AERIAL VIEW

EDITED & PUBLISHED BY K. SRINIVASAN, PUBLIC RELATIONS OFFICER, SOUTHERN RAILWAY AT 18-A, MOUNT ROAD, MADRAS-2 AND PRINTED BY V. ANANDA KRISHNA CHETTY, B.A AT HOE & CO. THE 'PREMIER PRESS,' 31 STRINGER'S ST., MADRAS-1